Code of Practice on the Design and Construction of Tower Working Platforms (2021 Edition)

Electrical and Mechanical Services Department

PART NO.		PAGE NO.
0	INTRODUCTION	2
1	SCOPE	4
2	DEFINITIONS	5
3	TECHNICAL REQUIREMENTS	8
	SECTION	
A	STRUCTURAL DESIGN	9
B	PLATFORM	19
C	GENERAL MACHINE REQUIREMENTS, BASE FRAME AND CHASSIS, MAST AND GUIDE, WALL ANCHORAGE,	24
D	BUFFER, OVERRUN, LIFTING EQUIPMENT	30
E	LIFTWAY AND ACCESS GATE	32
F	DRIVING MACHINE FOR RAISING/ LOWERING OF PLATFORM	37
G	DRIVING MACHINE BRAKE FOR PLATFORM	43
H	DEVICE OR MEANS TO PREVENT PLATFORM FROM FALLING	45
I	OVERLOAD AND OVERMOMENT SENSING DEVICE	49
J	ELECTRICAL INSTALLATIONS AND APPLIANCES	51
K	EMERGENCY AND TRANSFER OPERATIONS	62
4	VERIFICATION	65
5	USER INFORMATION	68
6	TYPE EXAMINATION CERTIFICATES	77
ANNEX I	STRUCTURAL CALCULATIONS (INFORMATIVE)	
ANNEX II	REQUIREMENTS FOR ELECTRICAL AND ELECTRONIC ASPECTS OF OVERLOAD DETECTING DEVICES (NORMATIVE)	
ANNEX III	COMPETENT OPERATORS	
ANNEX IV	FIGURES	
ANNEX V	REFERENCES	
INDEX		

PART 0

INTRODUCTION

This Code is established under section 11 of the Builders' Lifts and Tower Working Platforms (Safety) Ordinance ("the Ordinance"), Chapter 470. 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. Figure IV.1 shows one typical layout of a tower working platform of the fixed type with base enclosure and Figure IV.2 shows one typical layout for a tower working platform of the mobile type with the guard 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 operators 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 following:
    - 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 gear.
    - 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 gear.
(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 including an existing building. Special precautions should

be taken when carrying out construction works using flammable materials or liquid on the 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 ground or rails.

If a registered examiner or registered contractor carries out tower working platform work in accordance with the relevant portions of this Code, he/she shall be deemed to have carried out the work to the satisfaction of the Director. Otherwise, he/she shall, before carrying out the work, submit details of the proposed tower working platform work to the Director and obtain his approval in writing for the proposed work.

PART 1

SCOPE

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

The following configurations of tower working platforms are included in the Code:
- the platform is supported on at least one vertical mast,
- the tower working platform may be of the 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 ground or rails,
- the platform is elevated by rack and pinion,
- 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 the Factories and Industrial Undertakings (Suspended Working Platforms) Regulation, Chapter 59AC,
- 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 59I,
- 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 Figure IV.1 and IV.2 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 to 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.

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
A barrier enclosing an area to prevent access of persons.

Guardrail
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.

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.

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 usually refers to the case when the platform is 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 work platform attains a predetermined speed above rated speed, causes the safety gear to be applied.

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 ("RPE")
A person who has been registered under the Engineers Registration Ordinance, Chapter 409.

Safety Gear (also referred to as an overspeed safety device)
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 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. The structural support and concrete foundation should be designed and checked by an RPE in structural or other appropriate disciplines. Figure IV.1 illustrates one typical layout of a tower working platform of the fixed type. Figure IV.2 illustrates one typical layout of a tower working platform of the 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 (assume 80 kg per person),
- w_t - maximum allowable personal tools and equipment carried by each person (40 kg 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 0.1 m from the uppermost inner rail of the guard. The separation distance between persons shall be 0.5 m. Figure IV.3 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 the weight of material shall be calculated as follows:

i. For single-mast tower working platform: (refer to Figure IV.4)

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

where L_m is the greater of L_1 and L_2

ii. For multiple-mast tower working platforms: (refer to Figure IV.5)

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

$M_4 = (w_m \times L_4^2 \times 1.2)/ 8$ (Equation 3)

$M_5 = (w_m \times L_5^2 \times 1.15)/ 2$ (Equation 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 A 2.2.3(b)** and **Section A 2.2.3(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 in Hong Kong - 2019.

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)	12.7	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.

The design wind pressure,

$Q_z = Q_{o,z}\, S_t\, S_\theta$

Where

$Q_{o,z}$ = wind reference pressure at effective height defined in Table 2 (extracted from the Code of Practice on Wind Effects Hong Kong - 2019)

S_t = topography factor (refer to Code of Practice on Wind Effects in Hong Kong - 2019 Section 3.4)

S_θ = wind directionality factor (refer to Code of Practice on Wind Effects in Hong Kong - 2019 Appendix A1)

Table 2:

Effective height Z_e (m)	Wind reference pressure $Q_{o,z}$ (N/m^2)
≤ 2.5	1 590
5	1 770
10	1 980
20	2 210
30	2 360
50	2 560
75	2 730
100	2 860
150	3 050
200	3 200
250	3 310
300	3 410
400	3 570
500	3 700
>500	Seek specialist advice

(c) Erection and dismantling wind pressure

The minimum design wind pressure during erection or dismantling shall be 100 N/m^2 which corresponds to a wind speed of 12.7 m/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 0.7 m^2 (0.4 m average width × 1.75 m height) with the centre of area at 1.0 m above the platform floor, for persons fully exposed; or an area of 0.35 m^2 with the centre of area at 1.45 m above the platform floor, for each person standing behind an imperforated guard. 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 0.5 m and divided by 0.5 m; or
   ii. the number of persons allowed on the platform if less than the number in subsection (i).

   If the number of persons allowed on the platform is greater than that in 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 1.0 m above the platform floor.

2.2.6 Erection and dismantling load

The load for which tower working platform has been designed during erection and dismantling. Erection load may be higher than rated load.

If the handling crane is used during erection and dismantling of the tower working platform, then the crane's mass and the rated load shall together be treated as part of the erection load.

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 Manual force at platform

The minimum value for the manual force at the platform is assumed to be 200 N for each of the first two persons on the platform and 100 N for each additional person. It is assumed that the force is applied at a height of 1.1 m 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.

2.2.9 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:

- Effect of any item which significantly increases 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

2.2.10 Forces from the use of power tools

Where the manufacturer of the tower working platform permits the use of power tools which impose horizontal reaction forces on the work platform which are in excess of those given in Section A 2.2.8 then the manufacturer shall specify the maximum force permitted. It is to be assumed that the force is applied at a minimum height of 1.1 m above the floor of the work platform.

Such forces may be caused by the use of, for example:

- Water jetting equipment;
- Sand or grit blasting equipment;
- Mechanically assisted drilling machine;
- Hammer assisted drill;
- Electrically driven hammer/breaker.

2.2.11 Forces from the use of weather protection screens on the work platform

If the work platform is designed to permit the use of weather protection, in the form of a roof over part of, or the whole of a work platform, then the resulting wind forces shall be considered to act on walls which reach the full height from the work platform floor to the top of the roof. Wind forces shall be calculated according to Section A 2.2.4a) and b). For platform regions protected by such weather screens, the wind forces on persons, equipment and material coming under the protection of these weather screens may be neglected.

The mass of the weather protection screens shall be treated as part of the rated load.

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 structural 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 and aluminium are 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 and aluminium

Load Case	Combination of Loads and Forces	Steel S_y	Aluminium S_y
Tower working platform in service without wind, static	structural loads, rated load, horizontal forces and inaccuracy in setting up	1.5	1.7
Tower working platform in service without wind, dynamic	structural loads, rated load, dynamic forces and inaccuracy in setting up	1.5	1.7
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	1.55

Load Case	Combination of Loads and Forces	Steel S_y	Aluminium S_y
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	1.55
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	1.55
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	1.55
Tower working platform striking the buffer while in service	structural load, rated load and buffer force	1.25	1.4
Tower working platform during action of safety means while in service	structural loads, rated load and action of safety means (c)	1.25	1.4
Tower working platform out of service	structural loads and out of service wind loads	1.25	1.4

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.

(c) To determine the forces produced by an operation of these means, the total sum of all travelling masses shall be multiplied by a factor of 2. A lower factor, but not less than 1.2 may be used if it can be verified by test under all conditions of loading up to 1.5 times the rated load.

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:

All forces causing stabilising moments shall be multiplied by a factor of 1.0.

Table 4:

Overturning Moment Created By	Overturning Factor
Structural loads	1.1
Rated loads	1.2
Wind loads	1.2
Manual forces	1.2

2.5.5 Forces occurring during transfer conditions according to Section A 2.2.2 shall be treated in the same way as specified in Table 4 as appropriate.

2.5.6 Inaccuracies in setting-up according to Section A 2.3.1 shall be taken into account in the stability calculation.

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

2.6 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 an RPE 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 an RPE 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 an RPE 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: PLATFORM

1 BASIC REQUIREMENTS

Every platform shall consist fundamentally of a frame, a floor and guardrails on all sides above the floor. The frame, floor and guardrail 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 IV.6.

1.1 Each platform frame shall have a serial number as a unique identification made by the manufacturer. The serial number is used for identification of the platform frame for non-destructive tests and diagnoses if necessary. The contractor shall provide and inform EMSD of the details of the platform frame identification numbers before the first installation, alteration, replacement, and disposal.

1.2 Suitable non-destructive tests to prove the integrity of the platform shall be conducted at intervals not more than 5 years or according to the manufacturer's recommendation, whichever is shorter.

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 15 mm in diameter.

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

3.3 The platform of a tower working platform of single or multiple mast

configuration shall remain in a horizontal position (within ± 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 not be more than 0.5 m above or below the level of 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 15 mm in diameter. The height of the guardrail shall be not less than 1 000 mm and not more than 1 150 mm 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 600 mm.

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 in 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 600 mm.

3.11 The maximum extension of the auxiliary platform for tower working platforms of the fixed type shall not be more than 1 800 mm as shown in Figure IV.6 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 1 800 mm if it is provided with an overload and overmoment sensing device in additional to the one specified in Section I. 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 being subject to overmoment.

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

4 GUARDING

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

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

4.2 The guardrail shall be constructed to withstand concentrated forces of 300 N for each person allowed on the platform. The forces shall apply outwards in horizontal direction at 500 mm intervals. The top rail of the guardrail shall also be constructed to withstand without permanent deformation a single vertical load of 1.0 kN applied in the least favourable position but not simultaneously with the horizontal load.

4.3 Chains or ropes shall not be used as guards.

4.4 The sides of the primary platform and any auxiliary platform adjacent to the mast shall be protected with guards to a height of at least 2 m to prevent any part of a person being trapped or struck. If perforated guards are used, the size of perforation shall conform to ISO 13857:2019 Table 4.

4.5 Guarding the side erected towards a wall depends on the horizontal distance (gap) between the platform and the wall. The following options shall be provided for use in accordance with Figure 3 and Table 7 in Part 5 of this Code:

1) 1 000 ~ 1 150 mm high guardrail in accordance with Section B 4.1;
2) 700 mm high guardrail (without intermediate rail but with toeboard);
3) 200 mm high toeboard.

4.6 When it is foreseen (e.g. maintenance) that the fixed guard rails will be removed regularly then the fastenings shall remain attached to the guard rail segments or to the platform.

5 PLATFORM GATE

There shall have at least one platform gate for each platform for normal access of operator and workers.

5.1 Each platform gate which forms part of the guardrail 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. Chains or ropes shall not be used as platform gate.

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

5.3 The platform gate shall be provided with a mechanical lock designed in accordance with Section E 4 in the same manner as the access gate.

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 FALL-FROM-HEIGHT HAZARD ON PLATFORM

7.1 Every person on the platform is prohibited from leaning over the guardrail to reach out.

7.2 Every person riding on a tower working platform shall be provided with a safety harness, an individual lifeline and/or individual anchorage point, and fittings; and such safety harness, lifeline, anchorage point and fittings shall be of such a design, so constructed and properly maintained as to prevent serious injury, in the event of a fall, to any person using it;

7.3 The hook of the lanyard of a safety harness shall be anchored directly to an individual designated anchorage point on the working platform. Where the individual anchorage point is provided on the adjacent structure or at distance from the platform, the safety harness shall be anchored via the rope chuck of an individual lifeline attached thereto. No part of the working platform other than the designated anchorage points shall be used for anchorage of the lifeline or lanyard of a safety harness.

7.4 Steps shall be taken to ensure that the tower working platform not be used unless every person carried on it is wearing a safety harness securely connected to an anchorage point on the working platform or adjacent structure.

7.5 The platform shall be provided with suitably placed designated anchorage points of adequate strength. The number of individual anchorage points shall be not less than the maximum number of persons (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 refer 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 C: GENERAL MACHINE REQUIREMENTS, BASE FRAME AND CHASSIS, MAST AND GUIDE, WALL ANCHORAGE

1 GENERAL MACHINE REQUIREMENTS

1.1 The tower working platform and all parts belonging to it shall be calculated in accordance with Section A.

1.2 Tower working platform shall be equipped with a permanently installed device on the work platform to switch off the work platform and secure it against unauthorised use whilst out of service.

Similar devices shall be permanently installed at the chassis of self-propelled tower working platform which isolates all movements of the tower working platform.

Such devices shall be secured by a pad-lock or similar device.

1.3 Trapping and shearing points between the chassis and work platform shall be avoided by providing safe clearances or adequate guarding. See ISO 13854 and ISO 14120. When it is foreseen (e.g. for maintenance) that the fixed guard will be removed regularly then the fastenings shall remain attached to the guard or to the machinery.

