

**ENGINEERING STANDARD**

**FOR**

**INDUSTRIAL STAIRS, LADDERS, PLATFORMS**

**AND SCAFFOLDS**

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## **0. INTRODUCTION**

This Standard provides basic data on means of escape, operational access and scaffolds. It includes guidance for designers concerned with industrial buildings, plants, installations and constructions on the stability of scaffolds and sets forth a fixed safe means of egress .

It should be borne in mind that helical and spiral stairs are not normally permitted for use as a means of escape where large numbers of persons are involved, and also the Standard does not cover all the innumerable and variety of purposes for which scaffolding is required.

## 1. SCOPE

This Standard covers guidance and minimum requirements for the design, construction and protection of means of escape and use of common scaffolds in steel, normally used in construction, maintenance, repair and demolition works. It also includes temporary installed suspended scaffolds, work cage, cradle or safety chair.

The Standard is divided in two parts and five sections as follows:

### Part I: Stairs, Ladders and Platforms

Section (1)	Industrial Stairs
Section (2)	Ramps
Section (3)	Fixed Ladders
Section (4)	Platforms and Walkways
Section (5)	Design Details for Cages and Wells

### Part II: Scaffolds

## 2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually upon by the Company and the Vendor/Consultant/Contractor.

### Part I:

#### IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-SF-380	"Fire Protection in Buildings"
IPS-E-EL-200	"Lighting and Wiring"

#### BSI (BRITISH STANDARDS INSTITUTION)

BS 5606	"Accuracy in Building"
BS 5395	"Stairs, Ladders and Walkways"
BS 4592	"Industrial Type Metal Flooring, Walkways and Stair Treads"

### Part II:

BS 5973	"Access and Working Scaffolds"
BS 1139	"Spec. for Tubes for Use in Scaffolding"
BS 5974	"Temp. Installed Suspended Scaffolds"
BS 449	"Spec. for the Use of Structural Steel in Building"

## 3. DEFINITIONS AND TERMINOLOGY

Part I (see Figs. 1a and 1b in advance).

### **3.1 Cage**

A barrier, which may be referred to as a cage guard or basket guard, that is an enclosure mounted on the side rails of the fixed ladder or fastened to the structure to enclose the climbing space of the ladder in order to safeguard the employee climbing the ladder.

### **3.2 Clear Width**

The unobstructed walking area throughout the stair's rise, measured as described in Clause 5.2.2.

### **3.3 Companion Way Ladder**

Ladder having a pitch from 65° to 75° inclusive, with steps.

### **3.4 Helical Stair**

A stair describing a helix around a central void .

### **3.5 Ladder**

A device incorporating or employing steps, rungs, or cleats on which a person may step to ascend or descend.

### **3.6 Landing**

Any area such as the ground, roof, or platform that provides access/egress for a fixed ladder.

### **3.7 Nosing**

The front edge of a tread.

### **3.8 Platform**

A landing surface that is used as a working or standing location.

### **3.9 Rail**

The side members jointed at intervals by either rungs or steps.

### **3.10 Ramp**

Surface walk road joining different levels.

### **3.11 Spiral Stair**

A stair describing a helix around a central column.

### **3.12 Stair Way**

The route of travel including the stair and any landings forming part of that route.

**3.13 Toeboard**

A barrier erected along the exposed edges of a platform or landing surface to prevent falls of materials or tools that would create hazards to persons below.

**3.14 Tread**

The horizontal part or upper surface of the step.

**3.15 Walkway**

Lateral access, e.g. from one section of plant or equipment to another.

**3.16 Well (Shaft)**

A walled enclosure around a fixed ladder that provides the person climbing the ladder with the same protection as a cage.

**3.17 Bay**

That section of a platform between any two adjacent suspension points.

**3.18 Bosun's Chair**

A suspended safety chair suitable for one man use.

**3.19 Box Tie**

An assembly of tubes and couplers forming a frame round a part of buildings and industrial installations.

**3.20 Brace**

A tube placed diagonally with respect to the vertical or horizontal members of a scaffold and fixed to them to afford stability.

**3.21 Brick Guard**

A brick or other fender filling the gap between the guardrail and toeboard and something incorporating one or both of these components.

**3.22 Bridle**

A horizontal tube fixed across an opening or parallel to the face of a building to support the inner end of a putlog transom or tie tube.

**3.23 Butting Tube**

A tube which butts up against the facade of a building or other surface to prevent the scaffold moving towards that surface.

**3.24 Castor**

A swiveling wheel secured to the base of a vertical member for the purpose of mobilizing the scaffold.

**3.25 Coupler**

A component used to fix scaffold tubes.

**3.26 Cradle**

That portion of the assembly designed to carry the work people and their equipment.

**3.27 Facade**

Face of a building.

**3.28 Forkhead**

A U-shaped housing for assembly on the end of a tube to accept bearers.

**3.29 Fulcrum Point**

The point of pivoting nearest to the outside edge of the roof rig about which the balancing moments of the roof rig are calculated.

**3.30 Gin Wheel or Block**

A single pulley for fiber ropes attached to a scaffold for raising or lowering materials.

**3.31 Going**

The horizontal distance between the nosings of two consecutive steps of a stair or terrace, measured in a horizontal line.

**3.32 Guy Anchor**

A pin or tube driven into the ground at approximately 45° to the horizontal to provide an anchorage for a rope.

**3.33 Inside Board**

A board placed between the scaffold and the building on extended transoms, or a hop-up bracket.

**3.34 Lashing**

A rope intended for joining two or more objects, such as scaffolding, at the points of intersection.

**3.35 Ledger**

A longitudinal tube normally fixed parallel to the face of a building in the direction of the larger dimensions of the scaffold. It acts as a support for the putlogs and transoms and frequently for the tie tubes and ledger braces and is usually joined to the adjacent vertical tubes.

**3.36 Lift**

The assembly of ledgers and transoms forming each horizontal level of a scaffold.

**3.37 Lip Tie**

An assembly of tubes forming L or J shaped hook round an inside surface of a building.

**3.38 Movable Tie**

A tie which may be temporarily moved for the execution of work.

**3.39 Outrigger**

The cantilevered portion of the rooting or roof trolley from which the cradle is suspended.

**3.40 Putlog Scaffold**

A scaffold which has one line of vertical tubes to support the outside edge of the deck and utilizes the wall being built or the building to support the inside edges.

**3.41 Raker**

An inclined load-bearing tube.

**3.42 Reveal Tie**

The assembly of a reveal tube with wedges or screwed fittings, and pads, if required fixed between opposing faces of an opening in a wall together with the tie tube.

**3.43 Scaffold Board**

A softwood board generally used with similar boards to provide access, working platforms and protective components such as toeboards on a scaffold.

**3.44 Suspended Scaffold**

A scaffold hanging on ropes which is capable of being suspended or raised and lowered.

**3.45 Through Tie**

A tie assembly through a window or other opening in a wall.

**3.46 Toeboard**

An upstand at the edge of a platform, intended to prevent materials or operatives feet from slipping off the platform.

**3.47 Transom**

A tube spanning across ledgers to form the support for boards or units forming the working platform or to connect the outer vertical tubes to the inner vertical tubes.

**4. UNITS**

This Standard is based on International System of Units (SI), except where otherwise specified.

## PART I INDUSTRIAL STAIRS, LADDERS & PLATFORMS

### SECTION (1)

#### 5. INDUSTRIAL STAIRS

##### 5.1 General

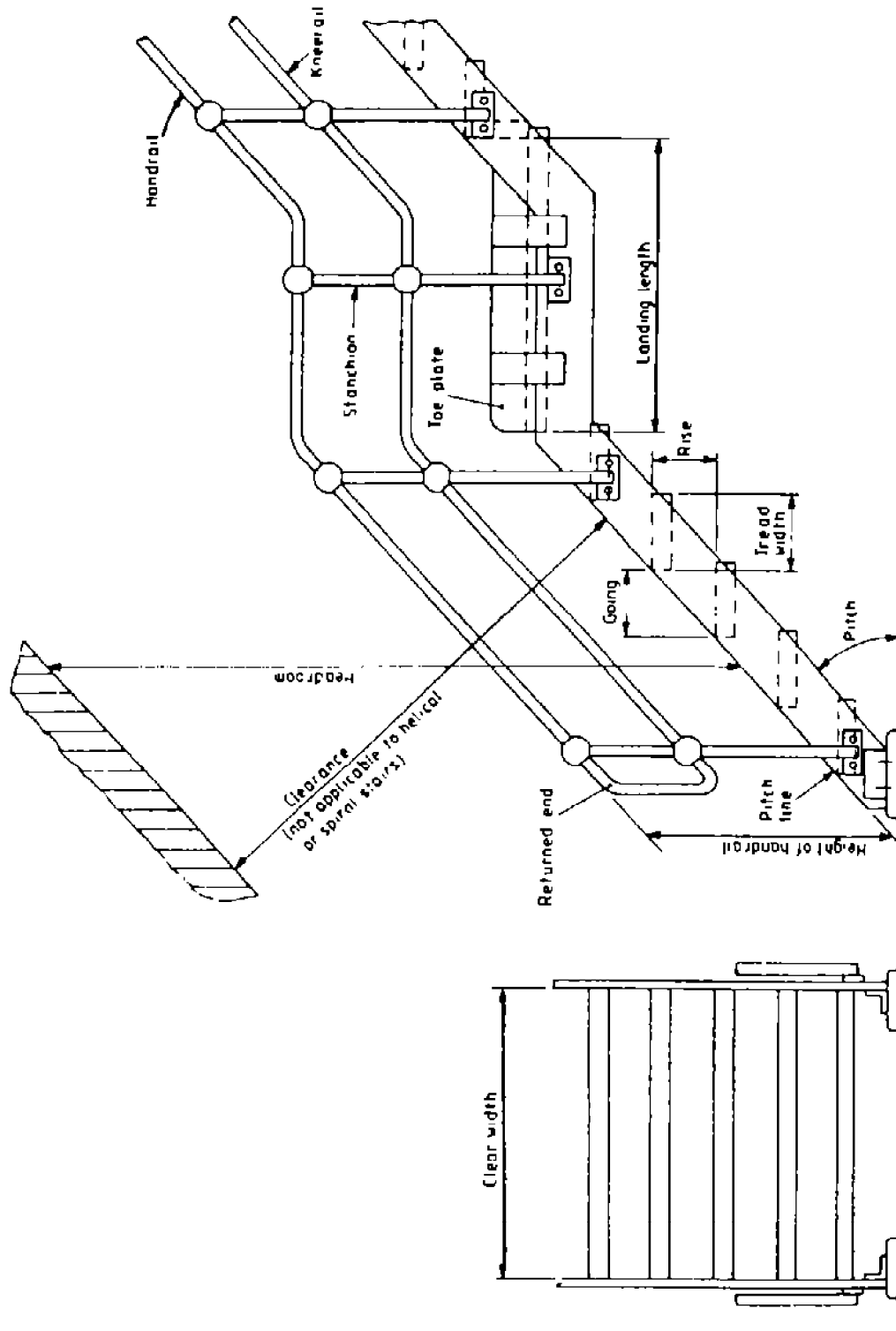
**5.1.1** When assessing the type of access or means of escape to be provided, the designer should take into account all the factors listed in Table 1. The design characteristics should be uniform in any given installation.

##### 5.1.2 Basic components and definitions of terms

See Fig. 1(a) and Fig. 1(b).

**TABLE 1 - FACTORS AFFECTING CHOICE OF MEANS OF ACCESS OF ESCAPE**

<b>FACTOR TO BE CONSIDERED</b>	<b>REMARKS</b>
Height of building or storey height	Height governs number of flights, rise and clearance and headroom
Plan area	Plan area governs going and clear width. Helical and spiral stairs require less space on plan than straight stairs
Convenience of use and safety	Straight stairs give maximum convenience of use. Where loads are being carried regularly, stairs should be used rather than ladders
Number of people	The number of people governs the size and the loading
Frequency of use	Ladders should only be installed where occasional access is required. A companion way ladder should be used in place of a fixed ladder on short rises of 3m or less.
Extent of supervision and control	
Fire	See IPS-E-SF-380 "Fire Protection in Buildings"

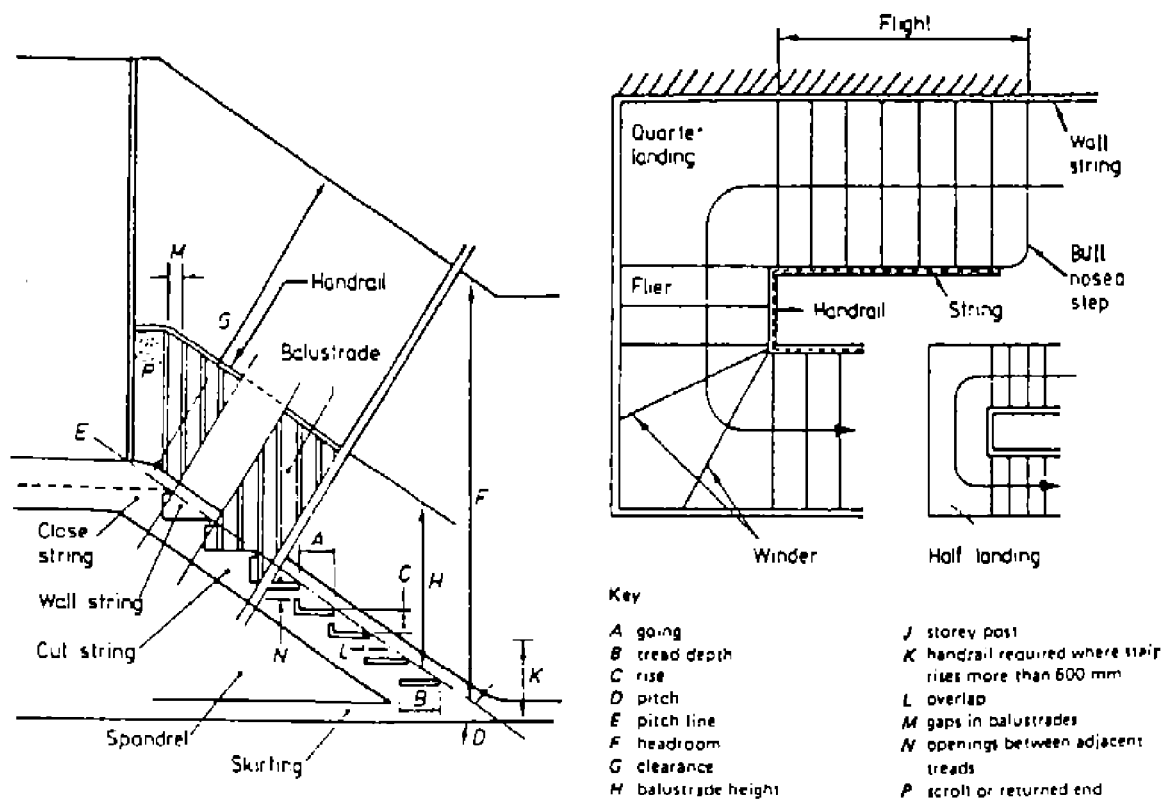


(a)

Fig. 1

(to be continued)

(continued)



(b)

Fig. 1

## 5.2 Typical Industrial Stairs

### 5.2.1 General

The maximum number of risers in a single flight should be 16 for straight stairs, or 22 for helical and spiral stairs.

There should be a change of line or direction of not less than 30 after 32 risers for straight stairs, or 44 risers for helical or spiral stairs. Landings at the head of a stair should be designed so that it is not possible to step from a platform or walkway onto the stair without a change in direction.

Typical industrial stairs are shown in Fig. 2.

**Note:**

Except where otherwise indicated, the standards given for straight, helical and spiral stairs should be followed.

### 5.2.2 Clear width

The minimum clear width should be 600 mm for occasional one-way traffic, 800 mm for regular one-way traffic and occasional two-way traffic and 1000 mm for regular two-way traffic.

### 5.2.3 Pitch (straight stairs)

The minimum pitch for straight stairs should be 30°.

The minimum pitch for occasional access should be 42°.

The maximum pitch for regular two-way traffic should be 38°.

### 5.2.4 Rise

It is essential to make all rises in a flight uniform, subject to the tolerances given in Clause 5.2.5. The relationship between rise and going for a stair should not change along the walking line, subject to the same tolerances. Size of 225 to 255 mm rise shall be considered (see Fig. 10).

### 5.2.5 Accuracy

For general guidance on accuracy in building, see BS 5606 .

The maximum permissible deviation for any size should not exceed the appropriate value given in Table 2 of:

BS 5606: 1978. For further guidance see 11.2.3 of:

BS 5395: Part 1 : 1977.

Consistency of rise and going are of prime importance for user confidence and safety.

### 5.2.6 Exposure

Where a stair is exposed to the weather and is not used solely as a means of access to plant, the total rise should not exceed 6m unless the stair is protected, e.g. by non-combustible infill.

### 5.2.7 Treads

Treads should comply with the requirements for strength given in BS 4592 and should be slip resistant or at least have a slip resistant nosing not less than 25 mm wide.

Treads on open riser stairs should overlap not less than 16 mm and have a nosing depth in the range 25 mm to 50 mm to aid visibility.

### 5.2.8 Strings

Strings should be sufficiently robust to minimize lateral flexing of the structure and should not project more than 50 mm beyond the nosing of the bottom tread (see Fig. 2a).

### 5.2.9 Landings

Landings should be designed following the recommendations for platforms and walkways given in Clause 5.4.1.7.

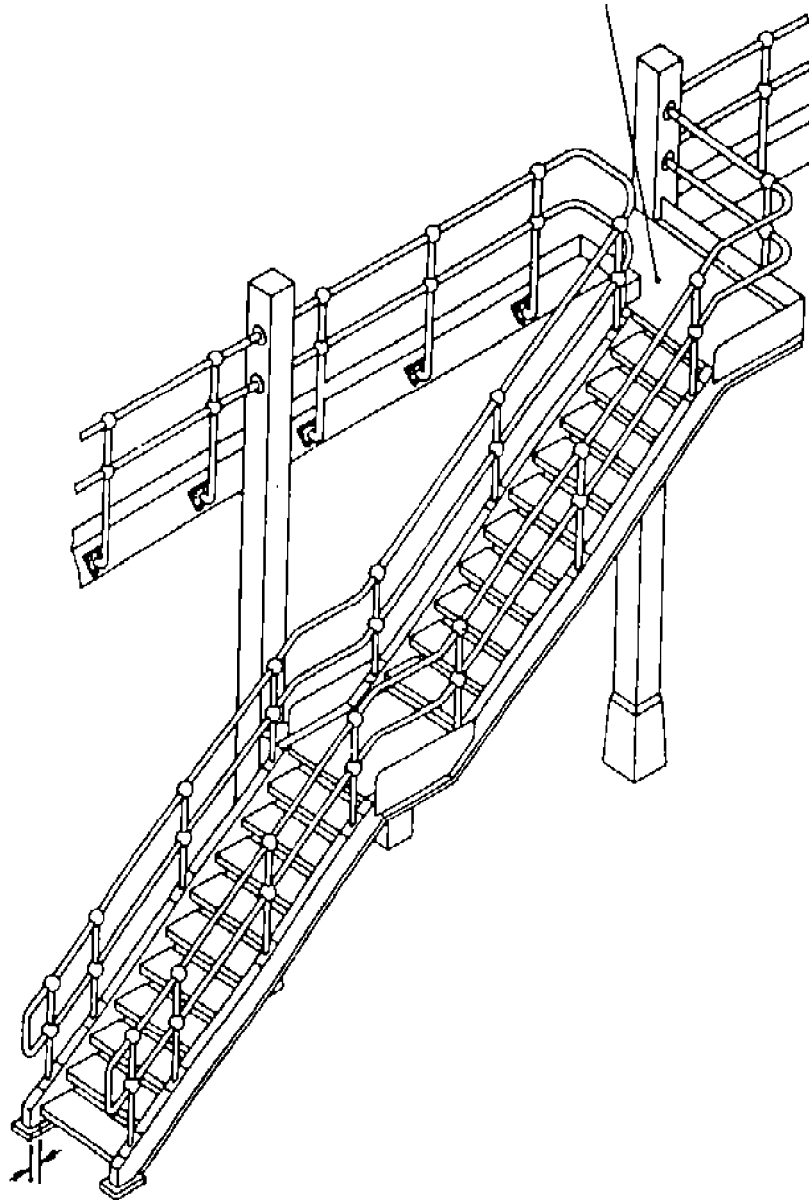
The length of a landing (see Fig. 1a) should not be less than the clear width of the stair or 850 mm, whichever is the greater.