If safe clearance or adequate guarding is not possible, then an acoustic warning device shall be fitted to the work platform which at least gives a continuous warning when the work platform is moving within 2.5 m of the chassis.

Trapping, crushing and shearing points need only be considered at those areas within reach of persons on the work platform or standing adjacent to the tower working platform at ground level, or at other points of access.

1.4 Locking pins shall be designed to be mechanically secured against unintentional disengagement and loss, e.g. split pin, locking nut whilst in position. In addition, they shall be provided with means to secure against unintentional loss when out of use e.g. captive chain.

1.5 Where compression springs are used for a safety function they shall be guided with secured ends.

Their design shall be such that if they break then the parts cannot coil into each other.

1.6 The design of all components that have to be handled during erection e.g. mast sections, platform components, erection cranes, shall have their mass assessed against manual handling. Where the permissible mass for normal handling, is exceeded, the manufacturer shall give recommendations in the instruction handbook concerning suitable lifting equipment.

2 BASE FRAME, CHASSIS AND OUTRIGGERS

Tower working platforms can be of the fixed or mobile type. For tower working platform of the 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 the 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.

2.1 Base frame for fixed type

2.1.1 The base frame shall be able to sustain any loading during normal operation, erection, dismantling, emergency lowering/raising and out of service condition. The base frame shall be equipped with fixings for safe and secure attachment of other parts of the construction such as mast and outriggers.

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

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

2.2 Chassis for mobile type

2.2.1 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.

2.2.2 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.

2.2.3 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.

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

2.2.5 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 the fail proof type. After being applied, the means of braking shall not depend on an exhaustible energy source.

2.2.6 Chains shall only shall be used in the 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 shall not be used for transmission.

2.2.7 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.

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

2.2.9 Means shall be provided to prevent instability of the tower working platform when any one of the tyres in the chassis should fail. For example by the provision of foam filled tyres or by giving instructions in the user manual regarding use of outriggers.

2.2.10 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.

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

2.2.12 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.

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

2.2.14 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.

2.2.15 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.

2.3 Outriggers

2.3.1 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 safety gear shall also be considered. Inclination and operation on a gradient permitted by the manufacturer shall also be considered.

2.3.2 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.

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

2.3.4 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.

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

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

2.3.7 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.

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

2.3.9 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 times be carried out by competent workers.

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

2.3.11 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.

3 MAST AND GUIDE

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

3.1 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.

3.2 Guides or masts shall be so designed that they are able to sustain all loads specified in Section A 2.2. 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.

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

3.4 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.

3.5 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.

3.6 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.

3.7 The mast sections shall have serial numbers as a unique identification made by the manufacturer. The serial number is used for identification of the mast sections for non-destructive tests and diagnoses if necessary. The contractor shall provide and inform EMSD of the details of mast section identification numbers before the first installation, alteration, replacement, and disposal.

3.8 Suitable non-destructive tests to prove the integrity of the mast sections shall be conducted at intervals not more than 5 years or according to the manufacturer's recommendation, whichever is shorter.

4 WALL ANCHORAGE

4.1 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.

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

4.3 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 an RPE in structural or other appropriate disciplines.

4.4 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.

4.5 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 an RPE 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.

4.6 The wall anchorages shall provide sufficient torsional rigidity to the mast, which is normally achieved by triangulation of the anchorage members. The wall anchorages shall be designed for manual handling and ease of assembly using hand tools and shall provide a degree of adjustment to accommodate tolerances between the platform mast and the supporting structure.

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

SECTION D: BUFFER, OVERRUN, LIFTING EQUIPMENT

1 BUFFER

1.1 Buffers shall be placed at the bottom limit of travel for the platform.

1.2 The total possible stroke of the buffers shall be at least equal to the 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 1.0 g (where g is the gravitational acceleration which is equal to 9.81 m/s^2).

1.3 If the buffers travel with the work platform they shall strike against a clearly recognizable pedestal.

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 normal operation of the platform shall depend on the return of the buffers to their normal extended position after operation.

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 250 mm.

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 EN 13001 or other relevant international standards.

3.3 The safe working load of each lifting equipment shall not exceed 1 000 kg. 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 E: 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 operator and workers, or working personnel 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 2.0 m. The size of any perforation or opening in the enclosure related to the clearances from adjacent moving parts shall conform to ISO 13857:2019 Table 4. 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 300 N applied normally by rigid square or round flat face of 500 mm^2 at any position and also it shall not sustain an elastic deflection more than 30 mm.

The enclosure shall possess a structural strength such that when a force of 1.0 kN is vertically applied at any point along the top member of the enclosure, the enclosure shall sustain without permanent deformation.

1.1.2 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 E 3.

1.1.3 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 2.0 m. 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.

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

1.1.5 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 the fixed type shall be provided. In the case of tower working platforms of the mobile type, the device shall be at the chassis.

1.1.6 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 500 mm, an access ladder or staircase shall be provided. The steps or rungs shall be not more than 300 mm 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 25 mm deep and shall have a slip-resistant surface. The front of steps or rungs shall be located to give at least 150 mm toe clearance. Hand holds shall be provided to facilitate climbing the access ladder to the platform.

1.1.7 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, guardrail shall be provided to enclose the working area of the platform. The guardrails shall meet the following requirements:

(a) The height of the guardrail shall not be less than 1.1 m with intermediate rails at the middle.
(b) The guardrail shall be constructed to withstand concentrated forces of 300 N at 500 mm intervals acting horizontally at the top rail. The top rail shall be capable of withstanding a single vertical load of 1.0 kN in the least favourable position but not simultaneously with the horizontal load.
(c) A gate shall be provided for access of working personnel to the platform. This gate, which forms part of the guardrail, 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 protected by guardrails 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 1.0 m, a liftway enclosure shall be provided and it shall have a minimum of 2.0 m height or extend to the full length from the access floor to ceiling where this is less than 2.0 m.
(b) If the safety separation is 1.0 m or more, a fixed enclosure to minimum

height of 1.5 m shall be provided.

The size of perforation of the liftway enclosures shall conform to ISO 13857:2019 Table 4 and the strength of liftway enclosure shall have the equivalent strength of the base enclosure.

1.2.2 Provision of guardrails

For wall openings on the building side which are provided with guardrails 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 9 m along the platform;

(b) Guardrails shall be installed or fixed on the building structure. They shall comply with Sections E 1.1.8(a) and (b). Toeboards of at least 200 mm high shall be provided.

(c) Warning notices in Chinese and English with letters and characters as shown in Figure 1 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 50 mm in height and that for English letters and characters shall be not less than 30 mm 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

Figure 1

2 ACCESS ON OTHER LEVEL

The intention of tower working platforms is to provide vertical movement for persons and their equipment and materials to and from a single boarding point. 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 100 mm.

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 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 2.0 m. The width shall not be less than 650 mm.

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 300 N applied normally by rigid square or round flat face of 500 mm^2 at any position and also it shall not sustain an elastic deflection more than 30 mm.

(b) The access gate shall possess structural strength such that when a force of 1.0 kN 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 E 4**. 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 E 3.10** 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 10 mm 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 1.0 kN 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 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 F: 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 gear, 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 F 1.11 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, 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. The fastenings shall remain attached to the guard or to the machinery. The perforated guards shall have openings conforming to ISO 13857:2019.

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. Manual drive systems shall be designed and constructed to prevent rebound (kick-back) if handles are to be used.

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 0.2 m/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 ISO 6336-5 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.

Or

The drive pinion shall be designed according to ISO 6336, regarding tooth-strength, for a minimum of 10^8 load-cycles. The pinion shall be so dimensioned that, based on ISO 6336-5, there shall exist a minimum safety factor of 1.5 for tooth-strength taking into account the actual stress induced in the teeth under the total suspended static load per pinion.

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 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.

Or

The rack shall be made from material having properties matching those of the pinion in terms of wear and shall be designed according to ISO 6336, regarding tooth-strength, for a minimum of 10^4 load-cycles representing static strength.

The rack shall be so dimensioned that based on ISO 6336-5, there shall exist a minimum safety factor of 1.5 for tooth-strength for the actual stress induced in the teeth.

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 coincides with, or within one-third of the module beyond the pitch line of the rack. See Figure IV.7.

2.4.2 Further means shall be provided to ensure that in the event of failure of the means provided in Section F 2.4.1, the pitch circle diameter of the pinion shall never be more than two-thirds of the module beyond the pitch line of the rack. See Figure IV.8.

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 IV.9.

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 IV.10.

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 a 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 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.

SECTION G: DRIVING MACHINE BRAKE FOR PLATFORM

1 The platform shall be provided with a 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 0.2 g and 1.0 g. 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, all the mechanical components of the brake which take part in the-application of the braking action on the drum or disc or drive pinion shall be constructed and installed in such a way that if a failure in one of them occurs sufficient braking shall remain to bring the work platform with rated load to a stop.

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 of not less than IP23 of 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 H: 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 0.5 m/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 0.05 g and 1.0 g 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.
- expiry date
- type examination certificate number

Note: The stopping distance is the distance the platform has moved when the safety gear is triggered until the platform has come to a full stop.

2.2 During erection or dismantling, when workmen carry out lift work on the platform, the safety gear shall be operational at all times.

2.3 Not be dependent on energizing or maintaining an electrical or other auxiliary circuit.

2.4 Be accessible for inspection, maintenance and testing without major dismantling.

2.5 The safety gear shall be designed so that all control circuits for normal operation

will be automatically interrupted by a safety switch before or at the time the safety gear is applied.

2.6 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.

2.7 The overspeed safety device shall be designed such that the braking effect of the safety gear shall increase progressively from the point of tripping of the overspeed governor to the point of bringing the platform to rest.

2.8 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.

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

2.10 Where there is a 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.

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

2.12 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.

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

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

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

2.16 The overspeed governor shall trip at a speed defined by the manufacturer, but in no case shall the work platform exceed the speed stated in section H 1. 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.

2.17 If wire ropes and pulleys are used for overspeed governors

- The rope diameter shall not be less than 8 mm;
- The ratio between the diameters of the ropes and the rope pulleys shall not be less than 30;
- The ratio between the highest pull force which could occur in the rope and the minimum breaking force of the rope shall not be less than 8;
- The minimum generated force shall not be less than 300 N and not less than twice the force necessary to engage the safety gear.

2.18 Overspeed governors shall operate mechanically and shall either be driven by the safety device pinion or by rope.

2.19 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.

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

2.23 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.

2.24 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.

2.25 The safety gear shall be discarded within 5 years after the date of installation or according to the manufacturer's recommendation, whichever is shorter.

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.

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 J, where appropriate, if it is dependent on energising or maintaining of an electrical circuit.

3.7 Each individual drive unit shall be fitted with a mechanical device that automatically prevents the work platform from descending in excess of 0.4 m/s. 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 The system shall detect malfunctions in each drive unit which endanger proper function. These shall at least indicate a loss of mechanical integrity which results in a differential in the current demand between each drive unit, exceeding 25 % of the full load current.

SECTION I: OVERLOAD AND OVERMOMENT SENSING DEVICE

1. The work platform shall be provided with an overload and overmoment detecting and indicating device. For exception see Section I 16.

2. This device shall detect the total load due to persons, equipment and materials on the work platform. It shall also detect those moments due to these loads that are likely to lead to overturning or failure of the work platform. This device shall at least detect:
   - Bending and torque moments on cantilevered main platforms;
   - Bending and torque moments on the central part of simply supported main platforms;
   - Bending moment on the mast.

3. Overload/overmoment detection device shall be carried out at least whilst the work platform is stationary.

4. The overload/overmoment detector shall be consistent with the rated loads and their location shown or described on the rated load chart(s) for the work platform.

5. The load and moment detection and indication shall function -

   a) Automatically for the different possible platform configurations; or

   b) If automatic detection and indication are not possible for different configurations, then a work platform configuration selector shall be provided which allows a clear classification of the chosen setting in comparison with actual work platform configuration. This can be done by either:

      1) A clear sign of the respective platform configuration; or

      2) A code at each setting. In this case a clear reference shall be given to the explanation of the code on a separate code or configuration sign.

6. The number of possible selections permitting use of the work platform shall not exceed the number of configurations for the work platform.

7. The selector shall be so situated or protected so as to be inaccessible to unauthorised persons.

8. The overload/moment detector shall be triggered before reaching a load/moment of 1.1 x rated load/moment and once triggered shall continuously isolate the controls concerned until the overload/moment has been removed.

9. The design and installation of overload/moment detectors and indicators shall take into account the need to test the work platform with overloads without

dismantling and without affecting the performance of the detector or indicator.

10. The overload/moment indicator shall continuously, visually and audibly, warn the operator and other persons in the vicinity of the work platform when the overload/moment detector is activated.

11. No provision shall be made for the user to cancel the warning.

12. Visual warnings shall be positioned to be in full view of persons on the work platform.

13. The overload/moment detector and indicator shall be arranged so that their operation (but not necessarily their accuracy) can be checked without applying loads to the work platform.

14. The overload/moment detector and indicator shall comply with the following:

    1) Compatible with the designed use of the tower working platform.
    2) Systems shall enable periodic functional checks to be carried out to verify that all functions are operating correctly.
    3) If interruption of the power occurs, all data and calibration of the indicators shall be retained.
    4) Limiting and indicating device systems shall fail to a safe condition, in which any fault results in a shutdown of the control circuits for normal operation.

15. The electrical and electronic requirements for overload detection devices are given in Annex II.

16. The devices according to Section I 1 to 15 are not required if the following demands are met:

    All design calculations shall be based on the loads w_p, W_m and w_t that are related to the rated load 'W' in Section A 2.2.3 increased by a further factor f as a function of 'W' according to Figure 2.