### 5.2.10 Handrails

Straight stairs and landings should have a continuous hand rail on both sides as described in Clause 8.7. Helical and spiral stairs should have handrails as described in BS 5395: Part 2.

Handrails should be provided wherever the total height of the pitch line above the adjacent construction exceeds 500 mm.

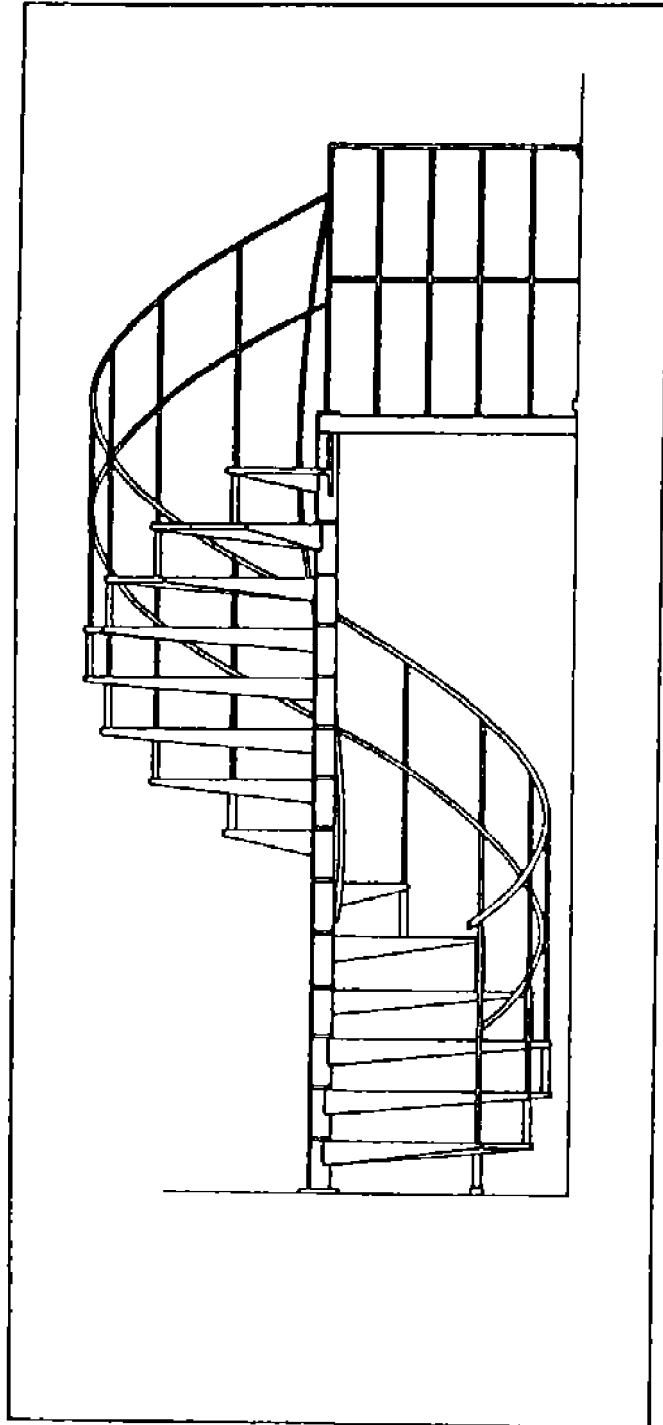
Landing arranged to prevent direct access to stair from platform  
(see Clause 5.2.1)



(a)

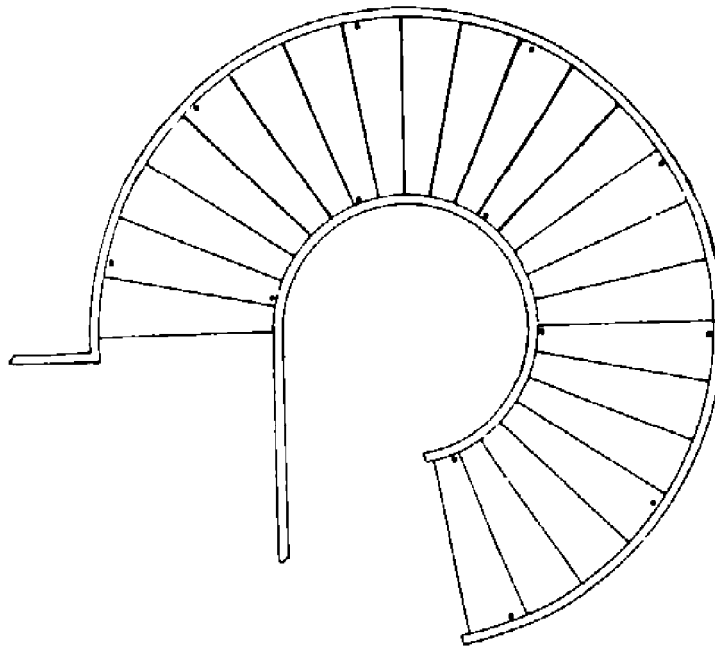
50 maximum projection of strings  
beyond nosing (see Clause 5.2.8)

**STRAIGHT STAIRS TYPICAL INDUSTRIAL STAIRS**  
**Fig. 2**



(b)

**SPIRAL STAIRS TYPICAL INDUSTRIAL STAIRS**  
**Fig. 2**



(c)

**HELICAL STAIR**  
**Fig. 2**

### **5.3 Straight Stairs**

For all types of buildings (see Fig. 2a).

#### **5.3.1 General design considerations**

##### **5.3.1.1 Going**

Optimum stairs dimensions to provide the maximum ease, comfort and safety, are dependent on the depth of the tread and the height of the riser.

The depth of the tread should be sufficient to provide adequate support to the shod foot and should permit at least a part of the heel to rest firmly on each step without having to place the foot at an awkward angle.

Elderly or physically incapacitated people and those guiding small children or carrying loads, wish to pause on the stairs, particularly during ascent. Deeper treads can provide a suitable platform which such people can use for this purpose without fear of overbalancing.

Goings of less than 250 mm may not provide sufficient support for the foot, and goings greater than 300 mm tend to be awkward to use.

### 5.3.1.2 Going of tapered treads

Because a tapered tread diminishes in depth across the width of the stairs it is necessary to determine a point or points on the tread where it is appropriate to measure the going. The going should be measured at a distance of 270 mm from both the inner and outer extremities of the step.

The goings measured at the given points should be within the range given in Table 2. Additionally the effective depth of the tread at its narrow end should never be less than 75 mm .

### 5.3.1.3 Rise

Steps with a shallow rise, tend to cause people to trip and this is particularly true where the rise is less than 75 mm. A rise of 230 mm or more, tends to be too great for people to negotiate with comfort, especially for the very young, the elderly or incapacitated. The maximum rise which people can be expected to negotiate is 220 mm, and in situations where the stair users are unfamiliar with the stairs or the stairs will be used by large numbers of people, it is necessary to have a much shallower rise.

### 5.3.1.4 Relation between rise and going

The average length of stride of most persons has been generally accepted as being between 550 mm and 700 mm. It is evident that the extra effort required in moving both forwards and upwards when mounting stairs, effectively reduces the horizontal distance which a person can travel in comfort. This distance will vary within limits, according to the rise.

In order to ensure that steps are suitably proportioned, it is necessary to consider rise and going together. Where shallow rises are provided, correspondingly greater going is required to ensure that the resultant step is comfortable in use.

### 5.3.1.5 Pitch

Stairs are generally considered as lying within the pitches of 15 and 55 from the horizontal. Pitches flatter than 15 are treated as ramps whilst those between 55 and 90 from the horizontal, where ascent and descent are usually achieved by using both hands and feet, are considered to be ladders.

Within limits, the flatter the pitch, the safer are the stairs to negotiate. This is especially true for stairs used by the very young, the elderly or infirm, and also where visitors may be unfamiliar with the stairs. Thus, in hospitals and institutional buildings and in places of assembly or public entertainment, a lesser pitch is required than in stairs to a single dwelling or where the people using these stairs are small in number and are generally familiar with the stairs.

### 5.3.1.6 Headroom and clearance

Headroom over stairs and landings should not be less than 2000 mm measured vertically above the pitch line.

Additionally, there should be a minimum clearance measured at right angles to the pitch line of at least 1500 mm. For pitches of less than approximately  $41\frac{1}{2}^\circ$  a minimum headroom of 2000 mm will ensure a clearance of at least 1500 mm. With pitches in excess of approximately  $41\frac{1}{2}^\circ$ , however, minimum clearance will become the critical dimension.

In addition to the minimum dimensions given above sufficient headroom and clearance should also be provided in relation to all the purposes for which the stair is designed, e.g. for moving furniture, goods, etc.

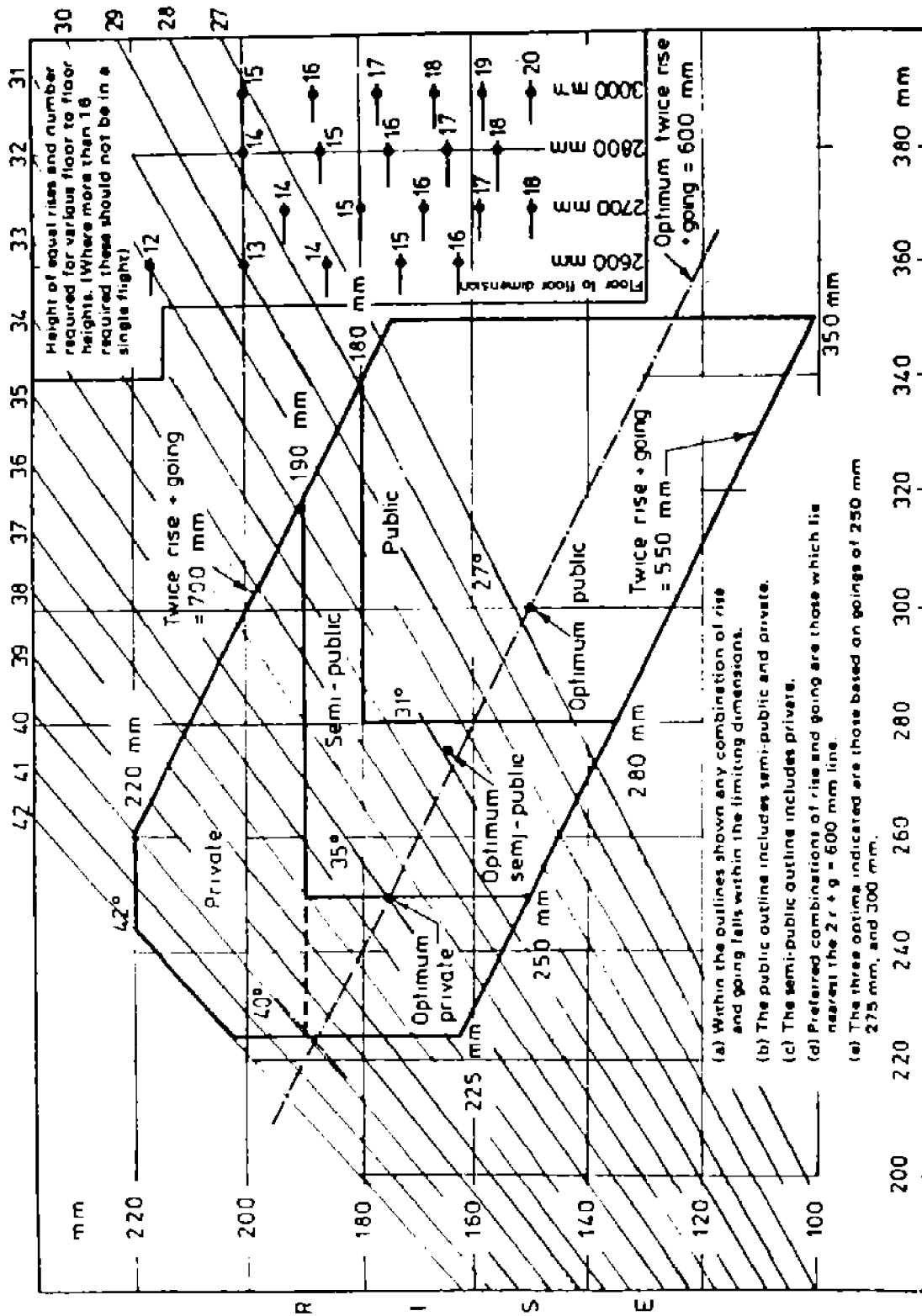
TABLE 2 - DIMENSIONS FOR STAIRS

STAIR	RISE				GOING				SUM TWICE RISE + GOING			PITCH			CLEAR WIDTH <sup>1)</sup>	
	Min.	Optimum	Max.	Min.	Optimum	Max.	Min.	Optimum	Max.	Min.	Optimum	Max.	Optimum	Max.	Min.	Reduced min. where stair has limited use
Private stair (Stair used by a limited number of people who are generally very familiar with the stair, e.g., the internal stair in a dwelling)	mm 100	mm 175	mm 190 desirable 220 absolute maximum	mm 225	mm 250	mm 350	mm 550	mm 600	mm 700		35°	40° desirable 42° absolute maximum			mm 800	mm 600
Semi-public stair (Stair used by larger numbers of people, some of whom may be unfamiliar with the stair, e.g., in factories, offices, shops, common stair serving more than one dwelling)	100	165	190	250	275	350	550	600	700		31°	38°			1000	800
Public stair (Stair used by large numbers of people at one time, e.g., in places of public assembly)  (stair used by people with ambulatory difficulties, e.g., in hospitals, children's homes)	100	150	180	280	300	350	550	600	700		27°	33°			1000 (hospitals 1200)	See Note 4

Notes:

- 1) Special circumstances may demand easier limiting dimensions than some of those given in the table.
- 2) The dimensions in these columns relate to width, i.e. clear of handrails and other obstructions. Requirements for means of escape in case of fire may require a greater minimum than indicated, and where means of escape is a factor reference should be made to IPS-E-SF-300.
- 3) The limiting dimensions in each column apply to the stair as a whole so that the most onerous requirement should be complied with in each case. Thus, for example, in the private stair the minimum going cannot be used with the maximum rise in view of the pitch limitation.
- 4) A reduced minimum clear width is not appropriate to this type of stair in view of its stated use.

The relationship between the rise/going/pitch limitations is illustrated in Fig. 3.



RELATIONSHIP BETWEEN RISE/GOING/PITCH LIMITATIONS

Fig. 3

## 5.4 Helical and Spiral Stairs

Internal or external for all types of buildings (see Figs. 2b & 2c).

### 5.4.1 General design

See IPS-E-SF-380 "Fire Protection in Buildings" Clause 12 .

#### 5.4.1.1 Going

Goings are given in column 3 of Table 2. It should be noted that the inner and outer goings differ considerably from the center going.

The inner going, which is the minimum going, should be measured at a point 270 mm horizontally from the inner hand-rail or from the column face where no inner handrail is fitted (see Fig. 3).

The center going should be measured at the central point of the clear width (see Fig. 3).

The outer going, which is the maximum going, should be measured at a point 270 mm horizontally from the outer hand-rail or string, whichever is the least radius (see Fig. 3).

#### 5.4.1.2 Rise

Rises are given in Column 2 of Table 2.

The maximum number of risers in a single flight should be 16 except where it is not practicable to fit in intermediate landings at 16 riser intervals. In such cases the number of risers shall be increased to 22. In no case should the number of risers be less than three in a single flight.

#### 5.4.1.3 Relation between rise and going

If a graph is plotted of rise against going and lines are drawn on the graph at the practicable limits of both risers and treads, a polygon is formed within which all acceptable combinations of rise and going should lie.

#### 5.4.1.4 Clear headroom

Normally, the clear headroom should not be less than 2000 mm, but it can be reduced to 1900 mm wherever this is not practicable, e.g. at a distance 150 mm or less from the center column or inner handrail across the tread.

#### 5.4.1.5 Clear width

The clear width should be determined as follows:

- a)** where there is an inner handrail, measure the radial distance between the outside face of this rail and the inside face of the outer handrail or the inside edge of the outer string, whichever is the nearer (see Fig. 4a):
- b)** where there is no inner handrail, measure the radial distance between the center column or the outside edge of the inner string and the inside face of the outer handrail or the inside edge of the outer string, whichever is the nearer to the center of the tread in each case (see Fig. 4b).

#### 5.4.1.6 Landings

Landings at storey levels should subtend an angle of not less than 60° at the geometric center on plan (see Fig. 5a ).

Intermediate or rest landings should have a plan area of not less than two consecutive treads or subtend an angle of 45° at the geometric center on plan, whichever is the greater (see Fig. 5b).

#### **5.4.1.7 Guarding of stairs and landings**

Protection against falling has to be provided on both sides of all stairs except that for short stairway where the total rise is no more than 600 mm. For safety reasons any gap between the end of a tread and the center column of a stair should never exceed 100 mm.