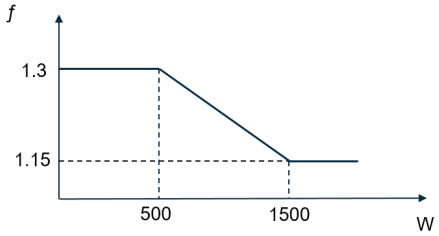


Figure 2

Brakes and safety devices/means shall be calculated with the same loads as mentioned in the first paragraph.

For stability calculations the increased loads shall be considered in case they give overturning moments.

SECTION J: 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 J 1.2.2 (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; and
   viii. non-closing of a contact.

(b) The non-opening of a contact in **Section J 1.2.2(a)vii** needs not be considered in the case of safety contacts conforming to **Section J 1.2.6**.

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 failure of a phase for the supply to the directional control device, 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 G 4**. 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 J 1.2.5 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

The operation of a safety switch shall be by positive separation of the contacts, even if the contacts have welded together. Safety switches shall comply with Section J1.2.6.

Table 5: Conditions for use of electric safety devices

Section	Devices checked	Switch	Category of control system according to ISO 13849-1
B 9.6	Separation distance switch	sc	1
H 2.5	Operation of overspeed safety devices	sc	1
J 2.1.1	Terminal stopping switch	ssr	B
J 2.1.2	Final limit switch	sc	1
Abbreviations: ssr = safety switch, self-resetting sc = safety switch in a safety circuit			

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 K 1.2.2 (b) and shall be provided for a rated insulation voltage of 250 V minimum.

The safety contacts shall belong to the categories as defined in 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 3.0 mm, the creeping distances at 4.0 mm and the distances for the breaking contacts at least 4.0 mm after separation.

In case of multiple breaks, the distance after separation between the contacts shall be at least 2.0 mm. Abrasion of conductive material shall not lead to short circuiting of contacts.

1.2.7 Safety circuits

The control system shall comply with category 1 of ISO 13849-1 unless otherwise stated in Table 6. This includes any control system using electrical or hydraulic power.

In redundancy-type circuits and diversity-type circuits measures shall be taken to limit as far as possible 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 J 3.

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.

1.3 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 the mobile type or outside the base enclosure for tower working platforms of the 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 J 1.4.1.

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 and 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.

1.4.10 Precautions shall be taken to ensure the free and safe movement of any trailing cable throughout the full range of travel of the work platform. For example, by making the cable follow the mast by the use of guides or the use of automatic cable reeling drums.

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 J3) shall belong to the following categories defined in 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 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 J 1.5.1 and for the relay contactors referred to in Section J 1.5.2, it may be assumed in the measures taken to comply with Section J 1.2.2, 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 J 1.5.2** are used as relay in a safety circuit, the assumption of **Section J 1.5.3** 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 J 1.2.2(a)v)** can be disregarded.

(c) Devices (if any) connected after electric safety devices shall meet the requirements of **Section J 1.2.6(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 J 1.5.1, J 1.5.2** and **J 1.5.4(a)** and which themselves fulfil the requirements of EN 60947-5-1, EN 60947-4-1, or other relevant international standards.

1.6 Control circuit

1.6.1 The voltage of the tower working platform control and operating circuits shall be not exceeded 130 V 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 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 6 below:

Table 6:

Terminal stopping switch	top	yes
	bottom	yes
Final limit switch	top	yes
	bottom	yes

2.1.1 Terminal stopping switches

Terminal stopping 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 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, further upward movement of the tower working platform shall be prevented but downward movement may be permitted 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 Stopping devices

The stopping devices shall consist of electric safety devices in conformity with Section J 1.2.5. 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.

2.5 Operation of safety gear

The switch shall conform to Section H 2.5.

3 STOPPING THE MACHINE

3.1 The stopping of the machine by means of an electric safety device in conformity with Section J 1.2.5 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 Code. 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 K: 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 400 N.

(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 K 2(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 III.)

(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 G 4.

(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 gear, the emergency lowering/raising speed shall be automatically controlled by a speed controlling device to not more than 0.3 m/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 0.3 m/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

VERIFICATION

1 DESIGN CHECK

The design check shall verify that the tower working platform is designed in accordance with this Code. It will include inter alia the check of the following documents:

a) Drawings containing the main dimensions of the tower working platform;
b) Description of the tower working platform with necessary information about its capabilities;
c) Information about the materials used;
d) Diagrams of the electrical, hydraulic and pneumatic circuits;
e) Operating instructions.

The above documents shall give all necessary information to enable

- The stability calculations to be checked (see Section A 2.5.4 to 2.5.6)
- The structural calculations to be checked (see Annex I)

2 PRACTICAL TESTS

Practical tests shall be made to verify that

- The tower working platform is stable;
- The tower working platform is structurally sound;
- All functions work correctly and safely.

These tests shall be made:

a) In the case of a tower working platform without wall anchorage, with the mast erected to its maximum freestanding height;

b) In the case of a tower working platform with wall anchorage, with at least two anchorages in position at their maximum permitted spacings with maximum permitted top overhang.

Tower working platforms which are capable of operating in both conditions with or without wall anchorages shall be tested in both configurations.

2.1 Stability tests

The tower working platform shall be set up on the maximum allowable inclination of the chassis defined by the manufacturer plus 0.5° with outriggers

(if fitted) used as specified by the manufacturer. Test loads shall be applied to represent all the most unfavourable load and force combinations specified in Section A 2.5.4 to 2.5.6.

The test may be carried out on level ground if the test loads are recalculated to include the effects of the maximum allowable inclination of the chassis defined by the manufacturer plus 0.5°.

The test loads may be applied at any suitable strong point, if necessary, to avoid overstressing any part of the tower working platform.

The test is to be repeated in all the most unfavourable extended and/or retracted positions.

The untied tower working platform is stable if it can come to a stationary condition without turning over while supporting the test load and force combination(s).

2.2 Braking test of the chassis

All tower working platforms fitted with wheeled chassis shall be subjected to a brake test with the unloaded platform in the worst transfer condition. The brake must be able to stop and hold the tower working platform in the worst transfer condition. Application of the brake must not induce instability.

2.3 Overload test

The test load shall be 125 % of the rated load. All movements with the test loads shall be carried out at accelerations and decelerations appropriate with safe control of the load.

When, due to the various combinations of loads or outreaches of a tower working platform, tests with different test loads are necessary, all movements shall be carried out with all test loads except where the most unfavourable conditions can be sufficiently simulated by one performance test.

During the overload test the test load shall be put into each position which creates maximum stress in any load carrying part of the tower working platform.

During the overload test the brakes shall be capable of stopping and sustaining the test load(s). After removing the test load(s) the tower working platform shall show no permanent deformation.

The overload/moment device, if provided, shall be checked for compliance with Section I 3 to 14.

2.4 Functional tests

2.4.1 General

Functional tests shall demonstrate that

- The tower working platform can operate smoothly for all motions whilst carrying the rated load at the rated speeds;
- All safety devices work correctly;
- Maximum permitted speeds are not substantially exceeded.

2.4.2 Test of the systems to prevent the work platform from falling with overspeed according to Section H 2 (safety gear)

Functional tests of the overspeed safety device shall be carried out with the platform carrying 1.1 × the rated load. The work platform shall be allowed to overspeed to the governor tripping speed in order to determine that:

a) The overspeed device operates as specified by the designer, and
b) The safety gear is capable of arresting the motion of the work platform without the assistance of motor brakes and is within the designer's quoted stopping distance.

2.4.3 Test of the systems to prevent the work platform from falling with overspeed according to Section H 3

Functional tests of the independent drive units shall be carried out with the platform carrying 1.1 × the rated load. It shall be determined that:

a) The work platform can be stopped and sustained from rated speed by each of the drive units in turn by intentional release of the motorbrake of each one of the drive units in turn during the test;
b) The platform can be stopped and sustained from rated speed by intentional activation of the safety system according to Section H 3.8;
c) In each case, the stopping distance is within the designer's quoted specification.

2.4.4 Test of the means for emergency lowering (and raising) of the work platform

a) For work platforms equipped with safety gear according to Section H 1(a) check that the controls comply with Section K 2 and that the work platform speed with 1.1 × rated load can be controlled according to the user instruction. Whilst lowering, permit the speed to increase further to the point where the safety gear operates.
b) For work platforms equipped with means according to Section H 1(b) check that the controls comply with Section K 2 and that the lowering (and raising, if applicable) speed does not exceed 0.3 m/s with 1.1 × rated load on the work platform.

PART 5

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, erection and dismantling 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
- details of wire rope
- 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 Operation instructions

These shall include the following:

- Operating procedures including information on safe distances such as the clearance to power cables and other overhead structures and between the platform and the building;
- Emergency procedures including the operation of safety devices, resetting by a competent person and action to be taken in case of power loss, including the safe use of the means for emergency lowering. This must include clear instructions regarding the safe lowering distance increments and any rest periods needed in order to avoid the overheating of brake linings;
- That travelling controls cannot be operated with any other movement unless the tower working platform is in transfer condition;
- The use of relevant personal protective equipment such as hard hats, protective shoes, eye protection, safety harness.

2.4 Operating personnel requirements

The instruction handbook shall state to the user the minimum requirements for the abilities of operating personnel.

2.5 Operating procedure requirements

These shall include the following:

- Each day before the tower working platform is taken into use, the user

shall check the operating devices, brakes and emergency stops. The condition of all trailing cables, travel limit switches, guardrails, structural connecting mast ties, cables and information plates shall also be checked;

- Keep the work platform clean from waste, building materials and of debris, etc.;
- Before any work is commenced, the operator shall visually check the outriggers and any timber or other packing on the ground shall be visually checked to ensure that it is in good order;
- Ensure that tools and other objects do not project outside the perimeter of the tower working platform;
- During the work the operator shall carefully follow the operation instructions;
- At the end of the work period the platform shall be brought into the "out of service" position and it shall be isolated to prevent unauthorised operation;
- In the event of a fault with the tower working platform, which can jeopardise safety, the operator shall immediately immobilise the tower working platform and notify a responsible person;
- In case of emergency the operator must follow the relevant instruction in the user manual.

2.6 Maintenance instructions

These shall include the following:

- Schedule of regular maintenance together with required adjustments and tolerances and the required intervals and personnel skill requirements;
- Information on precautions to be taken against hazards during maintenance;
- Regular replacement of specific parts including discard criteria;
- Information on the replacement of safety critical parts by identical components;
- Information into how to seal adjustable components which have safety related functions;
- Troubleshooting information;
- Electrical/Hydraulic/Pneumatic schematic diagrams;
- Parts lists/diagrams;
- List of maintenance work to be carried out only by specially trained persons together with a definition of that training.

The manufacturer shall stress that regular maintenance shall include visual inspection and necessary functional test and maintenance measures. Special attention shall be given to the inspection of load-bearing parts with attachments, driving and stopping devices, operating and safety devices, racks and pinions etc.

2.7 Periodic examinations and test on tower working platform

The instruction handbook shall state that the frequency and extent of periodic examinations and tests depends on national regulations, manufacturer's requirements, operating conditions and the frequency of use. It is normally not necessary to dismantle parts at periodic examinations, unless there are any doubts in relation to reliability and safety. The removal of covers, the exposure of observation apertures, and bringing the tower working platform to the transport position are not considered to be dismantling.

The instruction handbook shall state the maximum time between periodic examinations and tests. Such examinations and tests shall at least consist of the following:

- A visual examination of the structure with special attention to corrosion and other damage of load bearing parts and welds.
- An examination of the mechanical, hydraulic, pneumatic and electrical systems with special attention to safety devices.

2.8 Instruction for erection and dismantling

These shall include the following:

- Detailed explanation of erection and dismantling procedure with special attention to mast assembly, mast tie system, platform and extension assembly;
- Special hazards which can arise during erection and dismantling, with a description of any additional safety equipment and how this may be used to reduce these hazards. The use of personal protective equipment shall be mentioned in this connection;
- Preparation of the site with special regard to the bearing capacity of the foundation, gantry, asphalt etc.
- Preparation of the site so that under no circumstances can instability occur during transfer of the equipment when using movable chassis;
- If platform travel must be limited due to obstructions in the travel path and the platform therefore does not reach the normal limit switches, additional travel limit devices shall be installed to protect persons and material on the platform or the platform itself from hazardous situations;
- Procedures to be observed when preparing the tower working platform for transport shall be specified;
- If the tower working platform can be loaded on a vehicle for transport or transfer suitable loading procedures must be given;
- The clear gap between the ends of adjacent tower working platform shall be not less than 0.5 m;
- Precautions shall be taken to ensure the free and safe movement of any trailing cable throughout the full range of travel of the work platform. For example, by making the cable follow the mast by the use of guides or the use of automatic cable reeling drums.

Where the platform is erected towards a wall the instructions shall furthermore contain information regarding the required height (h) of guardrails on the work platform depending on the distance (w) between the platform and the wall according to Figure 3 and Table 7. The instructions shall include specific information to the user that it is very important to take into account the local use of the different guarding options in relation to the distance that is locally existing between platform and wall face. Contractors are responsible for any changes to, or removal of, guardrails in accordance with the legislation and possibly the working conditions in force in the member state where the platform is erected.