#### **5.4.1.8 Passage of large objects**

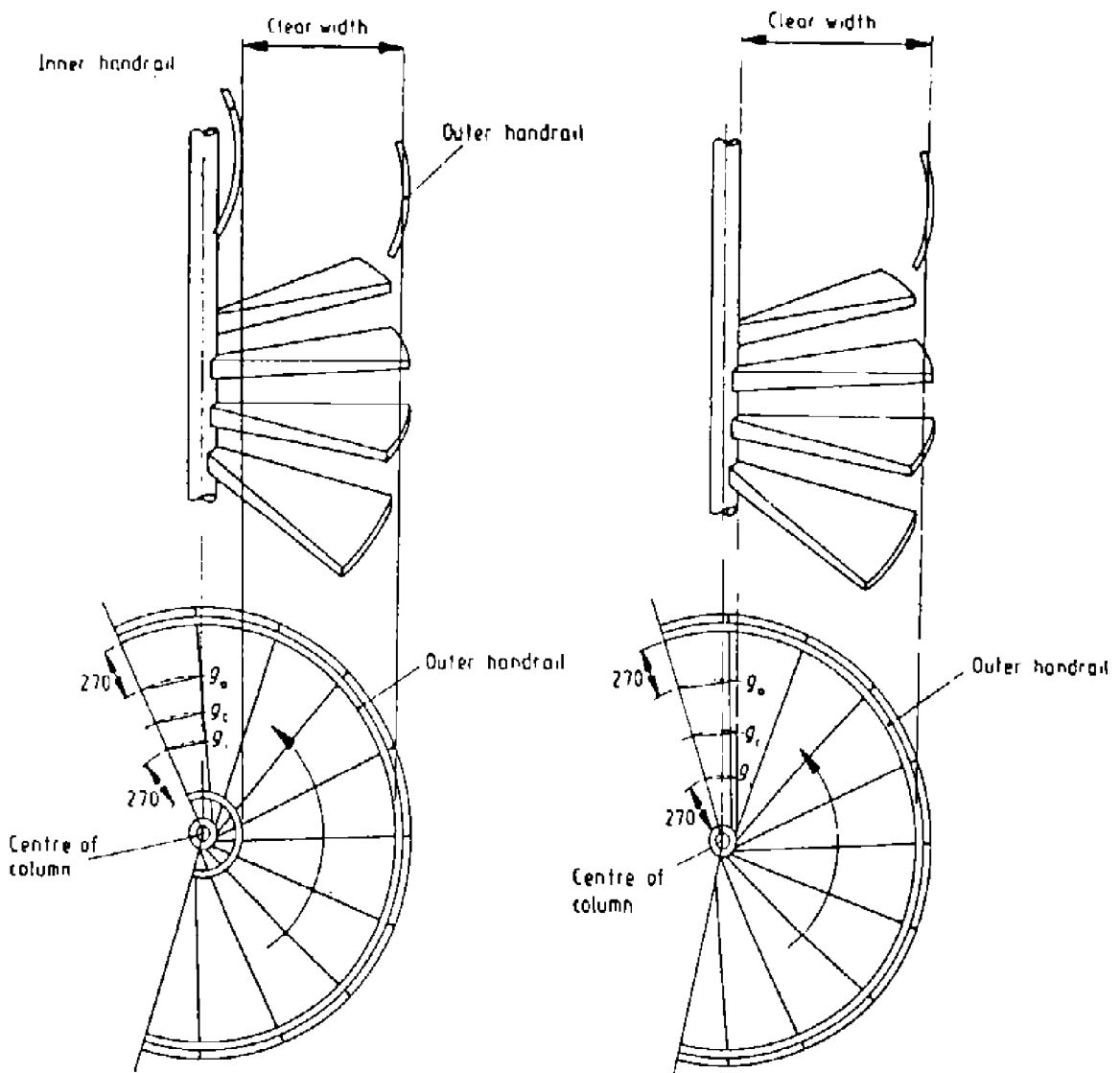
Designers should consider whether the minimum clearances given in Table 2 are sufficient for the passage of large objects, such as furniture and likewise. However stairs shall have balustrades and handrails that can be dismantled temporarily.

#### **5.4.1.9 Deflection**

Helical and spiral stairs should be designed to be rigid enough to give confidence to the user, since they can be subject to oscillations. Stairs should be designed to limit deflections under working conditions to the maximum values given in the appropriate standard.

#### **5.4.1.10 Nosings**

Nosings should be horizontal and straight between the pitch lines corresponding to the inner and outer goings.



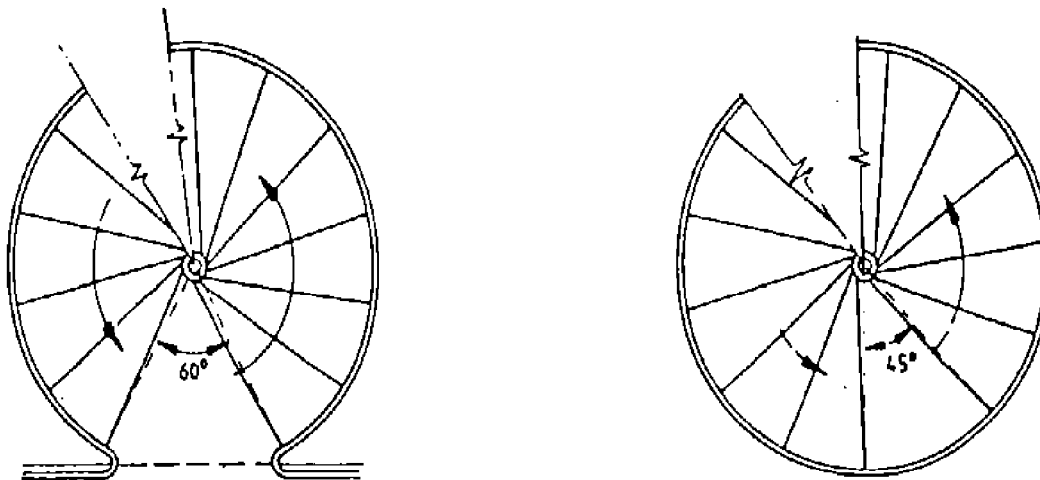
(a) Spiral Stair with inner handrail

(b) Spiral Stair without inner handrail

MEASUREMENT OF CLEAR WIDTH AND GOINGS  
Fig. 4

Note:

Fig. 4(a) shows a spiral stair only, but the same method of measurement applies to a helical stair.  
All dimensions are in millimetres.



(a) At storey level

(b) Intermediate or rest landing

**LANDINGS**  
**Fig. 5**

## 5.5 Special Provisions for Outside Stairs

### 5.5.1 Balconies

Balconies to which access doors lead shall be approximately level with the floor of the building.

**Note:**

In existing buildings in climates where balconies are subject to accumulation of snow or ice, one step, not to exceed 203 mm, is permitted below the level of the inside floor.

### 5.5.2 Visual protection

Outside stairs shall be arranged as to avoid any handicap to the use of the stairs by persons having a fear of high places. For stairs more than three stories in height, any arrangement intended to meet this requirement shall be at least 1220 mm in height.

**5.5.3** Subject to the approval of the relevant authorities, outside stairs is accepted where leading to roofs of other sections of the building, or adjoining building, where the construction is fire resistive, where there is a continuous and safe means of exit from the roof, and where all other reasonable requirements for life safety are maintained.

## 5.6 Smokeproof Enclosures

**5.6.1** Where smokeproof enclosures are required they shall comply with this Standard.

**5.6.2** A smokeproof enclosure shall be a stair enclosure so designed that the movement into the smokeproof enclosure of products of combustion produced by a fire occurring in any part of the building shall be limited.

**5.6.3** The appropriate design method shall be any system that meets the performance level stipulated in Clause 5.6.2 above .

The smokeproof enclosure can be accomplished by using natural ventilation, by using mechanical ventilation incorporating a vestibule, or by pressurizing the stair enclosure.

#### **5.6.4 Enclosure**

A smokeproof enclosure shall consist of a continuous stair enclosed from the highest point to the lowest point by fire barriers having a 2-hour fire resistance rating.

Where a vestibule is used, it shall be within the 2-hour enclosure and is part of the smokeproof enclosure.

#### **5.6.5 Discharge**

Every smokeproof enclosure shall discharge into a public way, into a yard or court having direct access to a public way, or into an exit passageway. Such exit passageways shall be without other openings and shall be separated from the remainder of the building by fire barriers having a 2-hour fire resistance rating.

#### **5.6.6 Access**

Access to the stair shall be by way of a vestibule or by way of an exterior balcony.

Smokeproof enclosures consisting of a pressurized stair enclosure complying with Clause 5.6.9 is excepted.

#### **Note:**

**Vestibule is a hall or chamber between outer door and the interior.**

#### **5.6.7 Natural ventilation**

Smokeproof enclosures by natural ventilation shall comply with all the following:

- a)** Where a vestibule is provided, the doorway into the vestibule shall be protected with an approved fire door assembly having a 1-hour fire protection rating, and the fire door assembly from the vestibule to the stair shall have not less than a 20-minute fire protection rating. Doors shall be designed to minimize air leakage and shall be self-closing or shall be automatic-closing by actuation of a smoke detector within 3 m of the vestibule door. Where access to the stair is by means of an open exterior balcony, the door assembly to the stair shall have a 1-hour fire protection rating and shall be self-closing or shall be automatic-closing by actuation of a smoke detector. Openings adjacent to such exterior balconies shall be protected as required in 5.2.2.3.3 of NFPA 101.15.
- b)** Every vestibule shall have a minimum net area of 1.5 sq. m of opening in an exterior wall facing an exterior court, yard, or public space at least 6.1 m in width.
- c)** Every vestibule shall have a minimum dimension not less than the required width of the corridor leading to it and a minimum dimension of 1830 mm in the direction of travel.

#### **5.6.8 Mechanical ventilation**

Smokeproof enclosures by mechanical ventilation shall comply with all of the following:

- a)** The door assembly from the building into the vestibule shall have a 1½ hour fire protection rating, and the door assembly from the vestibule to the stairway shall have not less than a 20-minute fire protection rating. The door to the stairway shall be designed and installed to minimize air leakage. The doors shall be self-closing or shall be automatic-closing by actuation of a smoke detector located within 3 m of the vestibule door.

- b)** Vestibules shall have a minimum dimension of 1120 mm in width and 1830 mm in direction of exit travel.
- c)** The vestibule shall be provided with not less than one air change per minute, and the exhaust shall be 150 percent of the supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate tightly constructed ducts used only for that purpose. Supply air shall enter the vestibule within 152 mm of the floor level. The top of the exhaust register shall be located not more than 152 mm down from the top of the trap and shall be entirely within the smoke trap area. Doors, when in the open position, shall not obstruct duct openings. Duct openings can be provided with controlling dampers if needed to meet the design requirements but are not otherwise required.
- d)** To serve as a smoke and heat trap and to provide an upward moving air column, the vestibule ceiling shall be at least 508 mm higher than the door opening into the vestibule.

The height can be decreased where justified by engineering design and field testing.

- e)** The stair shall be provided with a dampered relief opening at the top and supplied mechanically with sufficient air to discharge a minimum of 70.8 cu m/min through the relief opening while maintaining a minimum positive pressure of 25 Pa in the stair relative to the vestibule with all doors closed.

#### **5.6.9 Emergency lighting**

The stair shaft and vestibule shall be provided with emergency lighting. A standby generator that is installed for the smokeproof enclosure mechanical ventilation equipment can be used for such stair shaft and vestibule power supply.

## SECTION (2)

### 6. RAMPS

#### 6.1 Enclosure and Protection

**6.1.1** Where a ramp inside a building is used as an exit or exit component, it shall be protected by separation from other parts of the building

**6.1.2** Fixed fire window assemblies shall be installed in such a separation in a fully sprinklered building.

#### 6.1.3 Separation and protection of outside ramps

Outside ramps shall be separated from the interior of the building by walls with the fire resistance rating with fixed or self-closing opening protectives, as required for enclosed stairs.

This protection shall extend at least 3 m upward or to the roofline, whichever is lower and at least 3 m horizontally and downward to ground level.

#### Notes:

Exceptions to the above are:

- 1) Outside ramps can be unprotected where serving an exterior exit access balcony that has two remote outside stairways or ramps.
- 2) Outside ramps can be unprotected where serving a two-story building where there is a remote second exit.
- 3) The fire resistance rating of the portion of the separation extending 3 m from the ramp need not exceed 1 hour.
- 4) All openings below an outside ramp shall be protected:
  - a) Where in a court, the least dimension of which is less than one-third of its height, or;
  - b) where in an alcove having a width less than one-third of its height and a depth greater than one-fourth of its height.

**6.1.4** There shall be no enclosed usable space under ramps within an exit enclosure nor shall the open space under such ramps be used for any purpose. Where there is enclosed usable space under ramps, the walls and underneath structure of the enclosed space shall be protected the same as the ramp enclosure.

#### 6.1.5 Visual protection

Outside ramps shall be so arranged as to avoid any handicap to their use by persons having a fear of high places. For ramps more than three stories in height, any arrangement intended to meet this requirement shall be at least (1220 mm) in height.

### 6.2 Ramp Details

**6.2.1** All ramps serving as required means of egress shall be of permanent fixed construction.

**6.2.2** A ramp used as a means of egress in a building more than three stories in height or in a building of any height of noncombustible or fire-resistive construction shall be constructed of an assembly of noncombustible or limited-combustible material. The ramp floor and landings shall be solid and without perforations.

**6.2.3 A ramp shall have a slip-resistant surface.**

**6.2.4** The slope of a ramp shall not vary between landings. Landings shall be level, and changes in direction of travel, if any, shall be made only at landings.

**6.2.5** Guards shall be provided for ramps. Handrails shall be provided for ramps with a slope exceeding 1 in 15.

**6.2.6** Ramps and intermediate landings shall continue with no decrease in width along the direction of exit travel.

Every landing shall have a dimension measured in the direction of travel equal to the width of the ramp. Such dimension need not exceed 1220 mm where the ramp has a straight run.

**6.3 Special Provision for Outside Ramps**

**6.3.1** Balconies or landings to which doors lead shall be approximately level with the floor of the building.

**Note:**

**In existing buildings in climates where balconies or landings may be subject to accumulation of snow or ice, one step, not to exceed 203 mm can be permitted below the level of the inside floor.**

## SECTION (3)

### 7. FIXED LADDERS

#### 7.1 General

**Note:**

**A sloping ladder is generally easier and safer to use than a vertical ladder.**

Fixed ladders should have equal rises in successive flights wherever practicable.

Access points to the head of ladders from platforms and walkways should be protected by self-closing gates or chains. No part of the ladder should project onto the passageway.

Except on chimneys, the height of a ladder should not exceed 6 m without an intermediate landing, preferably breaking the line of the ladder. If a user could fall 2 m or more, or come into contact with dangerous equipment, the ladders should be fitted with safety equipment see Clause 7.2.

Typical fixed ladders are shown in Figs. 6a, b, c, d and e.

##### 7.1.1 Safety equipment

It is essential to fit a safety cage, or a fixed vertical rail or wire cable for use with a sliding fall-arrest system and harness, whenever a user could otherwise fall 2 m or more or come into contact with dangerous equipment. Cages should be constructed of components strong enough to minimize flexing.

The hoops on any safety cage should be placed at equal intervals not more than 900 mm apart. The top hoop should be in line with the top guard rail on the platform.

The bottom hoop should be at a height of 2500 mm above ground. The sizes of hoops should be as shown in Fig. 6(c).

Where maximum enclosure is desirable because of an elevated position or other hazard, one half of the hoop structure may be extended down to near floor level.

In particularly hazardous and exposed situations, mesh panels may be used to cover the ladder cage (see Fig. 6a).

**7.1.2** A cage or ladder safety device shall be provided where the length of climb is less than 7315 mm but the top of the ladder is at a distance greater than 7315 mm above ground level, floor, or roof, (see Fig. 7).

**7.1.3** A cage, well, or ladder safety device shall be provided where a single length of climb is greater than 7315 mm but does not exceed 15 m (see Fig. 8).

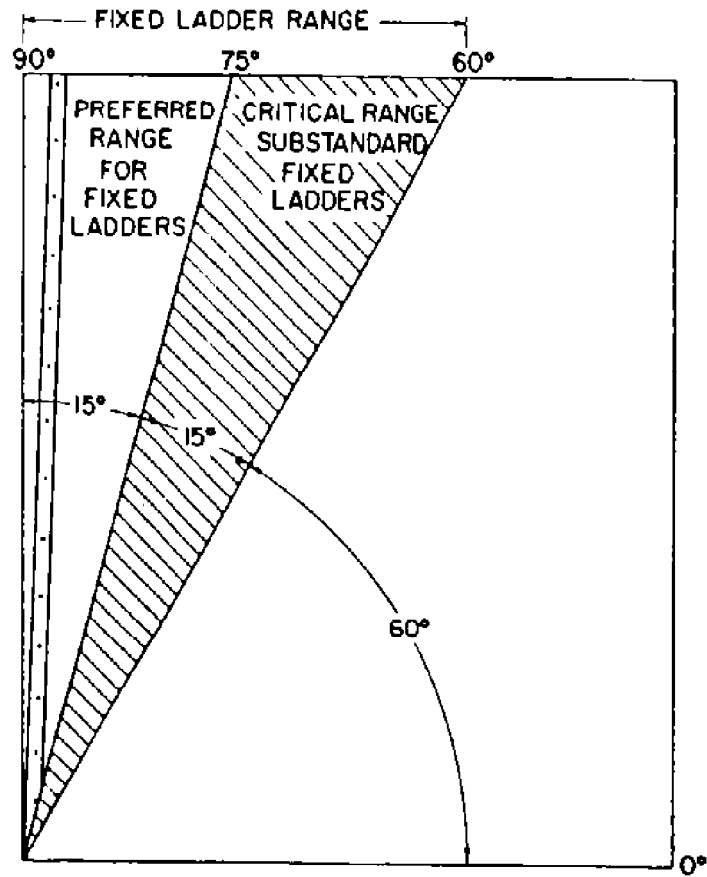
**7.1.4** Ladders having a length of climb greater than 15 m (see Fig. 9) shall be provided with a cage, well, or ladder safety device and shall meet the requirements in (a) or (b), whichever is applicable.

**a)** Where cages or wells are used:

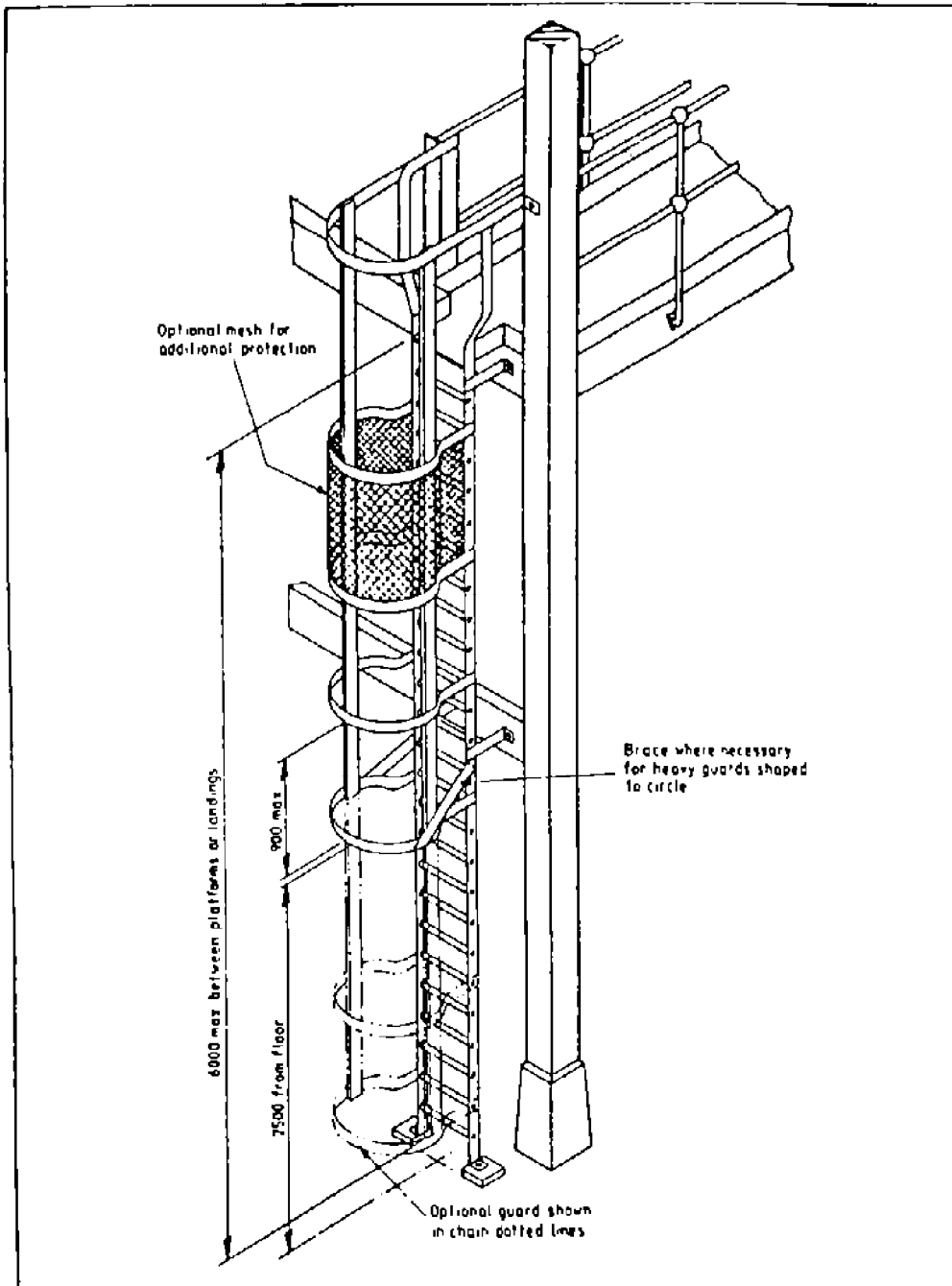
- The ladder shall consist of multiple sections.
- Each section shall be horizontally offset from adjacent sections.
- A landing platform shall be provided at least every 15 m. within the length of climb.