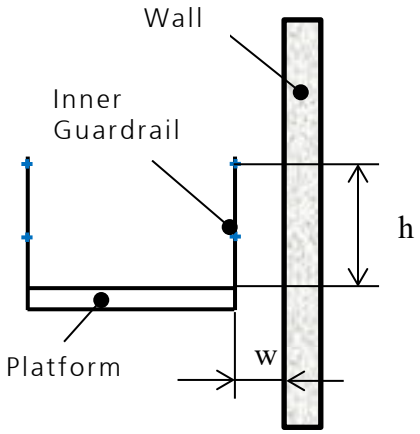


Figure 3

Table 7 - Height of guardrails

w (m)	≤ 0.25	0.25 < w ≤ 0.4	> 0.4
h (m)	0.2 [a]	≥ 0.7 [b]	≥ 1.1 [c]
[a] height of toeboard [b] without intermediate rail but with toeboard [c] with intermediate rail and toeboard according to Section B 4.1			
Explanatory note: The height "h" and the distance "w" has been chosen so as to avoid the risk of falling down between the platform and the wall, avoid ergonomic hazards and also to limit or reduce the crushing or shearing risk between the guardrail and wall obstacles when the platform is moving along the wall.			

2.9 Examinations and tests after major alteration or major repairs to a tower working platform already in use

Examination and test after major alterations or major repairs to tower working platforms already in use shall consist of the following

- Design check
- Practical tests

To an extent corresponding to the type of alteration of repair.

For the purpose of this Code, the details of "major alterations" are stipulated under section 17 of the Ordinance.

2.10 Check list

A list shall be provided in the instruction handbook which contains all safety relevant parts of the tower working platform to be checked after each erection. The result of the checks after each erection and the name and address of person(s) making it shall be recorded in a signed report.

2.11 Safety measures

The person responsible for the construction works has a duty to ensure the health and safety at work of persons working on the tower working platform, and should conduct risk assessment to identify safety and health hazards associated with the works, formulate and implement necessary safety measures, including relevant method statements for implementation of the safety measures and provide effective equipment, including personal protection equipment (PPE) and tools for carrying out the works. The responsible person will need to comply with other relevant ordinances and follow the instructions / orders issued by other Government departments.

3 MARKINGS AND NOTICES

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

3.1 Information, non-varying

- name and address of the manufacturer
- year of manufacturer
- type designation
- serial number or manufacturer number
- rated load and maximum number of persons
- maximum allowable freestanding height (m) in and out of service.
- height of travel
- Transfer, travel speed (m/s)
- Out-/indoor installation
- Limiting windspeed during erection/dismantling
- Maximum allowable windspeed in service/out of service (m/s)
- Hydraulic supply information if an external hydraulic power supply is used
- Pneumatic supply information if an external pneumatic power supply is used
- Electrical supply information if an external electric power supply is used
- All guardrails to be in place at all times except for loading and unloading at the access level.

3.2 Information, varying

- A load diagram showing the rated loads for particular main platform and platform extension configurations and any limitation as to load distribution. This shall be derived from the information presented by the manufacturer.

  The load diagram shall take the form of a durable sign or plate and shall be the responsibility of the user.

  The manufacturer shall provide a means of mounting the load diagram.

- Outrigger arrangements and required ground bearing pressure.

3.3 Mast section identification label
Each individual mast shall be marked serial number.

3.4 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 Figure 4.

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. 只許由合資格操作員操作此工作平台
EVERY PERSON RIDING ON A TOWER WORKING PLATFORM SHALL WEAR A SAFETY HARNESS CONNECTED TO AN ANCHORAGE POINT. 每名於塔式工作平台上的人員須佩戴連接在繫穩點上的全身式安全帶。

Figure 4

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 30 mm in height shall be prominently displayed on the auxiliary platform as shown in Figure 5.

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

Figure 5

3.5 Notice at ground level

A notice in both English and Chinese with letters and characters, as shown in Figure 6, shall not be less than 50 mm 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

Figure 6

For tower working platforms of mobile type, a notice in both English and Chinese with letters and characters not less than 30 mm, as shown in Figure 7, 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

Figure 7

3.6 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
- expiry date
- type examination certificate number

3.7 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

PART 6

TYPE TEST CERTIFICATES

The type test in accordance with this Code of Practice on the Design and Construction of Tower Working Platforms ("CoP(TWP)") should be conducted on a representative unit of the machinery. Type test certificates shall be issued by an accredited testing institution and independent of the manufacturer. The following items shall also be provided with type test:

- driving machine brake
- overspeed governor
- safety gear
- rack and pinion suspension

ANNEX I

STRUCTURAL CALCULATIONS (INFORMATIVE)

1 GENERAL

The calculations should conform to the rules and principles of applied mechanics and strength of materials. If special formulae are used, the sources should be given, if they are generally available. Otherwise the formulae should be developed from first principles, so that their validity can be checked.

2 IN THE ABSENCE OF A STANDARD FOR DESIGN CALCULATION THE FOLLOWING GUIDELINES MAY BE USED FOR THE DESIGN OF STEEL STRUCTURES.

2.1 PERMISSIBLE STRESSES

Symbols	f_y	yield strength [N/mm^2]
	F_u	ultimate strength [N/mm^2]
	E = 210 000	modulus of elasticity [N/mm^2]
	G = E / (2 x (1+ν))	shear modulus [N/mm^2]
	ν = 0.3	Poisson's ratio
	δ_5	elongation at failure on gauge length of 5 times the diameter of the original cross section [%]
	S	Safety factor on yield strength

2.1.1 NON-ALLOY STRUCTURAL STEELS ACCORDING TO EN 10025

Table I.1 – Nominal values of material properties

Type	Yield 1) Strength f_y [N/mm^2]	Ultimate 2) Strength f_u [N/mm^2]
S235 (Fe360)	235	360
S275 (Fe430)	275	430
S355 (Fe510)	355	510
1) Standard value for smaller thickness 2) Minimum		

2.1.2 PERMISSIBLE STRESSES FOR NON-ALLOY STRUCTURAL STEELS

$$\sigma_0 = f_y / S$$

Table I.2 – Permissible stresses for non-alloy structural steels (N/mm²)

Load case	A			B			C		
S	1.5			1.33			1.25		
Steel grade	235	275	355	235	275	355	235	275	355
Basic material and butt weld									
$\sigma_a = \sigma_0$	157	183	237	176	206	266	188	220	284
$\tau_a = \sigma 0/\sqrt{3}$	90	106	137	102	119	154	109	127	164
Fillet weld									
$\sigma_a = \sigma_0$	157	183	237	176	206	266	188	220	284
$\tau_a = \sigma 0/\sqrt{2}$	111	130	167	125	146	188	133	156	201
The indicated permissible stresses are valid up to a thickness of 40 mm. In the case of larger thicknesses the corresponding value of f_y should be taken into consideration.									

When selecting the materials special requirements should be taken into account, e.g.:

- Weldability;
- Use of the appliance in extreme climatic zones

2.1.3 OTHER STEEL GRADES

Depending on the minimum strength fu and the elongation at failure $\delta 5$ the following condition exists:

$510 < f_u \leq 590$ $\quad\quad$ $\delta_5 \times f_u \geq 10{,}800$
$510 < f_u$ $\quad\quad$ $\delta_5 \times f_u \geq 9{,}800$

If these conditions are fulfilled the following applies: $f_{y'} = 0.8 \times f_u$.

If the conditions are not fulfilled, a reduced yield strength $f_{y'}$ should be defined with the factor r, which is applied to the ultimate strength f_u:

$$r = \frac{2600 - f_u(6+\delta_5)}{9600} \qquad 1.28 \leq r \leq 1.44$$

$f_{y'} = f_u / r$

Values of "r" to be used should be not less than 1.28 and not more than 1.44.

Based on the lower value of the yield strength f_y or $f_{y'}$ the permissible stresses should be calculated with the safety factors given for non-alloy structural steels.

2.2 BOLTS

2.2.1 BLACK AND FITTED BOLTS

The permissible stresses are derived from X, which is the lower value of f_y and $0.7 \times f_u$.

$$\sigma_0 = X / S \qquad \tau_a = \sigma_0/\sqrt{2}$$

Table I.3 – Permissible stresses in bolts (N/mm^2)

		Grade	4.6	5.6	6.6	6.8	8.8	10.9
Load case	*S*	f_y	240	300	360	480	640	900
		X	240	300	360	420	560	700
A	1.5	σ_a	160	200	240	280	373	467
		τ_a	113	141	180	198	264	330
B	1.33	σ_a	180	225	270	315	420	525
		τ_a	127	159	191	223	297	371
C	1.25	σ_a	192	240	288	336	448	560
		τ_a	136	170	204	238	317	396

2.2.2 PRELOADED BOLTS

Grade 8.8 and 10.9 only. Grade 12.9 may however be used if the conditions stated below are fulfilled. (See Eurocode 3 – ENV 1993-1-1:1992).

Symbols		
	A_s	tensile stress area of bolt [mm^2]
	F_v	preload [N]
	d	nominal bolt diameter [mm]
	M_t	tightening torque [kNm]

Bolts used once	F_v	=	$0.8 \times f_y \times A_s$
Bolts used several times	F_v	=	$0.7 \times 0.8 \times f_y \times A_s$
Tightening torque	M_t	=	$(0.18 \times d \times F_v) / 1{,}000$

The applied load F in relation to the preload F_v should be:

$F/F_v \leq 0.67$	for load case A
$F/F_v \leq 0.75$	for load case B
$F/F_v \leq 0.8$	for load case C

2.2.3 BEARING PRESSURE

The permissible bearing pressure σ_L depends on the basic material and is valid for bolted connections and also for pins.

Loose connection	$\sigma_L = 1.3 \times \sigma_0$
Low accuracy, fixed connection	$\sigma_L = 1.5 \times \sigma_0$
High accuracy, fixed connection	$\sigma_L = 2.0 \times \sigma_0$

Table I.4 – Permissible bearing pressure (N/mm^2)

Load case	A			B			C		
Steel grade	235	275	355	235	275	355	235	275	355
Loose connection	204	238	308	229	268	346	244	286	369
Low accuracy, fixed connection	235	275	355	264	309	399	282	330	426
High accuracy, fixed connection	313	367	473	352	412	532	376	440	568

2.3 COMBINED STRESSES

Load carrying parts and butt welds:

$$\sigma = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \times \sigma_y + 3 \times \tau^2}$$

Bolts, pin and fillet welds:

$$\sigma = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \times \sigma_y + 2 \times \tau^2}$$

2.4 ELASTIC STABILITY

Crippling

Symbols

λ	slenderness
λ'	specific slenderness
ω	crippling factor
F	compressive force [N]
A	area [cm^2]
M	bending moment [Ncm]
W_c	section modulus; compressive edge [cm^3]
W_t	section modulus; tensile edge [cm^3]
σ_a	permissible stress [N/cm^2]

The crippling factor is defined in the following way:

$$\lambda' = \frac{\lambda}{\pi} \times \sqrt{\frac{f_y}{E}}$$

For $0 < \lambda' \leq 1.195$ $\omega = \frac{1}{(1-0.195\times\lambda'-0.185\times\lambda'^{2.5})}$

For $\lambda' \leq 1.195$ $\omega = 1.465\ \lambda'^2$

ω - factor already calculated for non-alloy structural steels see table I.5 to I.7.

The highest permitted slenderness is $\lambda = 250$.

The following conditions should be fulfilled:

$$\omega \times \frac{F}{A} + 0.9 \times \frac{M}{W_c} \leq \sigma_a$$

$$\omega \times \frac{F}{A} + \frac{300+2\lambda}{1\,000} \times \frac{M}{W_t} \leq \sigma_a$$

Buckling

Symbols	t	thickness of plate [cm]
	b	width of plate [cm]
	k	factor depending on the stress conditions
	σ_e	Euler's buckling stress [N/mm^2]
	σ_{ki}	ideal buckling stress [N/mm^2]
	σ_{vki}	ideal combined buckling stress [N/mm^2]
	σ_{vk}	reduced combined buckling stress [N/mm^2]
	σ_1	higher stress [N/mm^2]
	σ_2	lower stress [N/mm^2]
	$\sigma_{ki} = k_\sigma \times \sigma_e$	
	$\tau_{ki} = k_\tau \times \sigma_e$	
	$\psi = \sigma_1 / \sigma_2$	

The reduced buckling stress σ_{vk} is defined in the following way.

$\sigma_{vki} < 0.7 \times f_y$ $\sigma_{vk} = \sigma_{vki}$

$\sigma_{vki} \geq 0.7 \times f_y$ $\sigma_{vk} = f_y \times \sqrt[4]{\frac{1-0.461}{(\sigma_{vki}/f_y)^{1.4}}}$

The required minimum safety factor v depends on the load combination.

Load case A	$v \geq 1.71 + 0.180 \times (\psi - 1.0)$
Load case B	$v \geq 1.50 + 0.125 \times (\psi - 1.0)$
Load case C	$v \geq 1.33 + 0.075 \times (\psi - 1.0)$

For further information refer to accepted buckling calculation methods.