**b)** Where ladder safety devices are used, the length of climb should be continuous, but rest platforms shall be provided at maximum intervals of 46 m. (see Fig. 9b).

**7.1.5** All parts and surfaces of fixed ladder installations shall be free of sharp edges, burrs, or other details that is hazardous to the person using the ladder.



PITCH OF FIXED LADDERS



a) General Arrangement (Vertical Ladder)

**Note:**

Details of self-closing gate are omitted for clarity.

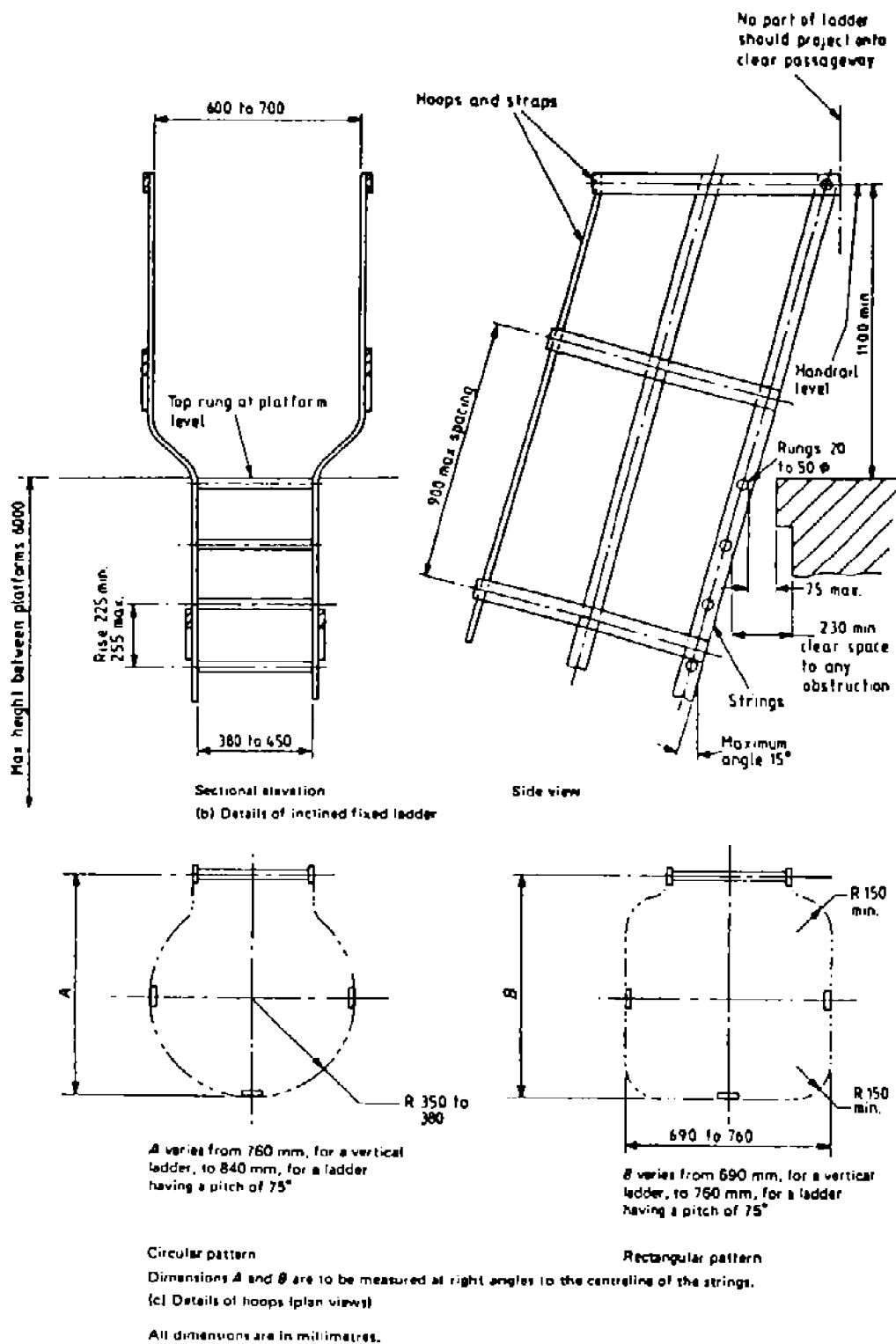
All dimensions are in millimetres.

**TYPICAL FIXED LADDERS**

**Fig. 6**

(to be continued)

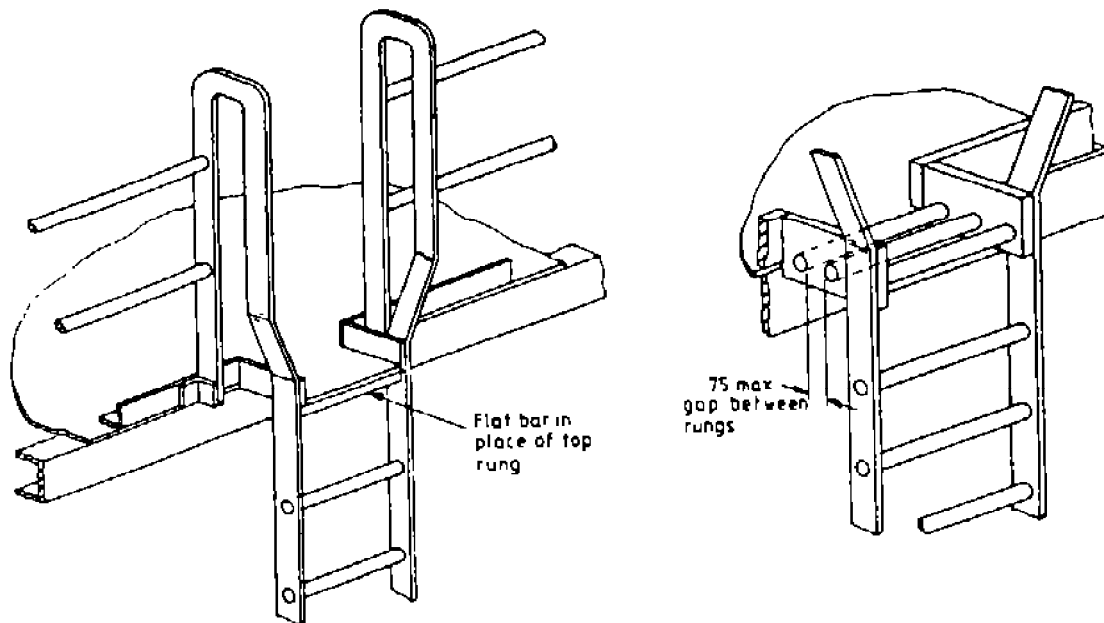
(continued)



TYPICAL FIXED LADDERS (b) & (c)  
Fig. 6

(to be continued)

(continued)

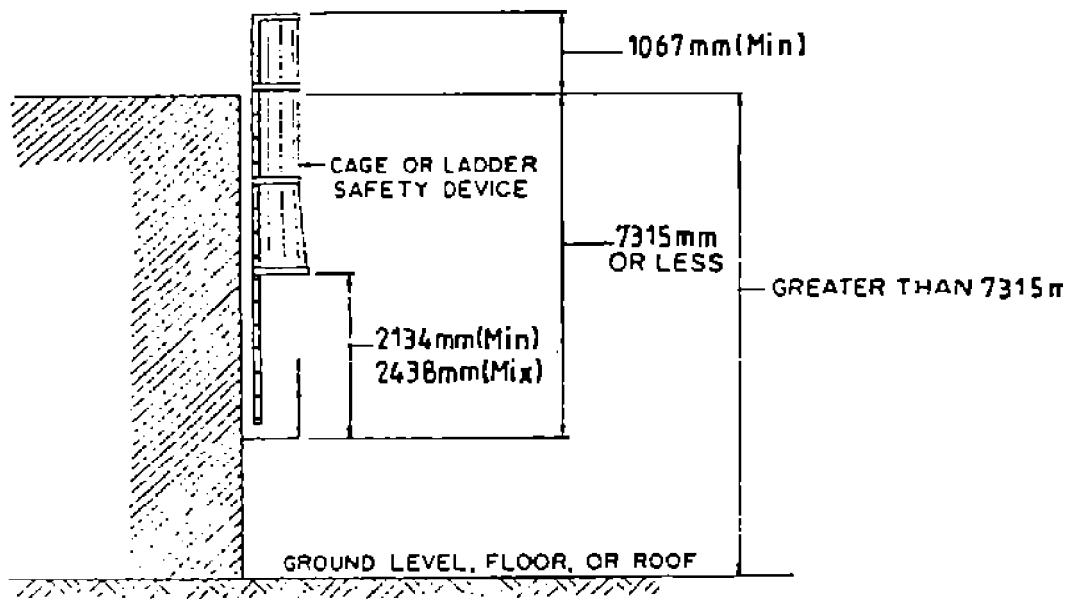


(d) Arrangement with chequer plate extended

(e) Arrangement with additional rungs

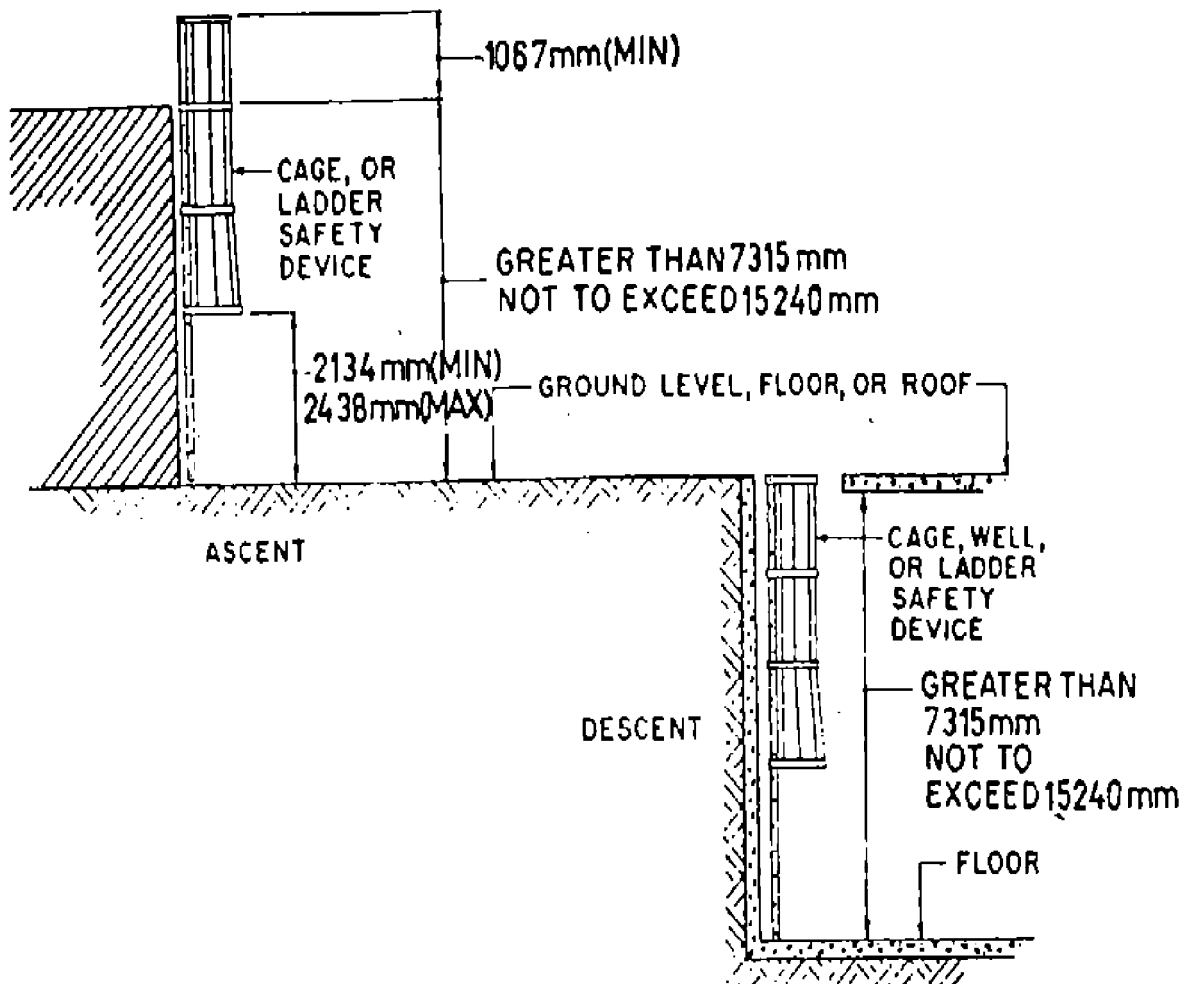
\*Dimension is in millimeters.

TYPICAL FIXED LADDERS (d) & (e)  
Fig. 6



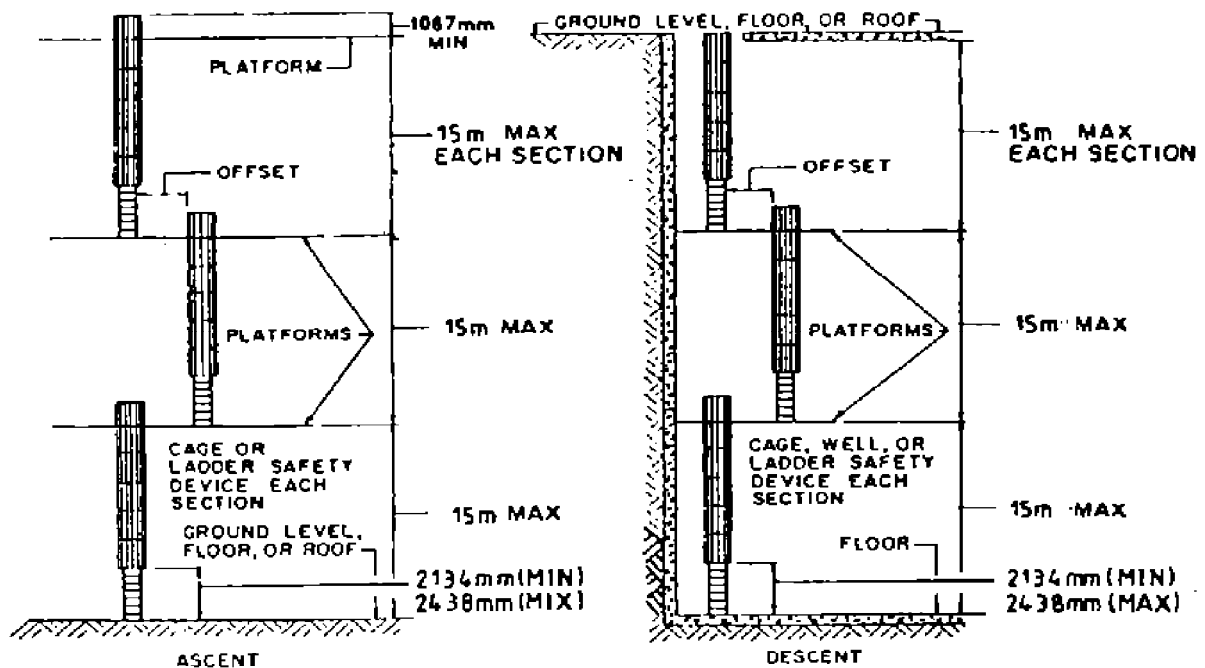
LENGTH OF CLIMB 7315 mm. OR LESS WITH ELEVATED ACCESS CAGE  
OR LADDER SAFETY DEVICE REQUIRED

Fig. 7

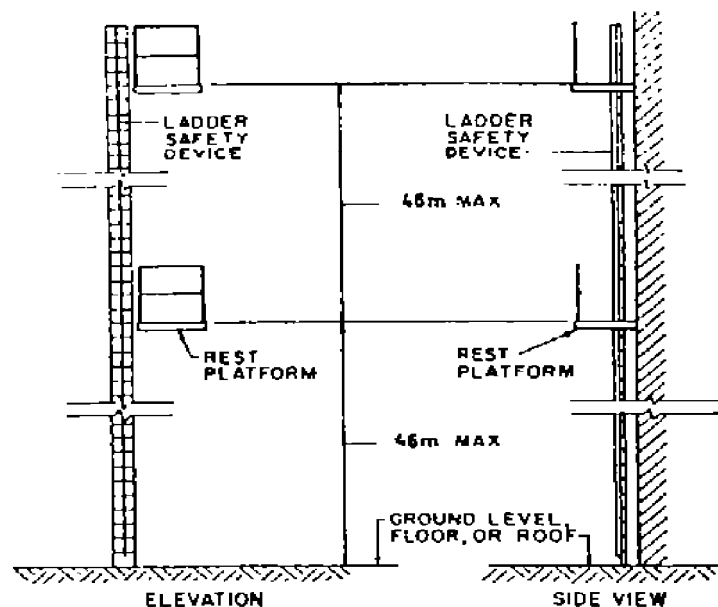


SINGLE LENGTH OF CLIMB GREATER THAN 7315 mm BUT NOT EXCEEDING 15240 mm CAGE, WELL, OR LADDER SAFETY DEVICE REQUIRED

Fig. 8



(a) Multiple sections, 15 m. max. each section when cages or wells are provided (ladder safety devices may also be used)



(b) Total lengths of climb greater than 15 m platforms cages, wells, or ladder safety devices required

CONTINUOUS LENGTH OF CLIMB 46 m Max. BETWEEN PLATFORMS WHEN LADDER SAFETY DEVICE IS PROVIDED

Fig. 9

## 7.2 Design Loads

All ladders, platforms, component, and fastenings shall be designed to meet the load requirements described in Clauses 7.2.1 and 7.2.1.6.

### 7.2.1 Live loads for ladders

**7.2.1.1** Live loads imposed by persons shall be as follows:

- a)** The minimum design live load shall be two loads of 114 kilos each concentrated between any two consecutive attachments. Each step or rung in the ladder shall be designed for a single concentrated live load of 114 kilos minimum.
- b)** The number and position of additional concentrated live load units of 114 kilos each, determined from anticipated usage of the ladder, shall be considered in the design.

#### 7.2.1.2 Other live loads

The following live loads shall be considered in the design, where applicable:

- a)** A uniform coating of ice on all parts of the ladder.
- b)** A wind load on all parts of the ladder.
- c)** The weight of rigging attached to the ladder, including the load to be lifted.
- d)** Anticipated impact loads resulting from the use of ladder safety devices.

#### 7.2.1.3 Live load concentration

All live loads shall be considered to be concentrated at such a point or points as will cause the maximum stress in the structural member in question.

**7.2.1.4** The designer should always allow for concentrated loads greater than 1.0 kN at 1.0 m centres after full consideration of machinery and other items which might be placed on the platform or walkway, and should make additional allowance for any dynamic loads.

**7.2.1.5** The deflection of a floor panel under design load should not exceed 10 mm or 1/200 of the span, whichever is the smaller.

#### 7.2.1.6 Dead loads

##### **a) Ladders**

The weight of the ladder and attached component shall be considered simultaneously with the live loads in the design of rails, supports, and fastenings.

## 7.3 Steps and Rungs

### 7.3.1 Vertical spacing

The vertical spacing of steps and rungs shall not exceed 305 mm on centers, and this spacing shall be uniform in the same length of climb.

### 7.3.2 Width

The minimum inside clear width of step surface for steps and rungs shall be 406 mm, and this width shall be uniform in the same length of climb.

### 7.3.3 Minimum size of steps and rungs

The following are general requirements for the minimum size of steps and rungs:

- a) The minimum size (cross section) requirements of steps and rungs specified in Clause 7.3.3 are based on section properties adequate to support the design loads specified in Clause 7.2 and on the minimum clear width specified in Clause 7.3.2.

## 7.4 Clear Spaces

There should be a minimum clear space of 230 mm behind each rung to allow foot room (see Fig. 6b).

The clear space measured at right angles to the strings on the users side of ladders should be as shown in Fig. 6c.

The top rung of a ladder should be replaced at the same level as the floor or platform to which access is provided by either:

- a) A flat supported plate (see Fig. 6d); or;
- b) industrial type metal flooring or;
- c) additional rungs in a horizontal plane (see Fig. 6e).

## 7.5 Rise

It is essential to make all rises in a flight uniform and the top surface of the top rung should be level with the platform or landing. The minimum rise should be 225 mm and the maximum rise should be 255 mm.

## 7.6 Strings

Strings should be strong enough to minimize flexing of the ladder and should be supported from the structure at adequate intervals. Handrails, which can be an extension of the string, should extend upwards at the same angle as the ladder to a height of not less than 1100 mm above the upper platform and be securely fastened at their extremities.

Such an extension should not encroach on the clear width of the platform passageway. At platform level the strings should widen out and be bent over and connected to the handrail. Above platform level the clear width between strings should not be less than 600 mm and not more than 700 mm.

## 7.7 Companion Way Ladders

**7.7.1** Fixed ladders in Clause 7 apply to companion way ladder except where otherwise indicated in Clause 7.7.2 to 7.7.7. Typical details of companion way ladders are shown in Fig. 10.

### 7.7.2 Width

The width between strings should be in the range 450 mm to 550 mm .

### 7.7.3 Slope

The minimum slope should be 65° and the maximum slope should be 75°.

#### **7.7.4 Clear spaces**

The minimum clear space on the user side of a companion way ladder, measured at right angles to the strings, should be 1200 mm. The front edge of the first step down from platform level should be a minimum of 250 mm from any vertical wall or other obstruction.

#### **7.7.5 Rise**

It is essential to make all rises in a flight uniform. The minimum rise should be 225 mm and the maximum rise should be 255 mm.

#### **7.7.6 Strings**

Strings should be designed following the recommendations for strings for stairs (see Fig. 2a)

#### **7.7.7 Treads**

Treads should be designed in the same way as treads for stairs see Clause 5.2.7 and should have a minimum width of 100 mm with an overlap of 20 mm. The top surface of the top tread should be positioned at platform level and there should be no gap between the tread and the platform (see Fig. 10).

#### **Notes:**

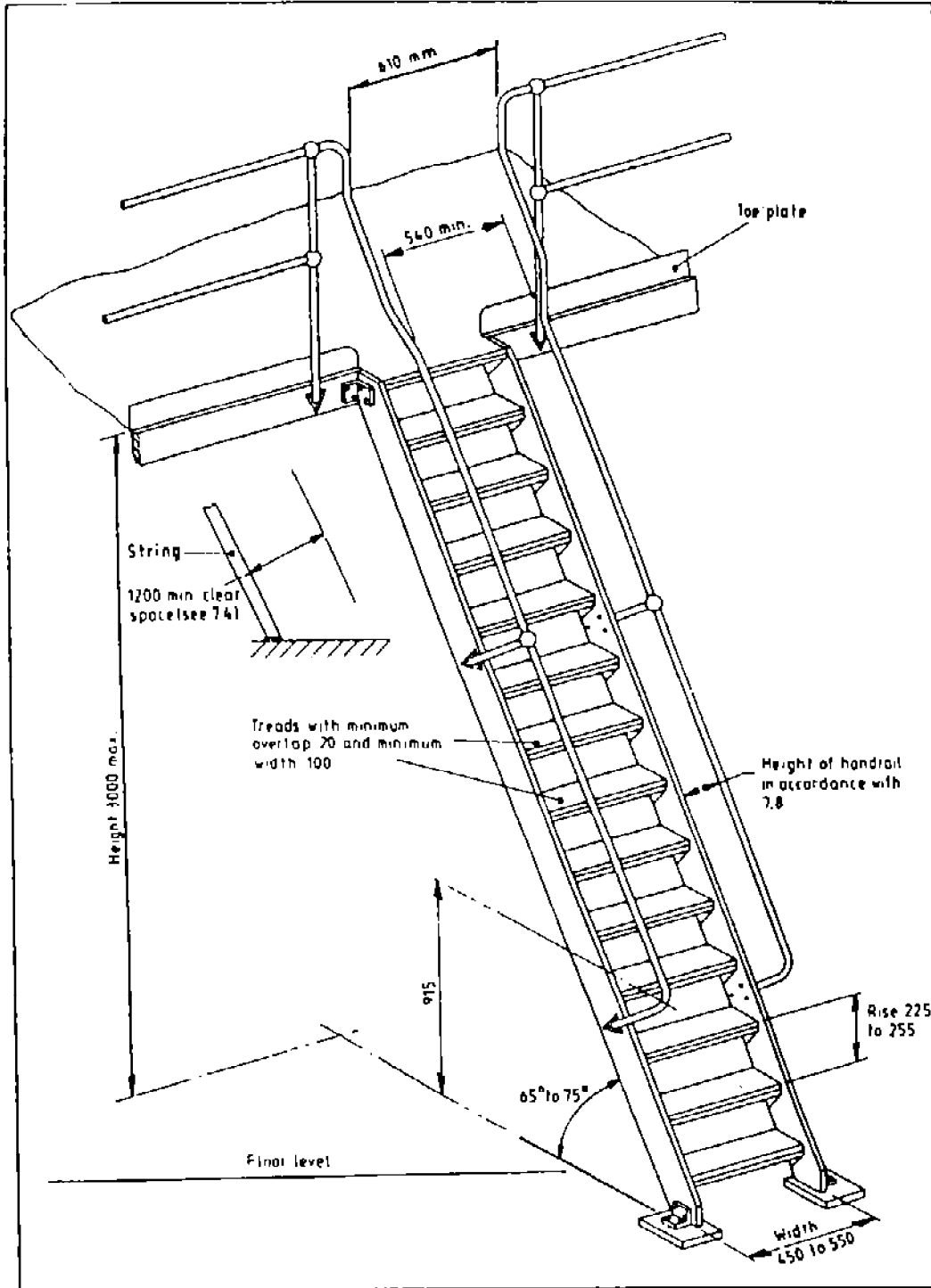
**1- Expanded metals shall be used for treads of all types of ladders in open areas.**

**2- Metal gratings shall be used for platforms.**

**3- The luminous in process areas shall be as follows:**

<b>Non-active</b>	<b>30 Lux</b>
<b>Active</b>	<b>50 Lux</b>

**Further details are covered in IPS-E-EL-200.**



**Note:**

Details of self-closing gate omitted for clarity.  
All linear dimensions are in millimetres.

**TYPICAL COMPANION WAY LADDER**  
**Fig. 10**

## **7.8 Ladder Safety Devices**

### **7.8.1 General design**

**7.8.1.1** All components of ladder safety devices shall meet the design requirements of this section.

**7.8.1.2** The ladder safety device shall allow at least two persons, but not more than four, averaging 114 kilos each (including equipment), to ascend or descend simultaneously; however, only one person at a time (except in rescue operations) shall use the same portion of carrier between intermediate mountings for rigid carriers or cable guides for flexible carriers.

**7.8.1.3** The ladder safety device shall be designed to absorb the impact load of a solid object weighing at least 228 kilos in a free fall of 450 mm.

**7.8.1.4** Design and installation of mountings shall not reduce the design safety factors of the fixed ladders.

**7.8.1.5** Brittle materials shall not be utilized in ladder safety devices.

### **7.8.2 Safety factors**

**7.8.2.1** Flexible components such as webbing and fabric shall have a safety factor of not less than 5 for the designed static load.

**7.8.2.2** Flexible carriers shall have a safety factor not less than 10 times the designed static load.

**7.8.2.3** Ductile material shall have a safety factor of not less than 5 times the designed static load.

#### **7.8.2.4 Ladder safety devices of other designs**

Ladder safety devices utilizing other designs shall meet the design requirements of this standard, including the requirements of Clauses 7.8.1 and 7.8.2.

## SECTION (4)

### 8. PLATFORMS AND WALKWAYS

#### 8.1 General

The minimum unobstructed width of a platform or walkway should be 450 mm for light duty and 750 mm for general duty (see Table 3).

The minimum headroom above the top surface of platform or walkway should be 2100 mm.

**Note:**

It is advisable to fix plates or labels to installations stating that they have been designed following the recommendations of this code.

**TABLE 3 - PLATFORM AND WALKWAY FLOOR LOADS**

USE OF PLATFORM OR WALKWAY	UDL (See Note 1) kN/m <sup>2</sup>	CONCENTRATED LOAD OVER SQUARE OF 300 mm SIDE (See Note 2) kN AT 1.0 m CENTERS
Light Duty Access limited to one person	3.0	1.0
General Duty Regular two-way pedestrian traffic	5.0	1.0
Heavy Duty High density pedestrian traffic	7.5	1.0

**Notes:**

- 1) The Uniformly Distributed Load (UDL) is the equivalent uniformly distributed static load per square metre of plan area.
- 2) Concentrated loads should be considered to be applied in the positions which produce the maximum stresses, or, where deflection is the design criterion, in the positions which produce maximum deflection.

#### 8.2 Vertical Loads and Deflections

Design loads should be taken to be not less than those given in Table 3. The platform or walkway should be designed to carry either the appropriate distributed load or the appropriate concentrated load, whichever produces the greater stress in the section being considered.

#### 8.3 Fixings

Platforms and walkways should not be fixed solely by their own weight.

When using fixings relying on tension alone, the working load(s) should be increased by a factor of 1.5.

The designer should consider whether corrosion or fatigue stresses will unduly affect the life of the fixing.

## 8.4 Toe Plates (Kicking Plates)

Toe plates should be provided around all open sides of platform and walkways and beneath the first step of any open riser stair, as stated here-under:

The open sides of platforms, walkways and landings, including under the first step of an open riser stair rising from an elevated position, should be protected by an upstand or toe plate not less than 100 mm high above floor level, so as to prevent personnel slipping below the mid-rail and also items such as tools being inadvertently pushed off the edge. Any gap between the floor and the upstand should not be greater than 15 mm.

## 8.5 Walkways

A walkway should normally be level. Where the use of inclined walkways cannot be avoided, particular attention should be given to ensuring that adequate traction can be obtained by individuals using the walkway. The slope should never exceed 10°.

## 8.6 Nosings

Where walkways are not slip resistant, a slip resistant nosing should be fitted at the head of all stairs and access points to ladders and should match those used on stair treads.

## 8.7 Guards and Handrails

### 8.7.1 Guards

Means of egress such as landings, balconies, corridors, passageways, floor or roof openings, ramps, aisles, porches, or mezzanines that are more than 76 cm. above the floor or grade below shall be provided with guards to prevent falls over the open side. Stairs that are provided with handrails as specified in Clause 8.7.4.4 need not be provided with guards.

**8.7.2** The guards that are required by Clause 8.7 should meet this requirement where the stair is not more than three stories high. Special architectural treatment, including application of such devices as metal or masonry screens and grilles, will usually be necessary to comply with the intent of the requirements for stairs over three stories in height.

### 8.7.3 Guard details

**8.7.3.1** The height of guards required by Clause 8.7.1 shall be measured vertically to the top of the guard from the surface adjacent thereto.

**8.7.3.2** Guards shall not be less than 1070 mm high.

Guards within dwelling units may be 910 mm high.

**8.7.3.3** Open guards shall have intermediate rails or an ornamental pattern such that a sphere in 152 mm in diameter cannot pass through any opening.

### Exception:

In industrial occupancies, and in storage occupancies the clear distance between intermediate rails measured at right angles to the rails shall not exceed 533 mm.

#### 8.7.4 Handrails

**8.7.4.1** Each new stair and each new ramp with a slope exceeding 1 in 15 shall have handrails on both sides. In addition, handrails shall be provided within 760 mm of all portions of the required egress width of stairs .

The required egress width shall be along the natural path of travel. Existing stairs and stairs within dwelling units and within guest rooms shall have a handrail on at least one side. (see Clause 8.7.4.4)

**Exception:**

On existing stairs, handrails shall be provided within 1120 mm of all portions of the required egress width of stairs.

**8.7.4.2** Required guards and handrails shall continue for the full length of each flight of stairs. At turns of stairs, inside handrails shall be continuous between flights at landings.

**Exception:**

On existing stairs, the handrails are not required to be continuous between flights of stairs at landings.

**8.7.4.3** The design of guards and handrails and the hardware for attaching handrails to guards, balusters, or masonry walls shall be such that there are no projecting lugs on attachment devices or non-projecting corners or members of grilles or panels that engage loose clothing. Openings in guards shall be designed to prevent loose clothing from becoming wedged in such openings.

##### 8.7.4.4 Handrail details

- a) Handrails on stairs shall not be less than 860 mm nor more than 970 mm above the surface of the tread, measured vertically to the top of the rail from the tread at the leading edge.

**Exception:**

Existing handrails shall not be less than nor more than 970 mm above the upper surface of the tread, measured vertically to the top of the leading edge.

- b) New handrails shall provide a clearance of at least 38 mm between handrail and wall to which fastened.
- c) Handrails shall have a circular cross section with an out-side dimension of at least 32 mm and not greater than 50 mm. New handrails shall be continuously graspable along the entire length.

**Exception to:**

Any other shape with a perimeter dimension of at least 102 mm, but not greater than 159 mm and with the largest cross-sectional dimension not exceeding 57 mm.

- d) New handrail ends shall be returned to the wall or floor or shall terminate at newel posts.
- e) New handrail that are not continuous between flights shall be extended horizontally a minimum of 305 mm at the required height at landings where a guard or wall exists.
- f) New handrails on open sides of stairs shall have intermediate rails or an ornamental pattern such that a sphere 152 mm in diameter cannot pass through any openings in such handrail. Industrial and storage occupancies are excepted.
- g) There should be not less than two rails in the same vertical plane, the lower rail being positioned midway between the top rail and the platform/stair pitch line or the top of the upstand or toe plate. On companion way ladders and on stairs bounded by a wall, a single handrail should be fitted.

Wherever possible, handrails should be continuous and follow the line of the nosing. Sharp changes of direction in the vertical plane should be avoided. To avoid injury or damage, rails should terminate in a returned end, either to the wall or to the kneerail, or return to the newel post.

Returned ends should not extend more than 350 mm from the centerline of a newel post. At the foot of the stairs the handrail returned end should extend at least to the point of maximum extension of the string.

**h)** A single handrail should always be provided on both sides of a companion way ladder; the distance between rails, from center to center, should not be less than 540 mm.

Stanchions supporting handrails should be positioned at right angles to strings. The rail should be 250 mm above the pitch line for ladders of 65° slope and 100 mm above the pitch line for ladders of 75° slope, with all other cases pro rata.

At the top of a companion way ladder, handrails should widen out to a minimum width of 610 mm (see Fig. 10).

#### **8.7.4.5 Lateral loads**

The minimum design imposed lateral loads given in Table 4 should be used for handrails.

**TABLE 4 - LATERAL LOADS FOR HANDRAILS**

<b>USE OF HANDRAIL</b>	<b>LOAD kN/m</b>
Light Duty Access limited to one person	0.36
General Duty Regular two-way pedestrian traffic	0.36
Heavy Duty High density pedestrian traffic; escape routes	0.74
Areas subject to crowd loading, over 3 m wide	3.00

#### **8.7.4.6 Joints**

Joints in continuous rails should be positioned at points of minimum stress, and not more than 150 mm from the center-line of a stanchions. They should not be placed outboard of the end stanchions and should not be placed between corner stanchions. Joints should not have any sharp edges or projections.

#### **8.7.4.7 Stanchions**

Stanchions should never be mounted from toe plates, unless it can be shown that the toe plates are structural members.

#### **8.7.4.8 Clear spaces**

There should be a clear space of not less than 75 mm behind the top rail, to allow the rail to be hand held.

#### **8.7.4.9 Safety gates**

Potentially hazardous areas, such as the gap in handrails at the head of a ladder, should be protected by a self-closing gate, which should close gently but securely and should be designed to swing into the landing. Hold-open devices should never be fitted.

## SECTION (5)

### 9. DESIGN DETAILS FOR CAGES AND WELLS

#### 9.1 Cages

**9.1.1** The general construction of cages shall consist of horizontal bands or supports and vertical bars. An example of cage construction is shown in Figs. 7 and 8, but equivalent construction may be used.

**9.1.2** Horizontal bands shall be fastened to the side rails of rail ladders, or directly to the structure, building, or equipment for individual rung ladders.

**9.1.3** Vertical bars shall be on the inside of the horizontal bands and shall be fastened to them.

**9.1.4** Cages shall be designed to support the loads and dead loads specified for ladders in Clauses 7.2.1 and 7.2.1.6.

#### 9.2 Cage Size

**9.2.1** Cages shall extend not less than 675 mm or more than 760 mm from the centerline of the step or rung (excluding the flare at the bottom of the cage), and shall not be less than 685 mm in width.

The inside of the cage shall be clear of projections.

**9.2.2** Horizontal bands shall be spaced not more than 1219 mm on center vertically for the size and spacing of vertical bars recommended in the example and shown in Figs. 11 and 12. For variations in size (cross section ) and spacing of vertical bars, the maximum spacing of horizontal bands shall be in accordance with recognized design practice.

**9.2.3** Vertical bars shall be spaced at intervals not more than 40° on center around the circumference of the cage. This will give a maximum spacing, center to center, of approximately 241 mm (see Fig. 12)

**9.2.4** The bottom of the cage shall be at a level not less than 2130 mm or more than 2438 mm above the point of access/egress to the bottom of the ladder. The bottom of the cage shall be flared not less than 100 mm all around within the distance between the bottom horizontal band and the next higher band (see Fig. 11).

Where practical difficulties are encountered, cages should start at 3048 mm above the point of access/egress.

**9.2.5** The top of the cage shall be a minimum of 1067 mm above the top of the platform, or the point of access/egress at the top of the ladder, with provision for access/egress to the platform or point of access/egress (see Fig. 11).

Any portion of the cage above the platform or above the point of access/egress that cannot be fastened to the side rail shall be fastened to the guard-rail, or directly to the structure, building, or equipment.