2.5 LIMIT STATE METHOD

The deflection of a structure should be taken into consideration when calculating the stresses. This is very important when calculating a slender design or using materials with a low modulus of elasticity and can be done by using the theory of the 2nd order. The safety factors against f_y or $f_{y'}$ should be at least the following:

Load case A: $S \geq 1.50$
Load case B: $S \geq 1.33$
Load case C $S \geq 1.25$

2.6 ω – VALUE FOR NON-ALLOY STRUCTURAL STEELS

Table I.5 – ω - values for S 235

	S 235 yield strength f_y = 235 N/mm²									
λ	0	1	2	3	4	5	6	7	8	9
20	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.08
30	1.08	1.08	1.09	1.09	1.10	1.10	1.10	1.11	1.11	1.11
40	1.12	1.12	1.12	1.13	1.14	1.14	1.14	1.15	1.16	1.16
50	1.17	1.17	1.18	1.18	1.19	1.19	1.20	1.21	1.21	1.22
60	1.23	1.23	1.24	1.25	1.26	1.26	1.27	1.28	1.29	1.30
70	1.31	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.39	1.40
80	1.41	1.42	1.43	1.45	1.46	1.47	1.49	1.50	1.52	1.53
90	1.55	1.56	1.58	1.60	1.61	1.63	1.65	1.67	1.69	1.71
100	1.74	1.76	1.78	1.81	1.83	1.86	1.89	1.92	1.95	1.98
110	2.01	2.05	2.08	2.12	2.16	2.20	2.24	2.27	2.31	2.35
120	2.39	2.43	2.47	2.51	2.55	2.60	2.64	2.68	2.72	2.76
130	2.81	2.85	2.89	2.94	2.98	3.03	3.07	3.12	3.16	3.21
140	3.26	3.30	3.35	3.40	3.44	3.49	3.54	3.59	3.64	3.69
150	3.74	3.79	3.84	3.89	3.94	3.99	4.04	4.09	4.15	4.20
160	4.25	4.31	4.36	4.41	4.47	4.52	4.58	4.63	4.69	4.74
170	4.80	4.86	4.91	4.97	5.03	5.09	5.15	5.20	5.26	5.32
180	5.38	5.44	5.50	5.56	5.62	5.69	5.75	5.81	5.87	5.93
190	6.00	6.06	6.12	6.19	6.25	6.32	6.38	6.45	6.51	6.58
200	6.64	6.71	6.78	6.85	6.91	6.98	7.05	7.12	7.19	7.26
210	7.33	7.40	7.47	7.54	7.61	7.68	7.75	7.82	7.89	7.97
220	8.04	8.11	8.19	8.26	8.33	8.41	8.48	8.56	8.63	8.71
230	8.79	8.86	8.94	9.02	9.10	9.17	9.25	9.33	9.41	9.49
240	9.57	9.65	9.73	9.81	9.89	9.97	10.05	10.13	10.22	10.30

Table I.6 – ω - values for S 275

	S 275 yield strength f_y = 275 N/mm²									
λ	0	1	2	3	4	5	6	7	8	9
20	1.05	1.06	1.06	1.06	1.07	1.07	1.07	1.08	1.08	1.08
30	1.09	1.09	1.10	1.10	1.10	1.11	1.11	1.12	1.12	1.13
40	1.13	1.14	1.14	1.15	1.16	1.16	1.16	1.17	1.18	1.18
50	1.19	1.20	1.20	1.21	1.22	1.22	1.23	1.24	1.25	1.25
60	1.26	1.27	1.28	1.29	1.30	1.31	1.32	1.33	1.34	1.35
70	1.36	1.37	1.38	1.40	1.41	1.42	1.44	1.45	1.46	1.48
80	1.49	1.51	1.53	1.54	1.56	1.58	1.60	1.62	1.64	1.66
90	1.68	1.70	1.73	1.75	1.78	1.80	1.83	1.86	1.89	1.92
100	1.95	1.99	2.02	2.06	2.10	2.14	2.18	2.23	2.27	2.31
110	2.35	2.39	2.44	2.48	2.53	2.57	2.62	2.66	2.71	2.75
120	2.80	2.85	2.89	2.94	2.99	3.04	3.09	3.14	3.18	3.23
130	3.29	3.34	3.39	3.44	3.49	3.54	3.60	3.65	3.70	3.76
140	3.81	3.86	3.92	3.97	4.03	4.09	4.14	4.20	4.26	4.32
150	4.37	4.43	4.49	4.55	4.61	4.67	4.73	4.79	4.85	4.91
160	4.98	5.04	5.10	5.16	5.23	5.29	5.36	5.42	5.49	5.55
170	5.62	5.68	5.75	5.82	5.89	5.95	6.02	6.09	6.16	6.23
180	6.30	6.37	6.44	6.51	6.58	6.65	6.72	6.80	6.87	6.94
190	7.02	7.09	7.17	7.24	7.32	7.39	7.47	7.55	7.62	7.70
200	7.78	7.85	7.93	8.01	8.09	8.17	8.25	8.33	8.41	8.49
210	8.57	8.65	8.74	8.82	8.90	8.99	9.07	9.15	9.24	9.32
220	9.41	9.49	9.58	9.67	9.75	9.84	9.93	10.02	10.10	10.19
230	10.28	10.37	10.46	10.55	10.64	10.73	10.83	10.92	11.01	11.10
240	11.20	11.29	11.38	11.48	11.57	11.67	11.76	11.86	11.96	12.05

Table I.7 – ω - values for S 355

	S 355 yield strength f_y = 355 N/mm²									
λ	0	1	2	3	4	5	6	7	8	9
20	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.09	1.10
30	1.10	1.11	1.11	1.12	1.13	1.13	1.14	l.U	1.15	1.15
40	1.16	1.17	1.17	1.19	1.19	1.20	1.20	1.21	1.22	1.23
50	1.24	1.25	1.26	1.26	1.27	1.28	1.30	1.31	1.32	1.33
60	1.34	1.35	1.37	1.38	1.39	1.39	1.41	1.42	L 44	1.47
70	1.49	1.50	1.52	1.54	1.56	1.58	1.60	1.63	1.65	1.67
80	1.70	1.73	1.75	1.78	1.81	1.85	1.88	1.92	1.95	1.99
90	2.03	2.08	2.12	2.17	2.22	2.26	2.31	2.36	2.41	2.46
100	2.51	2.56	2.61	2.66	2.71	2.77	2.82	2.87	2.93	2.98
110	3.04	3.09	3.15	3.20	3.26	3.32	3.38	3.43	3.49	3.55
120	3.61	3.67	3.73	3.80	3.86	3.92	3.98	4.05	4.11	4.18
130	4.24	4.31	4.37	4.44	4.51	4.57	4.64	4.71	4.78	4.85
140	4.92	4.99	5.06	5.13	5.20	5.28	5.35	5.42	5.50	5.57
150	5.65	5.72	5.80	5.87	5.95	6.03	6.11	6.19	6.26	6.34
160	6.42	6.50	6.59	6.67	6.75	6.83	6.91	7.00	7.08	7.17
170	7.25	7.34	7.42	7.51	7.60	7.68	7.77	7.86	7.95	8.04
180	8.13	8.22	8.31	8.40	8.50	8.59	8.68	8.77	8.87	8.96
190	9.06	9.15	9.25	9.35	9.44	9.54	9.64	9.74	9.84	9.94
200	10.05	10.14	10.24	10.34	10.44	10.55	10.65	10.75	10.86	10.96
210	11.07	11.17	11.28	11.38	11.49	11.60	11.71	11.82	11.93	12.03

	S 355 yield strength f_y = 355 N/mm²									
λ	0	1	2	3	4	5	6	7	8	9
220	12.14	12.26	12.37	12.48	12.59	12.70	12.82	12.93	13.04	13.16
230	13.27	13.39	13.51	13.62	13.74	13.86	13.98	14.09	14.21	14.33
240	14.45	14.57	14.70	14.82	14.94	15.06	15.19	15.31	15.43	15.56

2.7 ANALYSIS

2.7.1 GENERAL STRESS ANALYSIS

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

2.7.2 ELASTIC STABILITY ANALYSIS

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

2.7.3 FATIGUE STRESS ANALYSIS

Only load case A has to be considered.

The fatigue stress analysis is the proof against failure by fatigue due to stress fluctuations. The analysis should 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 a 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, 2 cycles per hour).

It is permissible for the rated load to be multiplied by a load spectrum factor 0.5.

For further information refer to accepted fatigue stress analysis methods.

3 IN THE ABSENCE OF A STANDARD FOR DESIGN CALCULATIONS THE FOLLOWING IS APPLICABLE FOR THE DESIGN OF ALUMINIUM STRUCTURES.

3.1 PERMISSIBLE STRESSES

Symbols	f_y	yield strength [N/mm²]
	f_u	ultimate strength [N/mm²]
	E = 70,000	modulus of elasticity [N/mm²]

G = 27,000	shear modulus [N/mm^2]
δ_5	elongation at failure on gauge length of 5 times the diameter of the original cross section [%]
S	safety factor on yield strength
V	safety factor on tensile strength

3.1.1 STANDARDISED STRUCTURAL ALUMINIUM ALLOYS

Table I.8 – Standardised aluminium alloys

Alloy No.	Alloy	Condition
1	AlZn4.5Mg11	F35
2	AlMgSi1	F32
3	AlMgSi1	F28
4	AlMgSi0.5	F22
5	AlMg4.5Mn	G31
6	AlMg4.5Mn	W28
7	AlMg4.5Mn	F27
8	AlMg2Mn0.8	F20
9	AlMg2Mn0.8	F19
10	AlMg3	F18

3.1.2 NOMINAL VALUES OF MATERIAL PROPERTIES

Table I.9 – Standardised aluminium alloys(thickness)

Alloy No.	Nominal thickness t of the element t ≤ 10 mm	
	f_y (N/mm^2)	f_u (N/mm^2)
1	275	350
2	255	315
3	200	275
4	160	215
5	205	310
6	125	275
7	125	275
8	100	200
9	80	180
10	80	180

3.1.3 PERMISSIBLE STRESSES

$\sigma_0 = f_y/S$ respectively f_u/V

$S_A \approx 1.7$; $VA \approx 2.5$; $SB \approx 1.55$; $VB \approx 2.25$; $SC \approx 1.4$; $VC \approx 2.05$;

Table I.10 – Permissible stresses for standardised aluminium alloys in N/mm²

Alloy	Load Case											
	A				B				C			
	Basic Material		Welds		Basic Material		Welds		Basic Material		Welds	
	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a	σ_a	τ_a
1	160	95	75	60	180	110	85	70	200	120	90	80
2	145	90	55	40	165	100	60	45	180	110	65	50
3	115	70	55	40	130	80	60	45	110	90	65	40
4	95	55	35	25	105	60	40	30	115	65	45	30
5	120	70	55	45	135	80	65	40	150	90	70	55
6	70	45	55	45	80	50	65	50	90	55	70	55
7	70	45	55	45	80	50	65	50	90	55	70	55
8	55	35	35	30	65	40	40	35	70	45	45	40
9	45	30	35	30	50	35	40	35	55	40	45	40
10	45	30	35	30	50	35	40	35	55	40	45	40

When selecting the materials, special requirements should be taken into account, e.g.:

- condition after heat treatment and ageing;
- weldability;
- use of the appliance in extreme climatic zones;
- for other material characteristics consult national standards.

3.1.4 COMBINED STRESSES

Load bearing parts and butt welds:

$$\sigma = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \times \sigma_y + 3 \times \tau^2}$$

3.1.5 ELASTIC STABILITY

Aluminium has a very low modulus of elasticity and a low shear modulus (~ 1/3 of the values of steel). Therefore the problems with the elastic stability are much more obvious compared with steel structures. Crippling, buckling, torsion buckling etc should be checked. Very slender constructions should be checked according to the theory of the second order.

Crippling, Omega Method

Symbols

- λ slenderness
- ω crippling factor
- ω - factors already calculated for aluminium (see table I.11 to I.14).

Limit State Method

The deflection of a construction should be taken into consideration when calculating the stresses. This is very important when calculating a slender design or using materials with a low modulus of elasticity e.g. aluminium and can be done by using the theory of the 2nd order. The safety factors against f_y or $f_{y'}$ should be at least the following:

Load case A $S \geq 1.7$
Load case B $S \geq 1.55$
Load case C $S \geq 1.4$

3.2 ω – VALUE FOR ALUMINIUM ALLOYS

The figures are valid for profiles but may also be used for tubes.

Table I.11 – ω - values for aluminium alloys 1 and 2

	Alloy 1 f_y = 275 N/mm²					Alloy 2 f_y = 255 N/mm²				
λ	0	2	4	6	8	0	2	4	6	8
20	1.00	1.01	1.03	1.05	1.07	1.00	1.00	1.02	1.04	1.06
30	1.10	1.12	1.15	1.18	1.21	1.08	1.11	1.14	1.17	1.20
40	1.25	1.29	1.33	1.38	1.43	1.23	1.27	1.31	1.36	1.40
50	1.43	1.60	1.73	1.86	1.99	1.45	1.50	1.60	1.73	1.85
60	2.13	2.28	2.43	2.58	2.74	1.98	2.12	2.25	2.40	2.54
70	2.90	3.07	3.25	3.42	3.61	2.70	2.85	3.01	3.18	3.35
80	3.79	3.98	4.18	4.38	4.59	3.52	3.70	3.88	4.07	4.26
90	4.80	5.02	5.24	5.46	5.69	4.46	4.66	4.86	5.07	5.28
100	5.93	6.17	6.41	6.66	6.91	5.50	5.72	5.95	6.18	6.42
110	7.17	7.43	7.70	7.97	8.25	6.66	6.90	7.15	7.40	7.66
120	8.53	8.82	9.11	9.41	9.71	7.92	8.19	8.46	8.74	9.01

130	10.01	10.32	10.64	10.96	11.28	9.30	9.59	9.88	10.18	10.48
140	11.61	11.95	12.29	12.63	12.98	10.78	11.09	11.41	11.73	12.05
150	13.33	13.69	14.05	14.42	14.79	12.38	12.71	13.05	13.39	13.74
160	15.17	15.55	15.94	16.33	16.72	14.09	14.44	14.80	15.16	15.53
170	17.12	17.53	17.94	18.35	18.77	15.90	16.28	16.66	17.04	17.43
180	19.20	19.63	20.06	20.50	20.94	17.83	18.22	18.63	19.03	19.45
190	21.39	21.84	22.30	22.76	23.23	19.86	20.28	20.71	21.14	21.57
200	23.70	24.18	24.66	25.14	25.63	22.01	22.45	22.90	23.35	23.80