#### 9.3 Wells

**9.3.1** Wells shall consist of a wall or walls, or equivalent construction, completely encircling the ladder. The inside of the well shall be clear of projections (see Fig. 13).

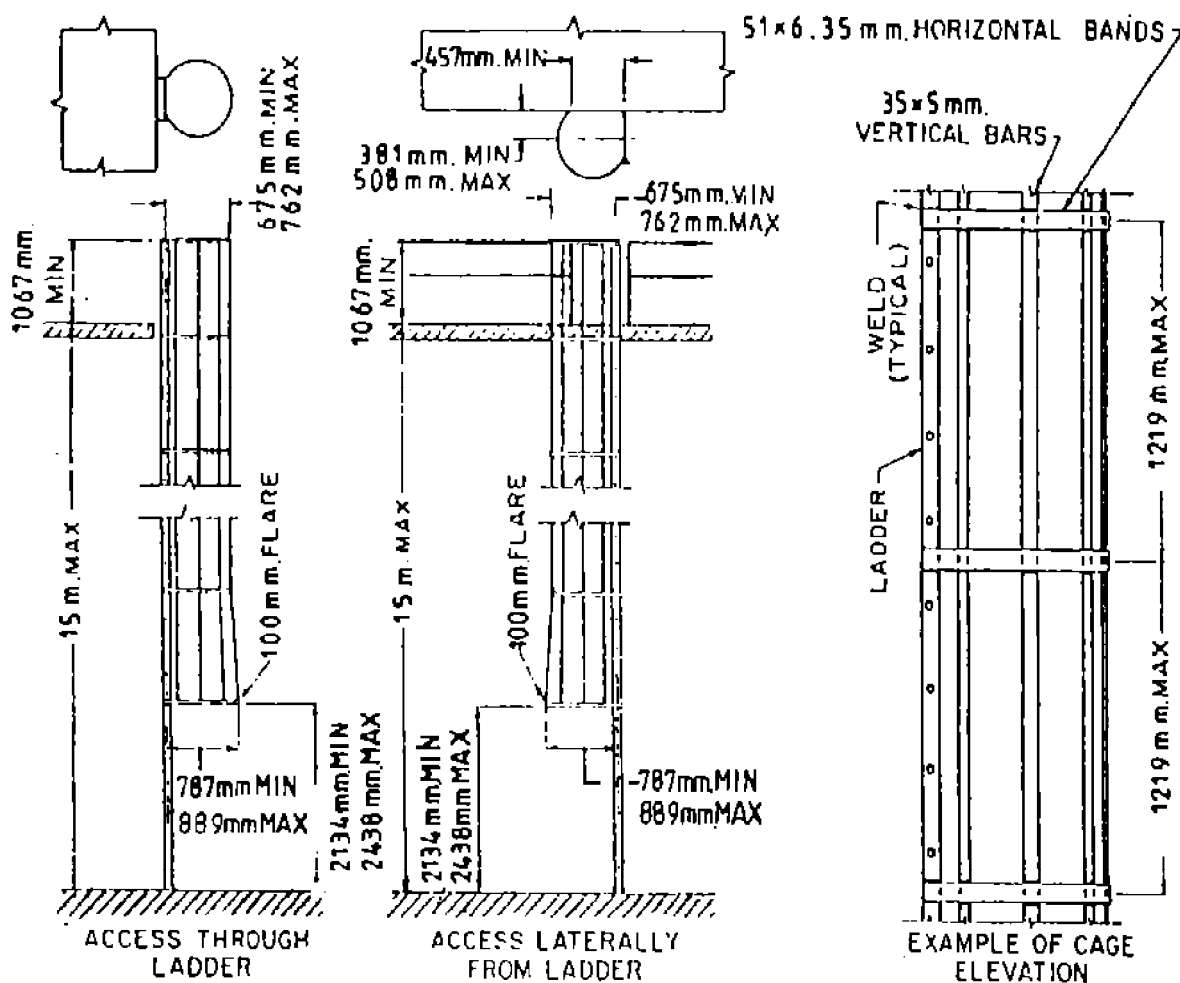
**9.3.2** The top rung or step of the ladder shall meet the requirements as shown in Fig. 6(b), except that individual rung ladders may have the top step or rung located not more than 152 mm below the top of the well or access/egress point.

**9.3.3** The top of the well shall have railings and toeboards and arranged as to provide safe access/egress for the well.

### 9.3.4 Well size

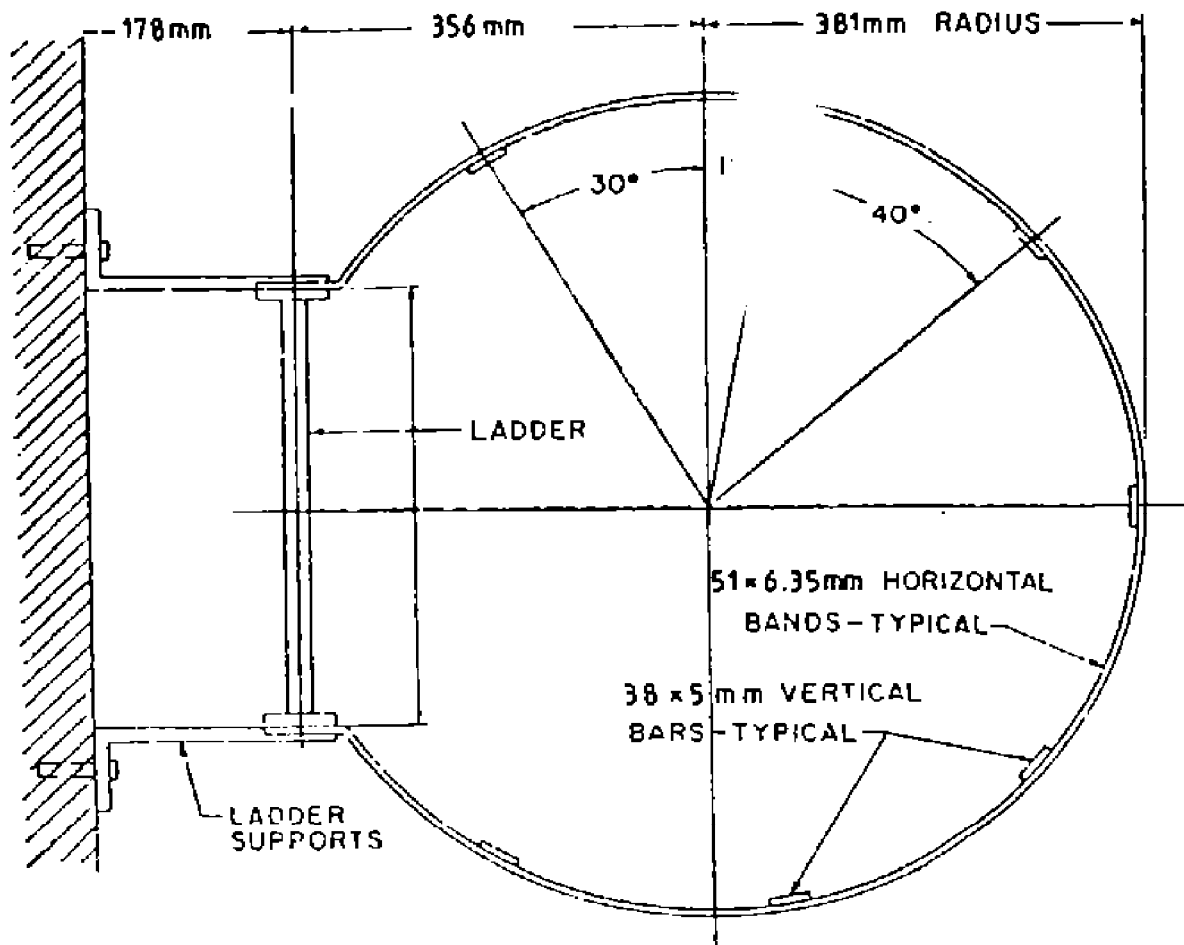
**9.3.4.1** The inside face of the well on the climbing side of the ladder shall extend not less than 675 mm or more than 762 mm from the centerline of the step or rung. The inside clear width of the well shall be a nominal 762 mm (see Fig. 13).

**9.3.4.2** The bottom of the wall on the access side shall start at a level not less than 2134 mm or more than 2438 mm above the point of access to the bottom of the ladder (see Fig. 11).

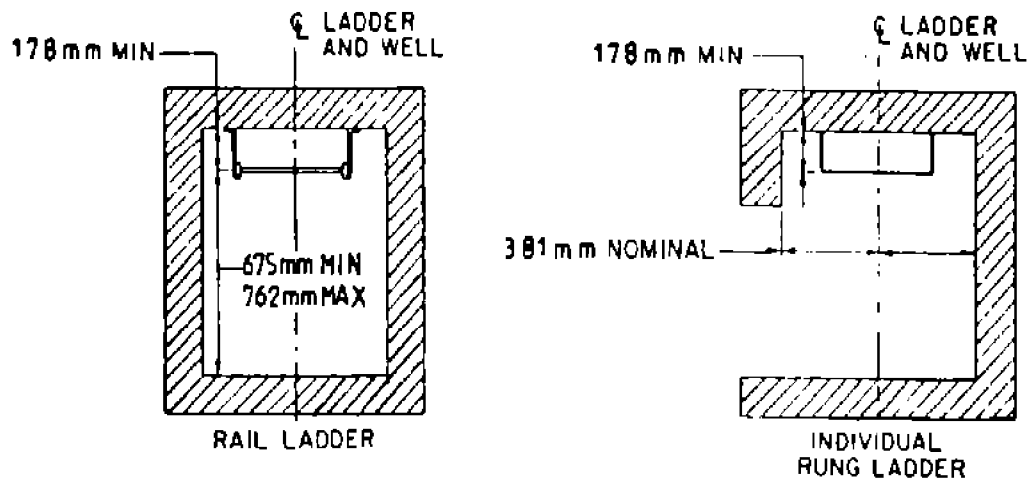


EXAMPLE OF THE GENERAL CONSTRUCTION OF CAGES

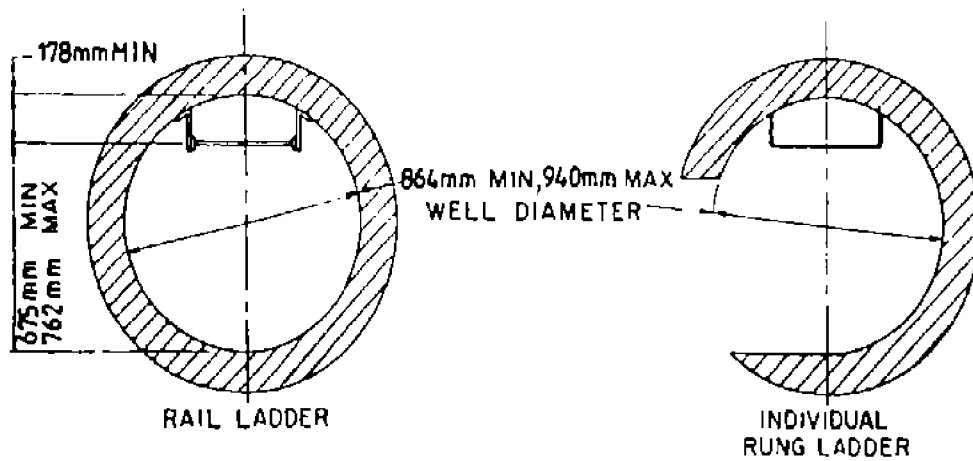
Fig. 11



EXAMPLE OF A CAGE PLAN  
Fig. 12



(a)  
Horizontal Sections  
Rectangular Wells



(b)  
Horizontal Sections  
Circular Wells

GENERAL ARRANGEMENTS FOR LADDERS IN WELLS  
Fig. 13

## PART II SCAFFOLDS

### 10. GENERAL REQUIREMENTS FOR ALL SCAFFOLDS

**10.1** Scaffolds shall be furnished and erected in accordance with this Standard for persons engaged in work that cannot be done safely from the ground or from a permanent structure.

**10.2** The components used to assemble scaffolds should conform to this Standard and its specifications of strength, dimensions, and weights. They shall be designed and erected to safely support the design load.

**10.3** The footing for scaffolds shall be sound, rigid, and capable of carrying the maximum intended load. Unstable objects, such as barrels, boxes, loose brick, or concrete block, shall not be used to support scaffolds or planks.

**10.4** Anchorage, guying, tying off, or bracing of scaffolds shall be affixed to substantial components sound structures or equivalent.

**10.5** Guardrail systems shall be installed on all open sides and ends of platforms more than 3 m. above the ground or floor with the following exceptions.

- a) During erection and dismantling of scaffolding.
- b) Scaffolds wholly within the interior of a building covering the entire floor area of any room therein and not having an open side or opening such as a hoistway, elevator shaft, stairwell, and the like.
- c) When needle beams, floats, boatswains' chairs, catenary scaffolds, and ladder jack scaffolds, are 3 m. or more above the ground or the floor, droplines and body harnesses shall be used.
- d) Other types of free-standing ladder supported scaffolds.
- e) Toprails shall be installed neither less than 90 mm or more than 1.14 m. high above the working surface.
- f) Guardrail systems shall be supported at intervals not to exceed 3m.
- g) Toeboards shall be 25 × 100 mm lumber or the equivalent. Toeboards shall extend a minimum of 90 mm above the working surface.
- h) Cross bracing is acceptable in lieu of a midrail when the crossing point of two braces is at least 500 mm, but no more than 760 mm above the platform.
- i) Cross bracing is acceptable as a guardrail system provided the crossing point of two braces is between 79 cm. and 122 cm. above the work platform. The end points at each upright shall be no more than 135 cm. apart.
- j) Toeboards shall be required with guardrail systems on all open sides and ends of scaffolds at locations where persons are required to work or pass under the scaffold.
- k) When materials are piled higher than the toeboard, and in areas where persons are required to work or pass under the scaffolds, the scaffolds shall be provided with a screen between the toeboard and the top rail extending along the entire opening, consisting of Number 19 Gage 4 cm. mesh or the equivalent, except needle beams, boatswains, chair, catenary scaffolds, or ladder jack scaffolds. When wire mesh is used, the midrail can be omitted.
- l) Guardrail systems shall not be required on the building side when the platform is less than 40 cm. from the building, except for suspended scaffolds where the maximum distance shall be 30 cm.

**10.6** Scaffolds shall be capable of supporting, without failure, their own weight and at least four times the maximum intended load. This requirement has exceptions as specifically noted herein for guardrail systems, suspension ropes, and for the design and application of solid sawn wood components and other wood-based members and connections to wood.

**10.7** Scaffolds shall not be moved nor altered while they are in use or occupied, except when a scaffold has been specifically designed for such use.

**10.8** Any scaffold damaged or weakened from any cause shall be immediately removed from service and shall not be used until repairs have been completed.

**10.9** Scaffolds shall not be loaded in excess of the design load. Manufactured scaffolds shall be used in accordance with the Manufacturer's recommendations.

**10.10** When scaffolds are secured to permanent structures, anchor bolts or other equivalent means shall be used. Window cleaners' anchor bolts shall not be used.

**10.11** Fasteners used in the construction of scaffolds shall be of adequate size and in sufficient numbers at each connection to develop the designed strength of the scaffold.

**10.12** Platforms on all working surfaces on all scaffolds shall be fully planked or decked with platform units as follows:

**a)** Platform units shall be placed as close as possible to adjacent units. Any space between adjacent units shall be no more than 3 cm. wide except as necessary to fit around uprights when side brackets are used to extend the width of the platform.

**b)** Where full planking or decking cannot be obtained using standard width units, the platform shall be planked or decked as fully as possible. However, the remaining open space between the platform and guardrail supports shall not exceed 24 cm.

**10.13** At intermediate supports in continuous runs, all platform units shall be secured from movement or shall be overlapped a minimum of 30 cm except for platforms supplied with cleats or hooks intended for the support of the plank. Overlap shall occur at supports and each unit shall extend a minimum of 15 cm. over support.

**10.14** At end supports, platform units, unless cleated or otherwise restrained by hooks or equivalent means at both ends, shall extend over their end support not less than 15 cm. nor more than 45 cm.

**10.15** Safe access shall be provided to work platforms of all types of scaffolds by one of the following, except during erection or dismantling.

**a)** Portable wood-, metal-, or glass-reinforced plastic ladders.

**b)** Scaffold frame when the maximum spacing between the climbing surfaces of the frame does not exceed 42 cm. The length of the climbing surface shall not be less than 25 cm.

**c)** "Hook-on" or attachable metal ladders specifically designed for use in conjunction with proprietary types of scaffolds.

**d)** Step-or stair-type access specifically designed for use with proprietary types of scaffolds.

**e)** Direct access from adjacent structure or personnel hoist. Ladders should be positioned so as not to tip the scaffold. Persons climbing or descending scaffold ladders shall have both hands free for climbing and shall remove foreign substances, such as, but not limited to, mud or grease, from their shoes and hands.

Cross braces shall not be used as a means of access or egress.

**10.16** The poles, legs, or uprights of scaffolds shall be plumbed, as well as securely and rigidly braced to prevent swaying and displacement.

**10.17** Materials being hoisted onto, or lowered from, a scaffold shall be provided with means to prevent damage to the scaffold and material. If the hoisting device is fastened to the scaffold, the scaffold shall be restrained from tipping at the hoisting elevation.

**10.18** When persons are at work on the scaffold and an overhead hazard exists, overhead protection shall be provided by the user and shall be positioned not more than 2.75 m. above the working platform.

**10.19** All ropes used for scaffold suspension shall be capable of supporting at least six times the intended load.

**10.20** When scaffolds are to be partially or fully enclosed, precautions shall be taken to assure the adequacy of the number, placement, and strength of ties attaching the scaffolding to the building because of increased load conditions resulting from the effects of wind and weather. The scaffolding components to which the ties are attached shall be strong enough to sustain, without failure, the additional loads imposed upon them.

**10.21** Free-standing scaffolds with height to base ratio of more than 4:1 shall be restrained from tipping by guying or other means.

**10.22** Where moving vehicles are present, the scaffold area shall be marked with warnings such as, but not limited to, flags, roped-off areas or barricades, or both roped-off areas and barricades.

**10.23** Metals shall not be used in combinations causing galvanic actions that will adversely affect the strength of the scaffold's components.

**10.24** Scaffolds shall not be erected or used in the immediate vicinity of power lines or electrical conductors until such are insulated, deenergized, or otherwise rendered safe against accidental contact.

## **11. EQUIPMENT**

### **11.1 General**

The materials and components and their method of assembly should comply with the relevant standards. A list of the other British Standards which give details of acceptable materials and components are given in Appendix A of BS 5973.

### **11.2 Steel Tubes**

Tubes are normally supplied with a maximum length of 6.40 m and are available in shorter lengths by request. Used tubes should be free from cracks, splits and excessive corrosion and be straight to the eye. The ends of load-bearing tubes should be cut cleanly and squarely with the axis of the tube and should not show excessive wear.

### **11.3 Section Properties of Scaffold Tubes**

The data given in Table 5 apply to tubes in the as new condition.

TABLE 5 - SECTION PROPERTIES OF SCAFFOLD TUBES

TYPE OF TUBE	OUTER DIA. $\phi$	WALL THICKNESS	MASS PER LINEAR $m$	CROSS SECTIONAL AREA $(A)$	MOMENT OF INERTIA $(I)$	MODULUS OF ELASTICITY $E$	ELASTIC MODULUS $E$	RADIUS OF GYRATION $r$	MINIMUM YIELD STRENGTH	MAXIMUM ALLOWABLE STRESS IN BENDING $P_{bc}$	MAXIMUM ALLOWABLE STRESS IN AXIAL COMPRESSION $P_c$	MAXIMUM ALLOWABLE STRESS IN SHEAR $P_s$	MAXIMUM ALLOWABLE STRESS IN AXIAL TENSION $P_t$	STIFFNESS $EI$
Steel tube complying with the requirements of BS 1139	mm	mm	kg/m	cm <sup>2</sup>	cm <sup>4</sup>	N/mm <sup>2</sup>	cm <sup>3</sup>	cm	N/mm <sup>2</sup>	N/mm <sup>2</sup>	N/mm <sup>2</sup>	N/mm <sup>2</sup>	N/mm <sup>2</sup>	N/mm <sup>2</sup>
	48.3 $\pm$ 0.5	4.0 $\pm$ 0.5 (permissible)	4.37 max.	5.57	13.8	210 000	5.70	1.51	210	139 <sup>(1)</sup>	See Table 14	93	127	2890 $\times 10^7$
		4.0 $\pm$ 0.4 (field)	7.3 % reduction											

(1) For those cases where tube may require the application of an allowance for corrosion,  $P_{bc}$  should be divided by 125 N/mm<sup>2</sup>.

## 11.4 Couplers and Fittings

Scaffold couplers and other fittings should, when new, comply with the requirements and recommendations and data provided by the manufacturer or supplier.

## 11.5 Decking Units

### 11.5.1 General

There are four groups of decking units, used to construct working platforms, as follows:

- a)** Timber scaffold boards of nominal cross sections  $38 \times 225$  mm. (For strength data, see Clause 6.5.2).
- b)** Components of similar width to those in (a), but fabricated, for example, of laminated timber or metal, with equal or greater strength.
- c)** Timber boards of greater thicknesses or width than those in (a).
- d)** Components of greater width than those in (a) and fabricated in various ways, such as platforms or light-weight staging.

All decking should have adequate strength to meet the recommendations for the appropriate duty of Table 6. To ensure this, timber scaffold boards should comply with the requirements of BS 2482.

#### Note:

Unless otherwise indicated, the use of the word 'board' in this document implies the decking described in (a) but the principles apply to all types.

### 11.5.2 Strength of scaffold boards and other timber members

#### 11.5.2.1 Scaffold boards

In some circumstances the strength of scaffold boards may be brought into play to contribute to the structural strength of the tubular framework. This is admissible, provided that the necessary calculations and design have been carried out. Table 6 gives some data for scaffold boards. When boards are used on edge as transoms, they should be maintained on edge by scaffold fittings and, if necessary, tubes.

The utilizations of the strength of a board on flat does not permit the omission of transoms supporting the boards at a maximum spacing in accordance with Table 8.

**TABLE 6 - PROPERTIES OF SCAFFOLD BOARDS<sup>1)</sup>**

BASIC CROSS-SECTIONAL SIZE <sup>2)</sup> mm	MINIMUM SECTION MODULES cm <sup>3</sup>	WORKING MOMENT OF RESISTANCE N/m
38 × 225	47.5	468
50 × 225	81.0	798
63 × 225	132.0	1300
1) Based on a maximum working stress of 9.85 N/mm <sup>2</sup> .		
2) Boards used on flat.		

**TABLE 7 - ACCESS AND WORKING SCAFFOLDS OF TUBE AND COUPLERS**

<b>DUTY</b>	<b>USE OF PLATFORM</b>	<b>DISTRIBUTED LOAD ON PLATFORMS kN/m<sup>2</sup></b>	<b>MAX. NUMBER OF PLATFORMS</b>	<b>COMMONLY USED WIDTHS USING 225 mm BOARDS</b>	<b>MAX. BAY LENGTH m</b>
Inspection and very light duty	Inspection, painting, stone cleaning, light cleaning and access	0.75	1 working platform	3 boards	2.7
Light duty	Plastering, painting, stone cleaning, glazing and pointing	1.50	2 working platforms	4 boards	2.4
General purpose	General building work including brickwork, window and mullion fixing, rendering, plastering	2.00	2 working platforms +1 at very light duty	5 boards or 4 boards +1 inside	2.1
Heavy duty	Blockwork, brickwork, heavy cladding	2.50	2 working platforms +1 at very light duty	5 boards or 5 boards +1 inside or 4 boards +1 inside	2.0
Masonry or special duty	Masonry work, concrete blockwork, and very heavy cladding	3.00	1 working platform +1 at very light duty	6 to 8 boards	1.8

**Notes:**

- 1) This Table should be read in conjunction with the remainder of the standard and Clauses 11 and 11.5.1 in particular.
- 2) The loads and number of loaded platforms and widths of scaffold from this Table have been used in the calculations given in Appendix B.

**TABLE 8 - MAXIMUM SPAN OF SCAFFOLD BOARDS**

<b>NOMINAL THICKNESS OF BOARD mm</b>	<b>MAXIMUM SPAN BETWEEN TRANSOMS m</b>	<b>MINIMUM OVERHANG mm</b>	<b>MAXIMUM OVERHANG mm</b>
38	1.5	50	150
50	2.6	50	200
63	3.25	50	250

## **12. DESCRIPTION OF ACCESS SCAFFOLDING**

### **12.1 General**

Putlog and independent tied scaffolds are generally as defined in definition and shown in Figs. 14 and 15. They are constructed in tubes and couplers for the purpose of providing working platforms adjacent to the surfaces of buildings. Guardrails and toeboards should be provided on all working platforms on a scaffold.

### **12.2 Putlog Scaffolds (see Fig. 14)**

A putlog scaffold consists of a single row of uprights parallel to the face of the building and set as far away from it as is necessary to accommodate a platform of four or five boards with the inner edge of the platform as close to the wall as is practicable.

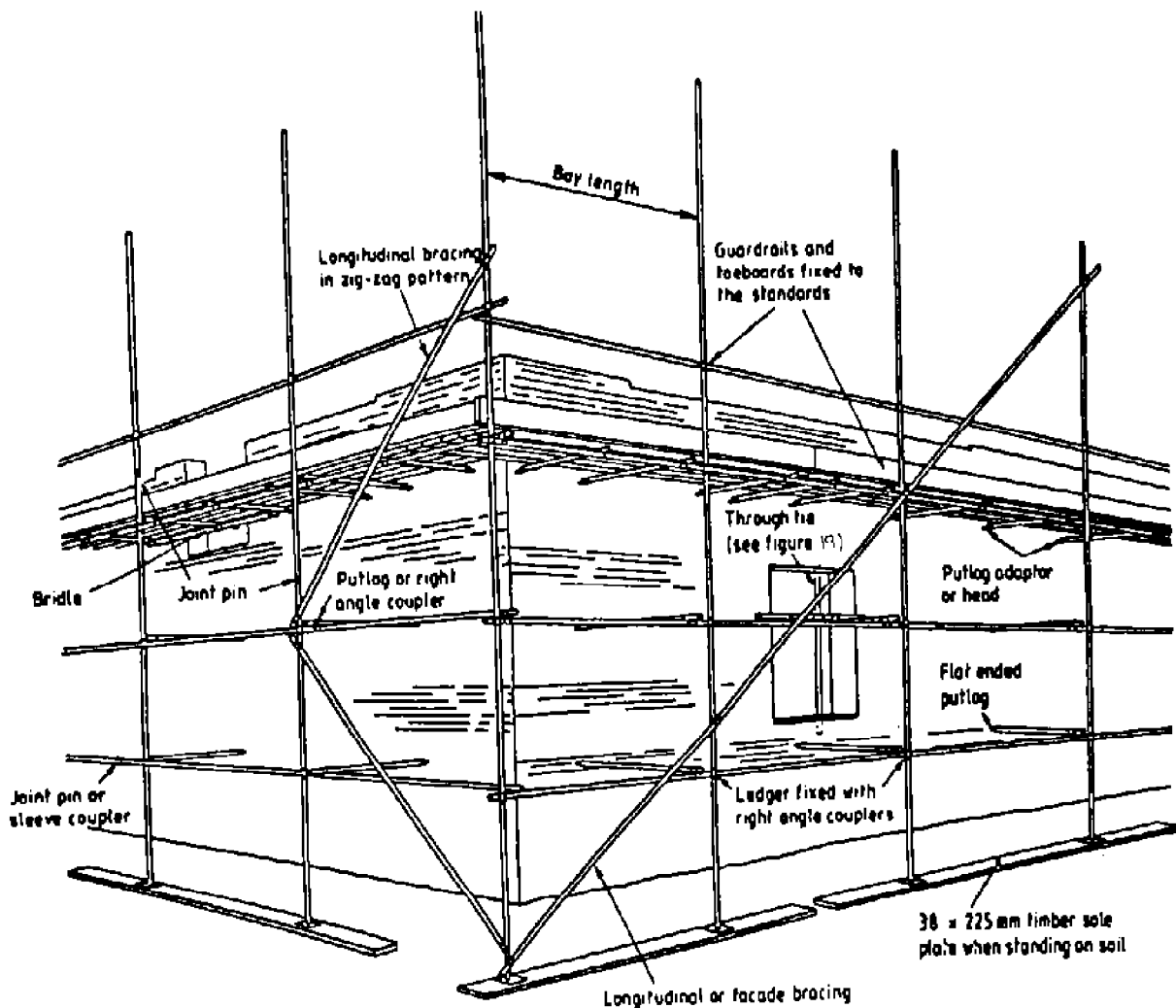
The vertical tubes are connected with a ledger fixed with right angle couplers and the putlogs are fixed to the ledgers with right angle or putlog couplers. The blade end of the putlog tube or putlog adaptor is normally placed horizontally on the brickwork being built. However, where putlog scaffolds are erected against an existing brick wall for repointing, the old putlog holes may be reused or others raked out. In this case the putlog blades may be inserted vertically.

Sole plates and base plates are usually used under each standard. Tying recommendations are detailed in Clause 8.

Where a putlog is required for a board support and it is opposite an opening in the building such as a window or doorway, the inside end of the putlog should be supported on an underslung bridle tube spacing between adjacent putlogs, as shown in Fig. 14, which also shows a method of tying through these openings.

Longitudinal bracing is required, at intervals not exceeding 30 m but, unlike independent tied scaffolds, ledger bracing is not required in the finished structure.

For brickwork, the lift height should be about 1.35 m, although for certain types of masonry a lower lift height may be necessary.



TYPICAL PUTLOG SCAFFOLD

Fig. 14

Note:

This drawing should be read in conjunction with the text.

### 12.3 Independent Tied Scaffolds (see Fig. 15)

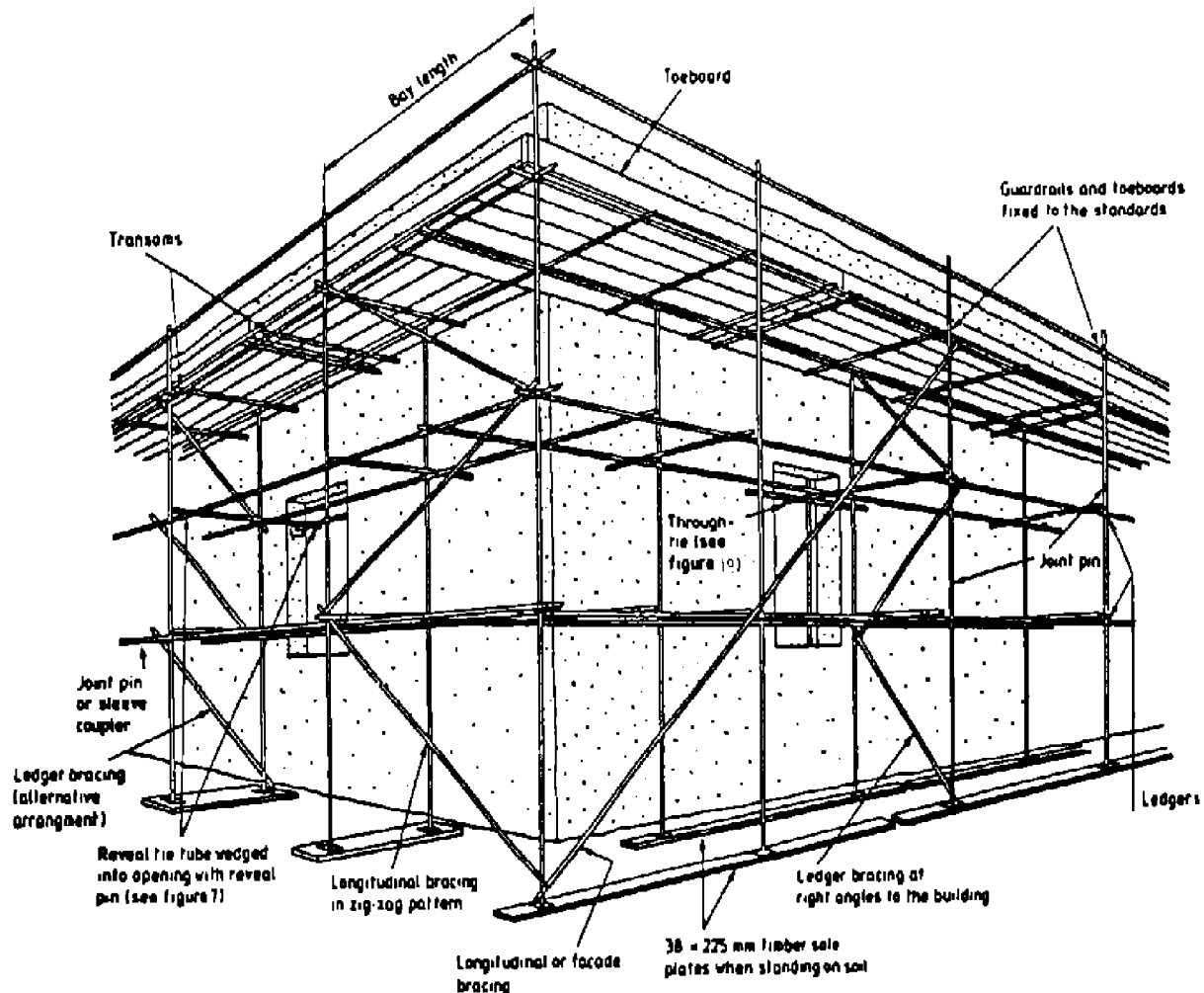
An independent scaffold consists of a double row of uprights, with each row parallel to the building. The inner row is set as close to the building as is practicable. The distance between the lines of uprights should be the minimum necessary to accommodate the required number of boards and toeboards.

A variation may be adopted in which the row of standards nearest to the building can be set back about 300 mm from the building face so that one of the boards of the platform can be laid between the inside row of standards and the building face.

The uprights should be connected with ledgers parallel to the building and fixed with right angle couplers and with transoms fixed to the ledgers with putlog couplers to give platform widths as given in Table 11.

Sole plates and base plates should be used under each standard when so recommended by Clause 16. The scaffold should be tied into the building at the frequency detailed in Clause 13.

Longitudinal bracing is required at intervals not exceeding 30 m. Ledger bracing is generally fixed to alternate pairs of standards.



**TYPICAL INDEPENDENT TIED SCAFFOLD**  
Fig. 15

Note:

This drawing should be read in conjunction with the text.

## 12.4 Duty of Scaffolds

### 12.4.1 Loading

Access and working scaffolds may be specifically designed and constructed for any particular distributed or point load and for a variety of purposes. If no load rating is quoted by the specifier, it is recommended that the selection is made from Table 7. For platform loadings on access towers and other types of scaffold, reference should be made to the relevant clause in section 5. of BS-5973.

### 12.4.2 Maximum bay lengths

The bay lengths depend on the height and loading of the scaffold. Table 7 gives maximum bay lengths of scaffolds with single standards (see Figs. 15 & 16).

### 12.4.3 Lift heights

The normal lift height for brickwork is 1.35 m, and for walk-through scaffolds is 2.0 m. In certain circumstances lifts greater than 2.7 m are required and are admissible provided the load applied to the vertical tube is not greater than the value given in Table 9 for the appropriate height.

**TABLE 9 - MAXIMUM PERMISSIBLE AXIAL STRESSES AND LOADS IN STEEL SCAFFOLD TUBES MANUFACTURED IN ACCORDANCE WITH BS 1139**

EFFECTIVE LENGTH $l$  mm	SLENDERNESS RATIO $V_r$	AS NEW TUBES		USED TUBES	
		PERMISSIBLE AXIAL COMPRESSIVE STRESS $P_c$ N/mm <sup>2</sup>	PERMISSIBLE AXIAL LOAD kN	PERMISSIBLE AXIAL COMPRESSIVE STRESS $P_c$ N/mm <sup>2</sup>	PERMISSIBLE AXIAL LOAD kN
0		127	70.7	108	60.1
250	15.9	123	68.5	105	58.2
500	31.8	119	66.2	101	56.3
750	47.8	113	63.0	96.2	53.6
1000	63.7	104	57.7	88.1	49.1
1250	79.6	90.3	50.3	76.8	42.8
1500	95.5	75.4	42.0	64.1	35.7
1750	111.5	61.4	34.2	52.2	29.1
2000	127.4	50.0	27.9	42.5	23.7
2250	143.3	40.9	22.8	34.8	19.4
2500	159.2	34.0	18.9	28.9	16.1
2750	175.2	28.7	16.0	24.4	13.6
3000	191.1	24.2	13.5	20.6	11.5
3250	207.0	20.9	11.6	17.8	9.9
3500	222.9	18.1	10.1	15.4	8.6
3750	238.8	15.9	8.8	13.5	7.5
4000	254.8	14.1	7.9	12.0	6.7
4250	270.7	12.5	6.9	10.6	5.9
4500	286.6	11.2	6.2	9.5	5.3
4750	302.5	10.1	5.6	8.6	4.8
5000	318.5	9.1	5.1	7.7	4.3
5250	334.4	8.2	4.6	7.0	3.9
5500	350.3	7.5	4.2	6.4	3.6
5750	366.2	6.9	3.9	5.9	3.3
6000	382.2	6.4	3.5	5.4	3.0

**Notes:**

- 1) It is recommended that, for columns carrying dead and imposed loads,  $V_r < 207$ .
- 2) For struts and braces intended to carry wind loads and lateral forces,  $V_r < 271$ .
- 3) For members designed as ties but which may suffer reversals of loading,  $V_r < 383$ .
- 4) Where there is combined bending and axial compression, treat as for combined stresses in BS 449, using the appropriate value of  $V_r$  and stress from table.

**12.5 Calculations Required for the Construction of Access Scaffolding****12.5.1 General**

Unsheeted access and working scaffolds may be constructed up to a height of 50 m without calculations provided that they are constructed in accordance with the instructions of Clause 12 and that they do not carry greater loads nor have greater bay lengths than those given in Table 7. A further instructions is that they are not subjected to loading of materials by mechanical means, such as by rough terrain fork lift trucks.

All other forms of scaffold should be subject to design and calculations.

Appendix A gives examples of the calculations.

**12.5.2 Sheeted scaffolds**

Where sheets are added to scaffold, for instance for the protection of the public or where weather protection sheeting is attached to part of it for the benefit of the workmen using the scaffold, special consideration should be given to tie spacing. The scaffold shall also need to be specially designed with consideration given to the wind velocities in excess of 39 m/s. The information can be obtained from local meteorological organization.

When a temporary roof is to be fixed to the top of an access scaffold, the scaffold and its attachments to the building should be specially designed.