Table I.12 – ω - values for aluminium alloys 3, 4 and 5

	Alloy 3 f_y = 200 N/mm² Alloy 5 f_y = 205 N/mm²					Alloy 4 f_y = 160 N/mm²				
λ	0	2	4	6	8	0	2	4	6	8
20	1.00	1.00	1.02	1.04	1.06	1.00	1.00	1.02	1.04	1.05
30	1.08	1.10	1.13	1.15	1.18	1.08	1.10	1.13	1.15	1.18
40	1.21	1.24	1.28	1.31	1.34	1.20	1.23	1.25	1.27	1.30
50	1.38	1.42	1.47	1.52	1.57	1.33	1.37	1.41	1.45	1.49
60	1.63	1.71	1.82	1.94	2.06	1.53	1.58	1.62	1.66	1.71
70	2.18	2.30	2.43	2.57	2.70	1.76	1.82	1.87	1.96	2.06
80	2.84	2.99	3.14	3.29	3.44	2.17	2.28	2.39	2.50	2.62
90	3.60	3.76	3.93	4.10	4.27	2.74	2.87	2.99	3.12	3.25
100	4.44	4.62	4.81	4.99	5.18	3.39	3.52	3.66	3.80	3.95
110	5.38	5.57	5.78	5.98	6.19	4.10	4.25	4.40	4.56	4.71
120	6.40	6.61	6.83	7.06	7.28	4.88	5.04	5.21	5.38	5.55
130	7.51	7.74	7.98	8.22	8.46	5.72	5.90	6.08	6.26	6.45
140	8.71	8.96	9.22	9.47	9.73	6.64	6.83	7.02	7.22	7.42
150	10.0	10.2	10.5	10.8	11.0	7.62	7.82	8.03	8.24	8.45
160	11.3	11.6	11.9	12.2	12.5	8.67	8.89	9.11	9.33	9.56
170	12.8	13.1	13.4	13.7	14.0	9.79	10.0	10.2	10.4	10.7
180	14.4	14.7	15.0	15.3	15.7	10.9	11.2	11.4	11.7	11.9
190	16.0	16.3	16.7	17.0	17.4	12.2	12.4	12.7	13.0	13.2
200	17.7	18.1	18.4	18.8	19.2	13.5	13.8	14.0	14.3	14.6

Table I.13 – ω - values for aluminium alloys 6 and 7

	Alloy 7 (profiles) f_y = 140 N/mm²					Alloy 6 & 7 (profiles and box sections of sheet metal) f_y = 125 N/mm²				
λ	0	2	4	6	8	0	2	4	6	8
20	1.00	1.00	1.01	1.03	1.05	1.00	1.00	1.01	1.03	1.05
30	1.07	1.09	1.11	1.14	1.16	1.07	1.09	1.11	1.14	1.16
40	1.19	1.21	1.24	1.27	1.30	1.19	1.21	1.24	1.26	1.29
50	1.33	1.35	1.38	1.42	1.45	1.32	1.35	1.38	1.41	1.44
60	1.49	1.53	1.57	1.61	1.65	1.47	1.51	1.55	1.58	1.62

70	1.70	1.75	1.80	1.85	1.90	1.66	1.70	1.75	1.79	1.84
80	1.96	2.01	2.09	2.19	2.29	1.88	1.93	1.98	2.03	2.08
90	2.40	2.51	2.62	2.73	2.85	2.14	2.24	2.34	2.44	2.55
100	2.96	3.08	3.20	3.33	3.46	2.65	2.75	2.87	2.98	3.09
110	3.59	3.72	3.85	3.99	4.13	3.21	3.32	3.44	3.57	3.69
120	4.27	4.41	4.56	4.70	4.85	3.82	3.94	4.07	4.21	4.34
130	5.01	5.18	5.32	5.48	5.64	4.48	4.62	4.76	4.90	5.05
140	5.81	5.97	6.14	6.32	6.49	5.19	5.34	5.50	5.65	5.82
150	6.67	6.85	7.03	7.21	7.40	5.96	6.12	6.28	6.45	6.62
160	7.58	7.78	7.97	8.16	8.36	6.78	6.95	7.13	7.30	7.48
170	8.56	8.77	8.97	9.18	9.39	7.66	7.84	8.02	8.21	8.40
180	9.60	9.81	10.0	10.2	10.4	8.59	8.78	8.97	9.17	9.37
190	10.7	10.9	11.1	11.3	11.6	9.57	9.77	9.97	10.1	10.3
200	11.8	12.0	12.3	12.5	12.8	10.6	10.8	11.0	12.2	11.4

Table I.14 – ω - values for aluminium alloys 8, 9 and 10

	Alloy 8 f_y = 100 N/mm²					Alloy 9 & 10 f_y = 80 N/mm²				
λ	0	2	4	6	8	0	2	4	6	8
20	1.00	1.00	1.01	1.03	1.05	1.00	1.00	1.00	1.02	1.04
30	1.07	1.09	1.11	1.14	1.16	1.06	1.09	1.11	1.14	1.16
40	1.19	1.21	1.24	1.26	1.29	1.18	1.21	1.23	1.26	1.28
50	1.31	1.34	1.37	1.40	1.43	1.31	1.34	1.37	1.40	1.43
60	1.46	1.50	1.53	1.57	1.60	1.46	1.49	1.52	1.56	1.59
70	1.63	1.67	1.71	1.75	1.79	1.62	1.66	1.69	1.73	1.77
80	1.83	1.87	1.91	1.95	2.00	1.80	1.84	1.87	1.91	1.95
90	2.05	2.10	2.15	2.20	2.25	1.99	2.03	2.08	2.12	2.17
100	2.31	2.37	2.42	2.48	2.54	2.21	2.26	2.30	2.35	2.40
110	2.60	2.67	2.75	2.85	2.95	2.45	2.50	2.56	2.61	2.66
120	3.05	3.15	3.25	3.36	3.47	2.72	2.78	2.83	2.89	2.95
130	3.58	3.69	3.80	3.91	4.03	3.01	3.08	3.15	3.21	3.28
140	4.15	4.27	4.39	4.51	4.64	3.35	3.42	3.51	3.61	3.71
150	4.76	4.89	5.02	5.15	5.28	3.81	3.91	4.02	4.12	4.23
160	5.42	5.55	5.69	5.83	5.97	4.33	4.44	4.55	4.67	4.78
170	6.12	6.26	6.44	6.56	6.74	4.93	5.01	5.13	5.24	5.36
180	6.86	7.01	7.16	7.32	7.48	5.49	5.61	5.73	5.86	5.98
190	7.64	7.80	7.96	8.13	8.30	6.11	6.24	6.37	6.50	6.64
200	8.47	8.64	8.81	8.98	9.16	6.77	6.91	7.05	7.18	7.32

ANNEX II

REQUIREMENTS FOR ELECTRICAL AND ELECTRONIC ASPECTS OF OVERLOAD DETECTING DEVICES (NORMATIVE)

1 RELIABILITY

1.1 Electronic components shall be selected on the basis of the most unfavourable load, temperature and tolerance parameters.

1.2 The power consumption of electronic components shall not exceed 66% of the power stated by the manufacturer at an ambient temperature outside the housing of + 60 °C.

1.3 Detecting devices shall be such that their sound operation is not affected by ambient temperatures between –20 °C and +60 °C outside the housings. Within the range of these temperatures, deviation from the set value shall not exceed +3%.

NOTE: The design should take into account that under the circumstances described a higher temperature than +60 °C can be reached inside the housing.

1.4 Electronic detecting devices or their components shall be such that their operation is not affected by:

a) Voltage pulses superimposed on the mains voltage:
Amplitude 1000 V
Pulse duration 50 µs (measured at 50% of the peak value of the voltage pulse)
Rise time 0.2 to 0.5 µs

b) Voltage pulses between mains and earth:
Amplitude 500 V
Pulse duration 100 ns (measured at 50% of the peak value of the voltage pulse)
Rise time 10 ns
Pulse repetition rate 10 Hz.

c) Voltage pulses between inputs or outputs and earth (common mode):
Amplitude 500 V
Pulse duration 100 ns (measured at 50% of the peak value of the voltage pulse)
Pulse repetition rate 10 Hz
Rise time 10 ns.

d) Alternating magnetic fields:
Magnetic field strength 400 A/m
Frequency 50 Hz

e) Electromagnetic fields:
Strength 4 V/m
Frequency 100 kHz to 500 MHz

2 REPORTING DEFECTS

2.1 The occurrence in a detecting device of the defects given below in Annex II 3 shall not cause inability to switch off the tower working platform if the limit value is exceeded.

2.2 The detecting device shall be designed and connected to the electric installation of the tower working platform in such a way that:

1) After the occurrence of one of the defects or actions given under Annex II 3.1 a), the tower working platform installation is automatically switched off and can no longer be started before the defect or interruption is eliminated and

2) After occurrence of one of the defects given under Annex II 3.1 b) and after the tower working platform is switched off, the tower working platform can no longer be started before the defect is eliminated. This requirement does not apply if continued safe operation of the tower working platform is automatically ensured by the detecting device.

NOTE: The provisions under Annex II 2.2 can be met by one of the following measures:

a) Design the circuit of the detecting device in such a way that the prescribed continued switched-off condition of the tower working platform is achieved when a defect has developed;

b) Use a circuit to check the circuits in the detecting device for the presence of a defect. Such a circuit shall be designed and connected in such a way that:

- The relevant test key shall be operated after each tower working platform shut-down before the tower working platform installation can be started and

- The tower working platform installation cannot be started if there is a defect in the test circuit or in the detecting device;

c) Design multiple circuits in the detecting device and incorporate them in a test circuit. The test circuit shall be designed and connected in such a way that the tower working platform is switched off if there is

a defect in the test circuit or one of the parallel circuits of the detecting device;

d) Earth or connect to the frame of a circuit in which relays or solenoid switches are incorporated to ensure the tower working platform is switched off if earth or frame leakage occurs.

3 DEFECTS TO BE ANTICIPATED

3.1 The following defects and actions shall be taken into account on the basis of Annex II 2.1 and 2.2:

a) Break, dislodging or detachment of a cable forming the connection between the individual units of the installation which are mounted in cabinets;

- Interruption or drop in (one of) the supply voltage(s) at any moment;

b) Earth or frame leakage or interruption in the circuit;

- A relay contact or a contactor failing to open or close;
- An auxiliary switch (such as a limit switch, hand operated switch, etc.) failing to open or close;
- Interruption or short-circuit in a signal transmitter (such as a potentiometer, strain gauge bridge or transducer);
- Interrupted connection of or short-circuit in a semiconductor component (such as transistor, diode or optocoupler) or a capacitator;
- Short-circuit or interruption in a resistor;
- A defect causing the output of an integrated circuit to give a positive or negative potential; if several similar circuits are mounted on a semiconductor printed circuit board, allowance shall be made for the same defect occurring simultaneously in all circuits.

NOTE: Requirements for microprocessor applications are under consideration.

3.2 The provisions of Annex II 3.1 do not apply to the following defects:

- Short-circuit between the cores of a cable if the cable satisfies the requirements provided in the relevant national standard(s) and if the rated voltage of the auxiliary circuit does not exceed that of the cable;
- A contact not opening if the relay satisfies the requirements in EN 60947-5-1 and proper protection against influences from the ambience is installed;
- A contactor contact not opening if the contact load does not exceed 25% of its rated power and proper protection against influences from the ambience is installed;
- A control switch not opening which is forced open mechanically if the values specified by the manufacturer for electrical protection, rated

power, method of installation, rate and angle of operation, etc, are taken into account for installation of the contact;

- Bridging of an auxiliary switch by (an) insulation defect(s) (but do apply if this results from earth leakage or moisture, against which a waterproof housing is often a reasonable solution);
- Interruption of or short-circuit between tracks of printed circuits if the printed circuits satisfy the applicable requirements specified in EN 60065.
- Short-circuit in an optocoupler if the creepage paths and air gaps between the connecting wires may be regarded as adequate and a test voltage of 2.8 kV can be sustained between the input and output circuits;
- Interruption or short-circuit in a resistor if the resistor has an insulating paint coating, a reduction of the rate power up to approximately 66% has been applied and short-circuit of the resistor is otherwise also prevented (by, for example, its arrangement).

3.3 If more defects can occur in the detecting device due to a defect in a component, the provisions of Annex II 2.1 and 2.2 are then also applicable.

ANNEX III

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 gear.
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 gear.

2 TRAINING REQUIREMENTS

The training for competent operators shall include the following aspects:

2.1 Basic construction and working principles including:

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

2.2 Operational aspects including:

(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 IV

FIGURES IV.1, IV.2, IV.3, IV.4, IV.5, IV.6, IV.7, IV.8, IV.9 and IV.10

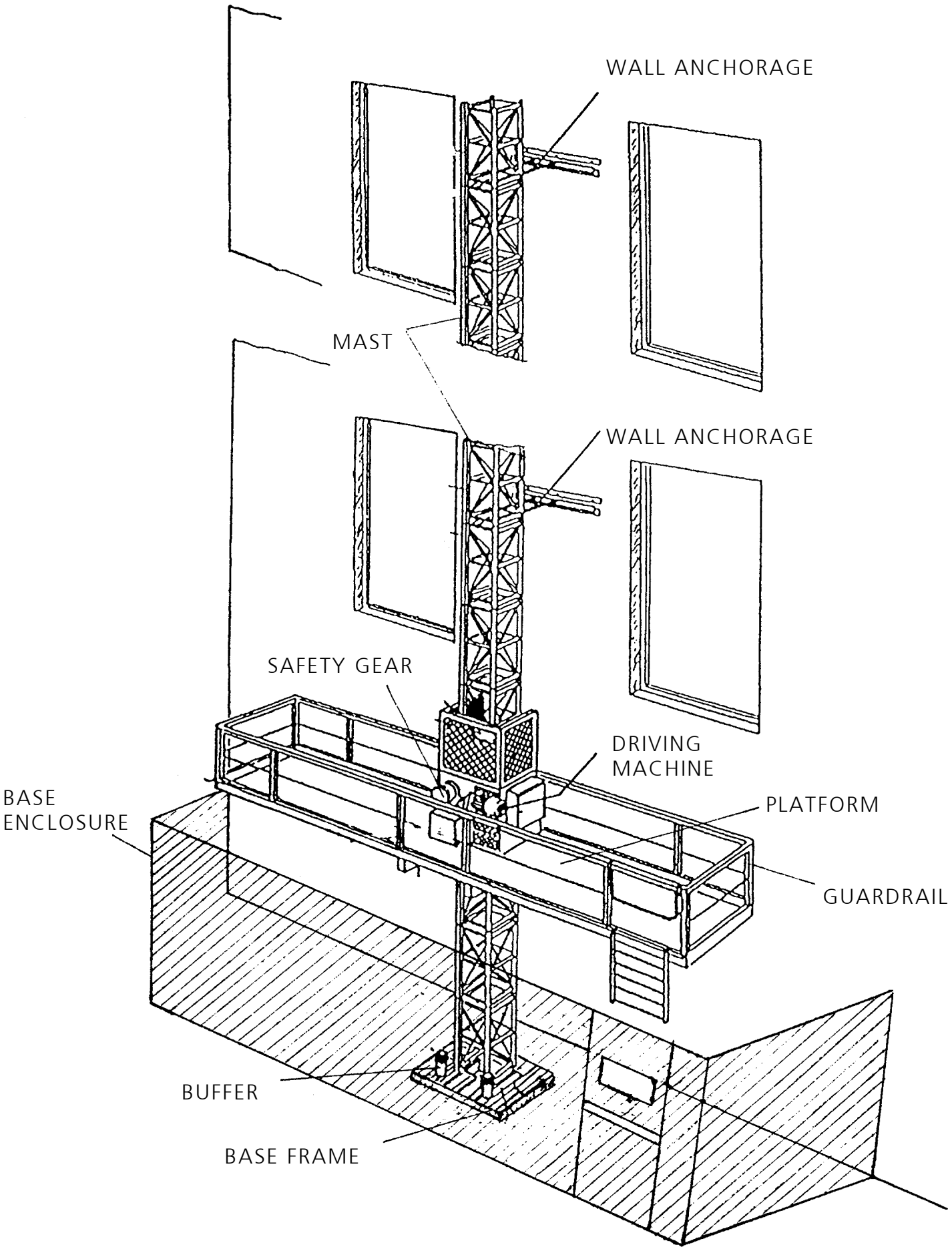


FIGURE IV.1: ONE TYPICAL LAYOUT OF A TOWER WORKING PLATFORM OF FIXED TYPE

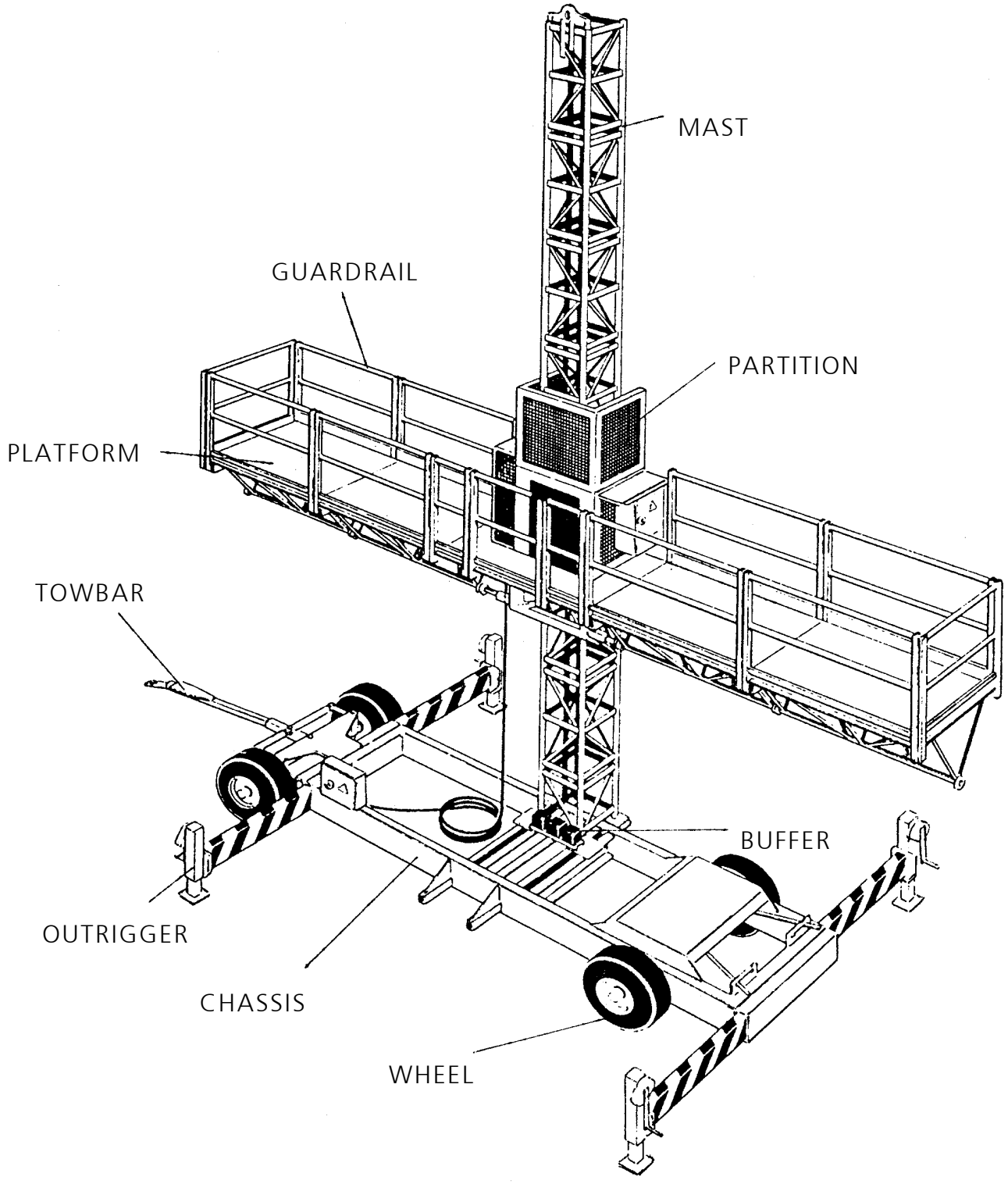
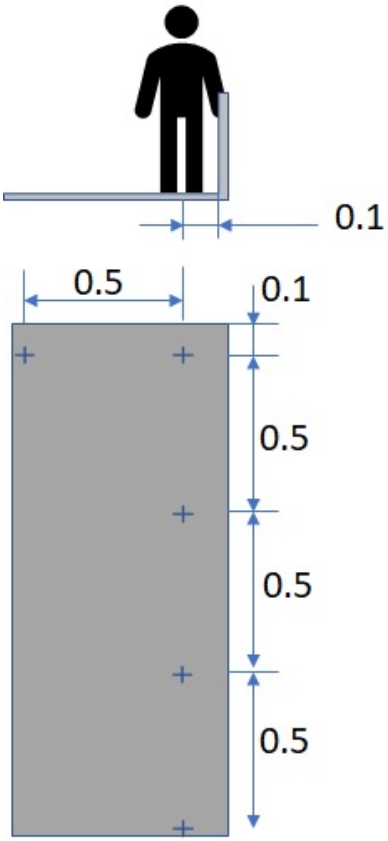


FIGURE IV.2: ONE TYPICAL LAYOUT OF A TOWER WORKING PLATFORM OF MOBILE TYPE



Unit: m

FIGURE IV.3: LOAD DISTRIBUTION ON PLATFORM

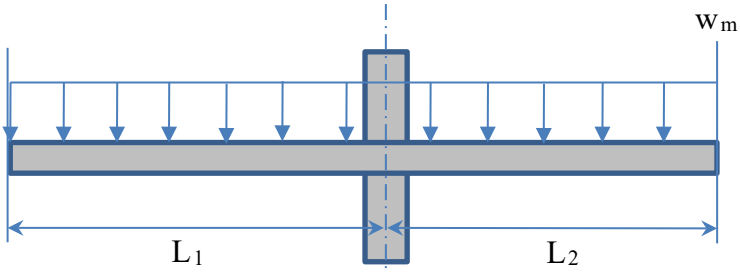


FIGURE IV.4

$BM_{max} = [1.15(L_{max})^2(w_m)] / 2$

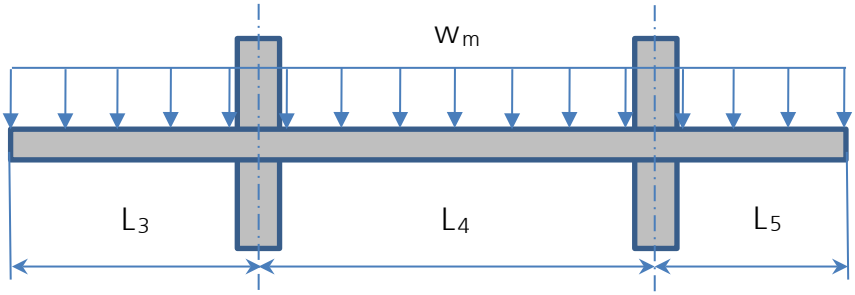
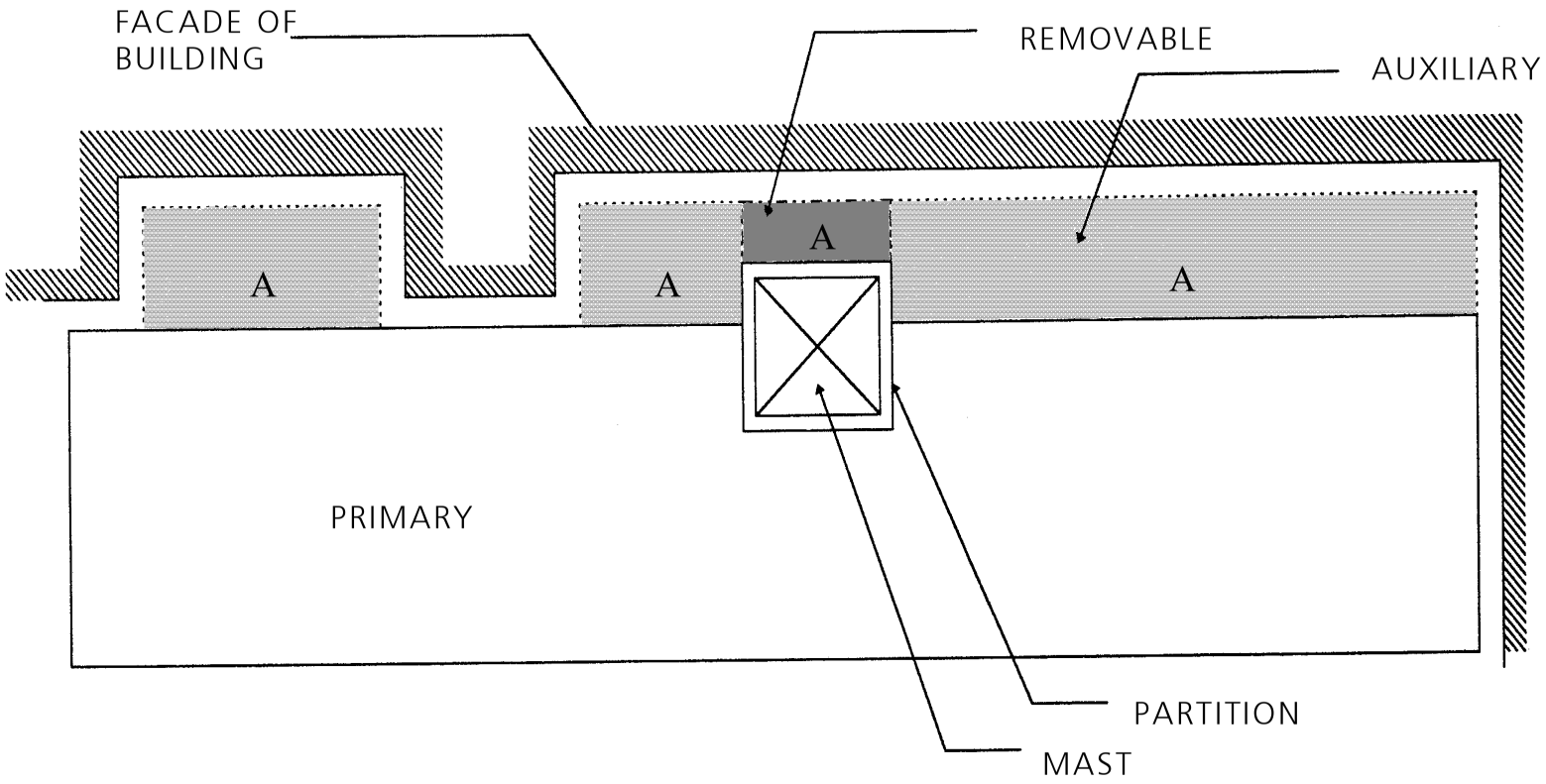


FIGURE IV.5

As cantilever, $BM_x = [1.15(L_x)^2(w_m)] / 2$

As simple support, $BM_x = [1.2(L_x)^2(w_m)] / 8$



A : AUXILIARY PLATFORM

FIGURE IV.6 : LAYOUT OF PLATFORM

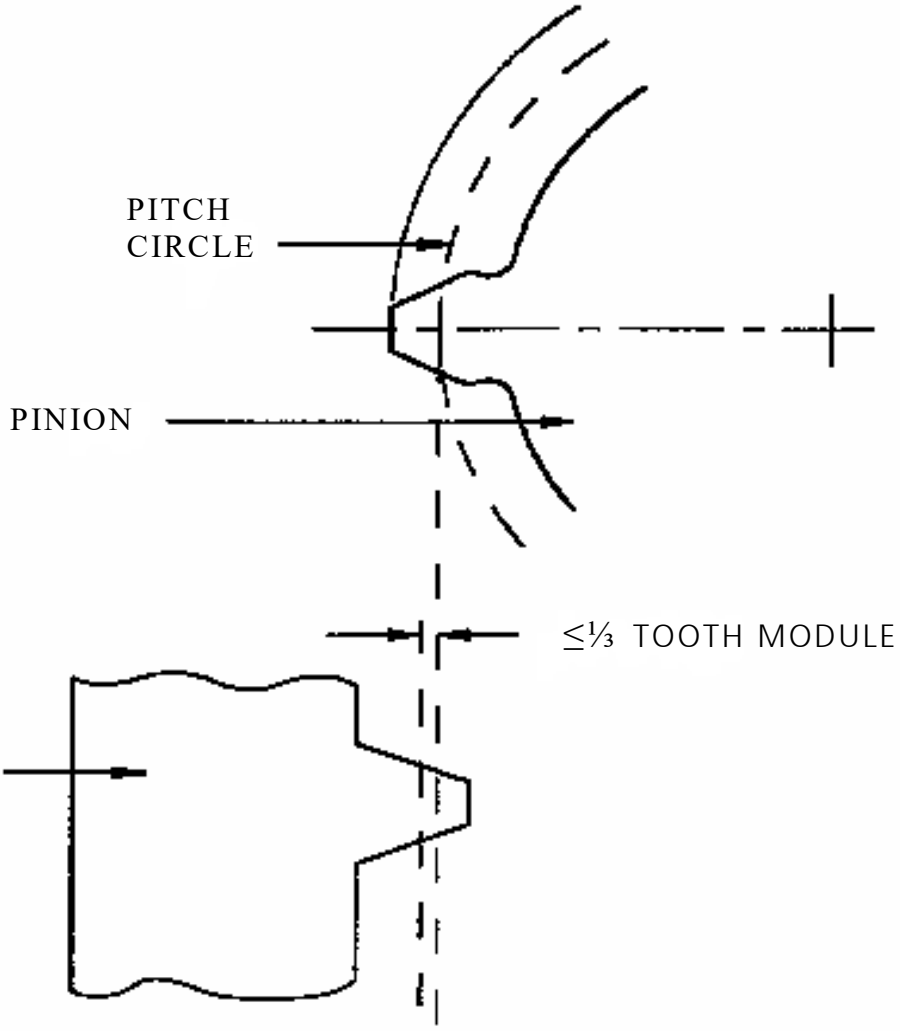


FIGURE IV.7

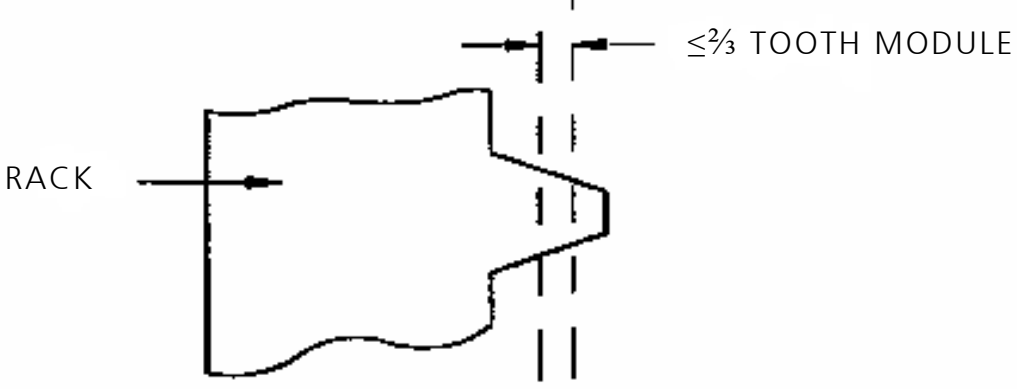


FIGURE IV.8

FIGURES IV.7 & IV.8: SEPARATION OF PINION FROM RACK

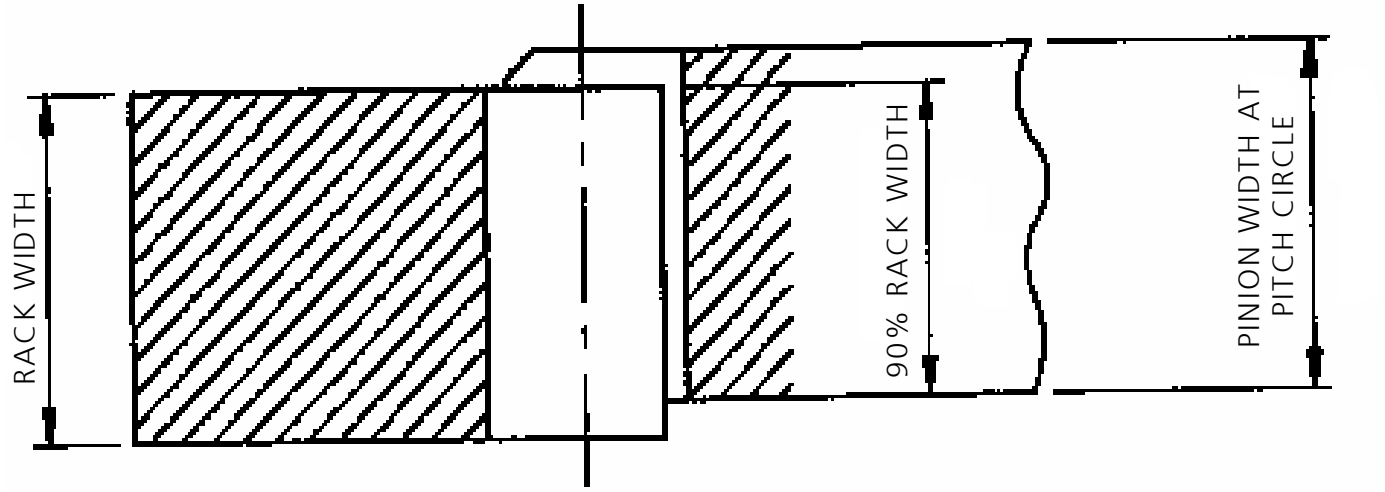


FIGURE IV.9: RACK / PINION ENGAGEMENT

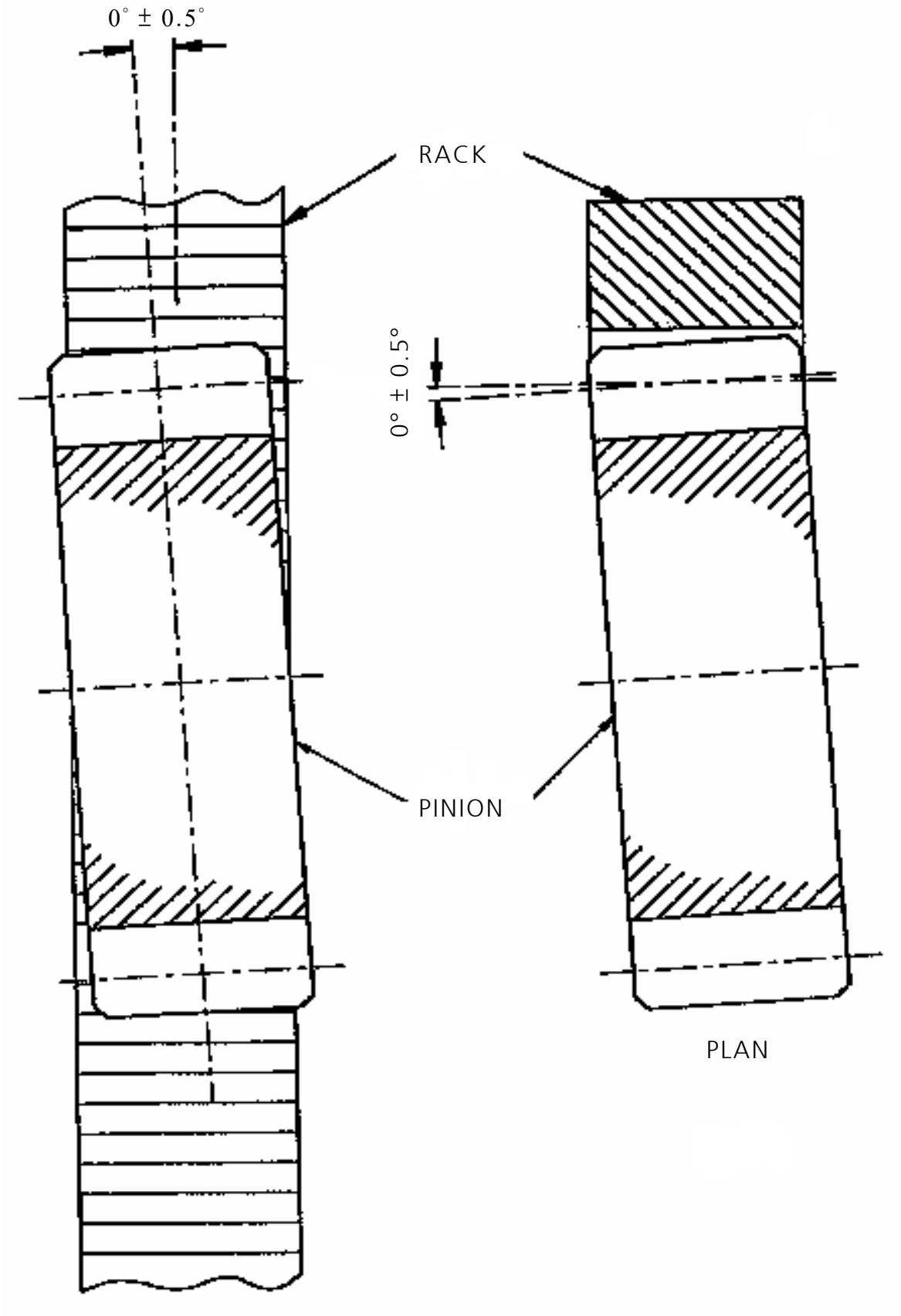


FIGURE IV.10: RACK / PINION ENGAGEMENT

ANNEX V

REFERENCES

(a) Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on Machinery
(b) GB/T 27547-2011 Elevating work platforms – Mast-climbing work platforms
(c) EN 1495:1997 + A2:2009, Lifting platforms – Mast climbing work platforms
(d) GB 23821-2009, Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs
(e) ISO 13857, Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs
(f) ISO 13849-1, Safety of machinery – Safety-related parts of control systems – Part1: General principles for design
(g) Code of Practice on wind effects in Hong Kong - 2019 by Buildings Department
(h) Code of Practice on the Design and Construction of Builders' Lifts issued by EMSD
(i) Code of Practice on the Design and Construction of Lifts and Escalators issued by EMSD
(j) Code of Practice for the Electricity (Wiring) Regulations issued by EMSD
(k) Factories and Industrial Undertakings Ordinance, Chapter 59
    i. Construction Sites (Safety) Regulations, Chapter 59I
    ii. Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations, Chapter 59J
    iii. Factories and Industrial Undertakings (Guarding & Operation of Machinery) Regulations, Chapter 59Q
    iv. Factories and Industrial Undertakings (Suspended Working Platforms) Regulation, Chapter 59AC
    v. Factories and Industrial Undertakings (Electricity) Regulations, Chapter 59W
(j) Electricity Ordinance, Chapter 406
(k) Lifts and Escalators Ordinance, Chapter 618

INDEX

Table	Title	Page No.
1	The minimum value for wind pressure and the corresponding wind speed under in service condition	11
2	Wind reference pressure at effective height	12
3	Factors of safety (Sy) for structural steel and aluminium	15
4	Factors of overturning	17
5	Conditions for use of electric safety devices	52
6	Combinations of travel limit switches	58
7	Height of guardrails located at wall side	72
I.1	Nominal values of material properties	78
I.2	Permissible stresses for non-alloy structural steels	79
I.3	Permissible stresses in bolts	80
I.4	Permissible bearing pressure	81
I.5	ω - values for S 235	83
I.6	ω - values for S 275	84
I.7	ω - values for S 355	84
I.8	Standardised aluminium alloys	86
I.9	Standardised aluminium alloys (thickness)	86
I.10	Permissible stresses for standardised aluminium alloys	87
I.11	ω - values for aluminium alloys 1 and 2	88
I.12	ω - values for aluminium alloys 3, 4 and 5	89
I.13	ω - values for aluminium alloys 6 and 7	89
I.14	ω - values for aluminium alloys 8, 9 and 10	90

Figure	Title	Page No.
1	Warning notices of Platform in motion Do not reach out the building face	34
2	Rated load factor	50
3	Height of guardrails on the work platform	72
4	Notice on primary platform	74
5	Notice on auxiliary platforms	75
6	Notice at ground level	75
7	Notice of mobile type tower working platforms	75
IV.1	One typical layout of a tower working platform of fixed type	98
IV.2	One typical layout of a tower working platform of mobile type	99
IV.3	Load distribution on platform	100
IV.4 & IV.5	Bending moment (M) on the mast(s) and platform due to weight of material	100
IV.6	layout of platform	101
IV.7 & IV.8	Separation of pinion form rack	102
IV.9 & IV.10	Rack / Pinion engagement	103