**13. TYING SCAFFOLDING TO BUILDING FACADES****13.1 General****13.1.1 Basic requirements**

Means of resisting inward and outward movement should be provided for both independent and putlog scaffolds. This will normally be by attachment with ties to the facade at a number of points. Where the structure and its components are strong enough in the interests of safety and economy, permission should be sought to use ties.

A tie to the facade consists of a tie member, normally a tube, and an anchorage. Various types are described in Clause 13.4. Where the recommendations of 13.1.2 to 13.8 can not be followed, the facade should be considered abnormal, and the scaffold should be specially designed (see Clause 13.9). See Clause 13.7 for alternatives to ties.

**13.1.2 Building structure**

It should be established, by test if necessary, that the strength of the building structure at the location of a tie is adequate to sustain the loads which will be transferred to it. This applies particularly to any proposed use of parapets or architectural features such as railings as it is frequently found that the anchorage value of such features is negligible.

### 13.1.3 Movable and non-movable ties

A scaffold should be erected, adequately tied, and wherever practical these ties left undisturbed until the scaffold is dismantled. The choice of appropriate ties and their positioning should make this possible. Such ties are referred to as non-movable and they are provided at an agreed regular spacing.

Where it is necessary to remove a tie, however temporarily, the scaffold will be less secure, and accordingly a higher provision of ties will be appropriate. The actual calculation of area should be made with any one tie removed. Ties which it may be necessary to remove temporarily are referred to as movable.

## 13.2 Layout of Ties

Ties should be evenly distributed over the scaffold, both horizontally and vertically. The spacing of lines of ties should not exceed 8.5 m, either vertically or horizontally, but individual ties should still be within the area rule (see Table 10). Where the building surface permits a staggered arrangement of ties, this should be adopted in preference to a rectangular pattern.

Where the capacity of individual anchorages is less than 6.25 kN, a tie should either be attached to two or more, or additional ties used, so that adequate capacity is provided. The friction of the foundation of a scaffold can be regarded as providing adequate attachment of the lower 3 m of the scaffold.

## 13.3 Frequency of Tie Points on the Scaffolds

### 13.3.1 General

At least the number of ties stated in Table 10 should be installed. The frequencies in the table do not apply where the design wind speed is greater than 39 m/s (140 km/h).

The frequency are based on a minimum tie and anchorage safe working capacity of 6.25 kN each, and the majority of ties will be this capacity. For reveal ties (see Clause 13.7.1 (b)) the capacity is less, and their security is less assured, so a smaller area per tie is appropriate. This has been taken into account in Table 10. No scaffold should rely only on reveal ties, and every attempt should be made to keep them below 50% (see also Clause 8.9). Some cast-in and drilled anchors do not have the standard capacity of 6.25 kN because of the weakness of the material into which they are fixed, and in such cases the number of anchors to be provided should be calculated by proportion. This also applies to any other case when a tie capacity of 6.25 kN cannot be made available.

### 13.3.2 Unsheeted scaffolds

The Figures given in Table 10 are for scaffolds less than 50 m high. If scaffolds are higher they should be specially designed.

### 13.3.3 Sheeted scaffolds

The recommendations given in Table 10 are for scaffolds less than 25 m high on sites other than open area and where there is a tie capacity of 12.5 kN at each tie position. If any of these conditions are not met the scaffold should be specially calculated.

## 13.4 Ties

### 13.4.1 Selection of ties

The type of tie and anchorage should be selected from those given in Clause 13.4.2 to 13.4.5 to suit the tying requirements and the nature of the facade.

**TABLE 10 - FREQUENCY OF TIES IN SQUARE METERS PER TIE**

This Table should be read in conjunction with Clause 13.3

UNSHEETED SCAFFOLDS	TIES 12.5 kN <sup>1)</sup>	TIES 6.25 kN <sup>1)</sup>	UP TO 50% REVEAL TIES 3.5 kN <sup>1)</sup>	OVER 50% REVEAL TIES 3.5 kN <sup>1)</sup>
Independent scaffolds with movable ties with non-movable ties	32 40	32 40	25 31	2) 22
Putlog scaffolds with non-movable ties	32	32	25	2)
Sheeted scaffolds with movable ties with non-movable ties	25 32	12.5 16		
1) Safe working capacity. 2) Not recommended.				

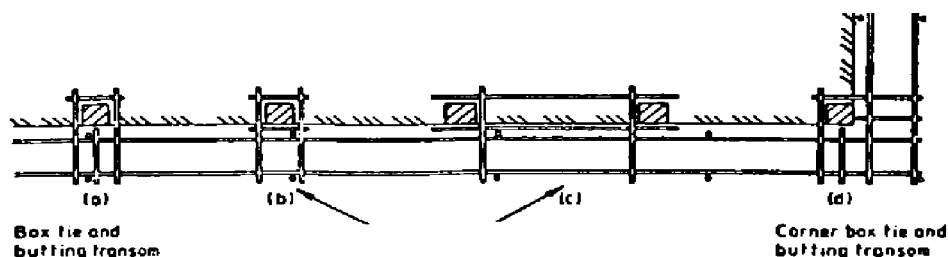
#### Notes:

- 1) Where tie capacities are less than those stated, appropriate frequencies should be calculated by proportion.
- 2) For tie capacity see 8.7.
- 3) The height of the scaffold has been assumed to be:  
for unsheeted scaffolds less than 50 m;  
for sheeted scaffolds less than 25 m, but see also 13.3.3.

### 13.4.2 Box ties

Box ties consist of an assembly of tubes and couplers arranged in the form of a square fixed around columns or other elements of the building, being wedged, where necessary, to resist both the inwards and outwards movement and to give some degree of lateral restraint. Figs. 16(b) and (c) are typical examples.

They should be at the level of the scaffold lift and be joined to both the inside and the outside ledgers or Vertical tubes. If this impedes free access through the scaffold, then it is permissible for them to be fixed to the inside vertical tube. In this case they should be adequately attached to resist the loading.



**PLAN OF TYPICAL BOX TIES**

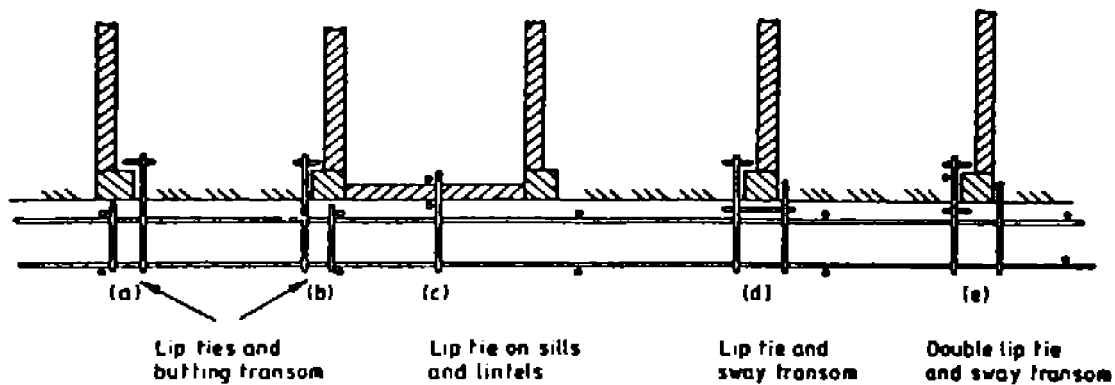
**Fig. 16**

### 13.4.3 Lip ties

Where it is not possible to use box ties, lip ties may be used (see Fig. 17). These consist of an L-shaped arrangement of tubes and couplers to hook the scaffold behind elements of the building. They do not resist inward movement of the scaffold and should be accompanied by an adjacent butting transom or have two cross tubes, nor do they resist sway. They are improved in performance by the use of a sway transom as shown in Fig. 17. Sway transoms should not be regarded as a substitute for facade bracing. They should be coupled to the ledger with load bearing couplers. Care should be taken to ensure that the strength of any building feature utilized is adequate, particularly if this is a parapet or similar structure.

Lip ties may also be used over sills and under lintels. In these cases, it will be infrequent that the sill or lintel tie is on a level with a lift of the scaffold and they can be fixed to the inside uprights only or to a bridle tube fixed to two inside uprights. They should be accompanied by adjacent butting transoms and sway transoms.

In certain circumstances it is not possible to fit butt tubes at right angles to the transom to form lip ties. Right angle couplers can be used as stops, provided there is at least a 25 mm lap onto a suitable part of the building.



PLAN OF TYPICAL LIP TIES AND SWAY TRANSOMS

Fig. 17

### 13.4.4 Through ties

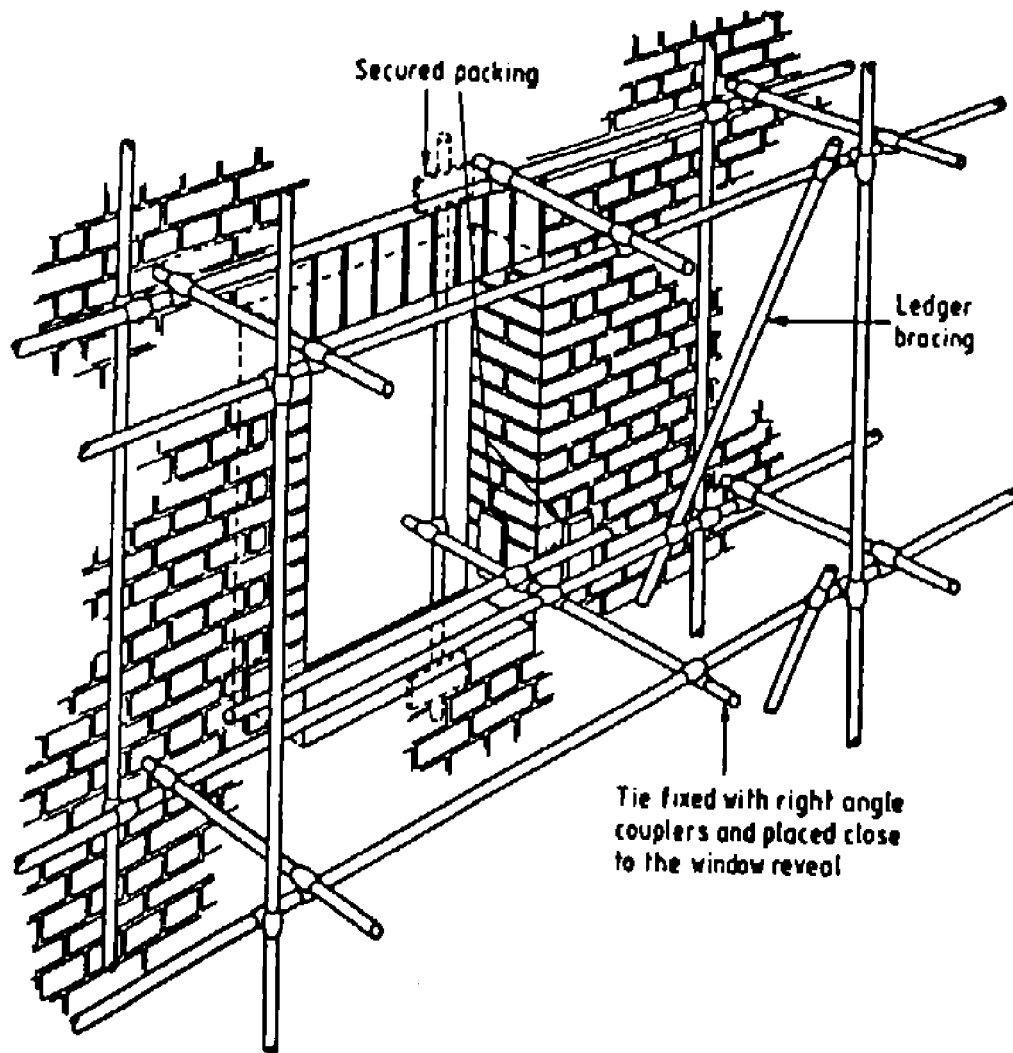
#### 13.4.4.1 Through ties for independent ties scaffolds

Through ties (see Fig. 18) rely on a tube across the inside of an opening such as a window in a building.

The inside tube should be placed vertically and rest on the floor so that it cannot slip downward, but it can be placed horizontally.

The tie tube should rest on the sill for the same reason but it may be placed under the lintel. Tie tubes attached to a tube across the inside of the window or opening should be as close to one of the edges of the opening as possible.

Where it is not possible to fix an outside tube, the adjacent transoms should butt against the outside surface of the wall.



Note:

This drawing should be read in conjunction with the text.

#### THROUGH TIE FOR INDEPENDENT TIED SCAFFOLD

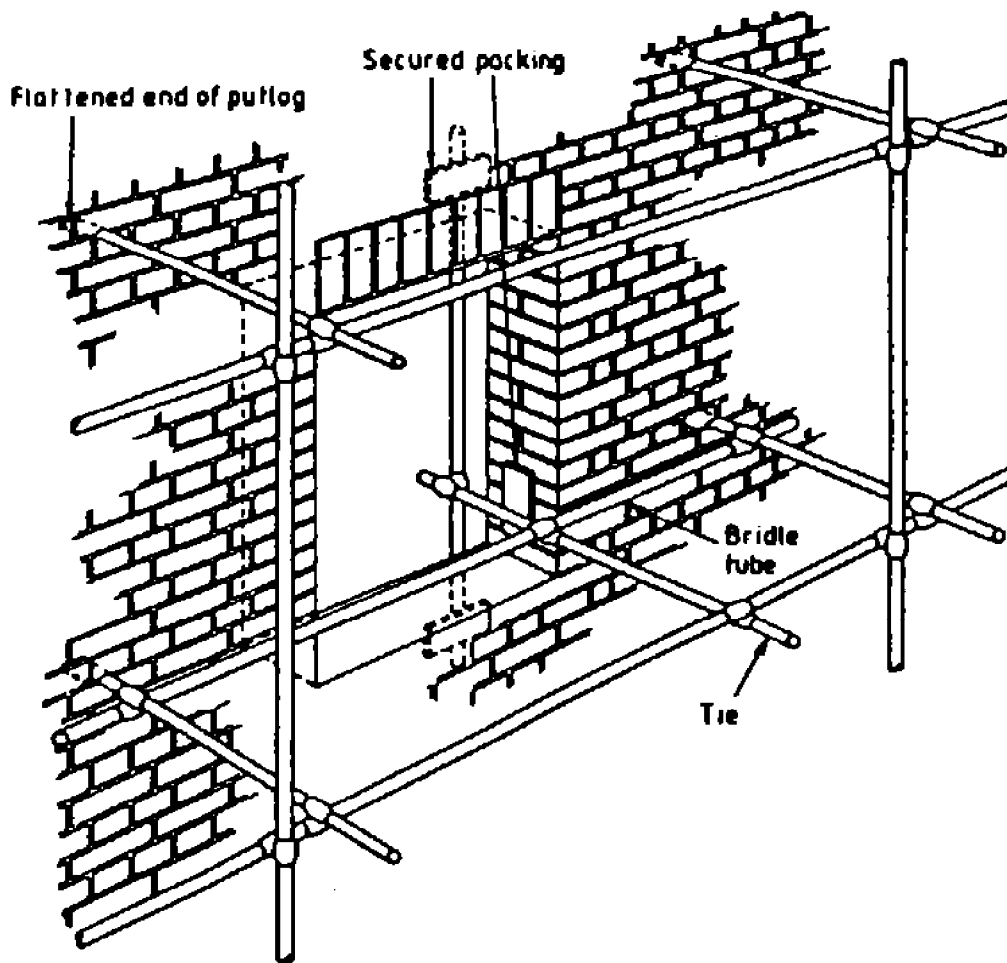
Fig. 18

##### 13.4.4.2 Through ties for putlog scaffolds

When a putlog is required to support boards and it is opposite a window opening, a bridle tube is frequently placed near the wall across the adjacent putlogs on either side of the window. The putlog opposite to the window is fixed to this.

A similar arrangement can be used to form a through tie.

Fig. 19 shows an arrangement in which a tie tube is underslung and attached to both ledger and bridle.



**Note:**

This drawing should be read in conjunction with the text.

**THROUGH TIE FOR A PUTLOG SCAFFOLD ON A BRIDLE TUBE**  
**Fig. 19**

#### 13.4.5 Reveal ties

In cases where it is impracticable to drill into the surface of a building for screw or anchor ties, or where the quality of the fabric of the building is not known, or where it is impracticable to open windows for tube and coupling ties, the attachment of the scaffold should be made by reveal ties which rely on friction (see Clause 13 and Fig. 21).

Opposing faces of a building surface, such as the two opposing sides of a window opening or alternatively the underside of the lintel beam and the sill if this is not sloping, can be used to make an attachments of a tube, wedged or jacked tight between the opposing faces.

It is essential that the manner of wedging the reveal tube into the opening be firm, reliable and, if possible, positive rather than by friction, i.e. if the reveal tube can be fixed behind indentations or masonry features advantage should be taken of this (see 13.4.3).

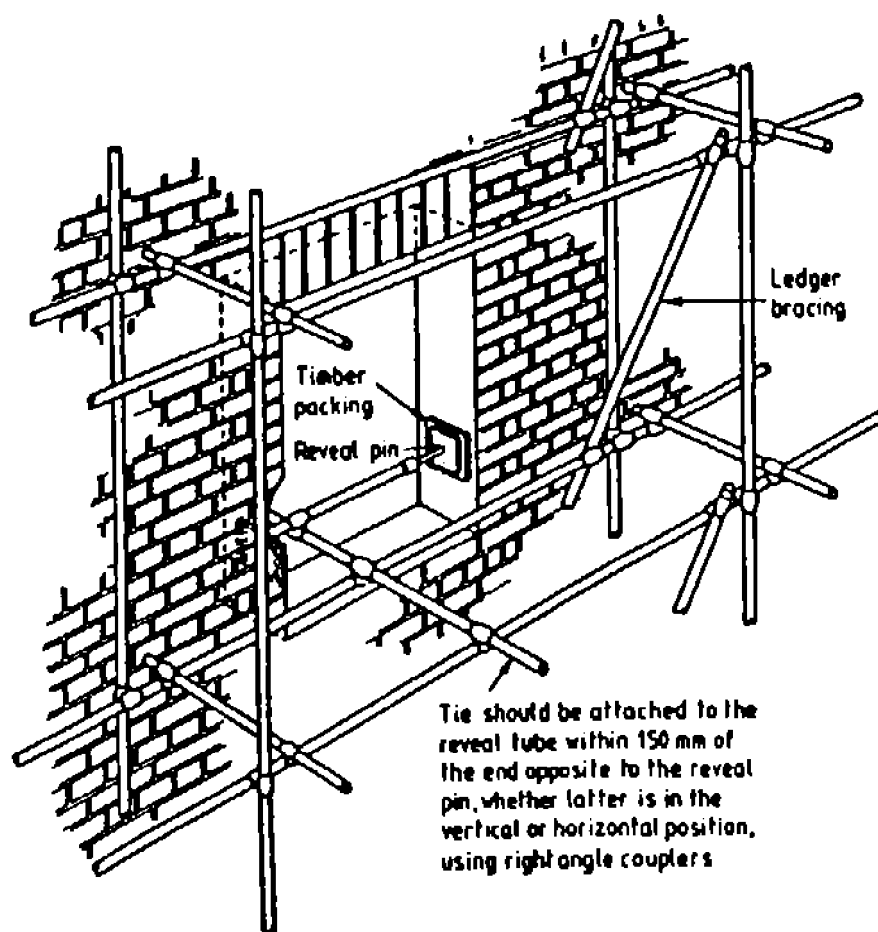
For most building surfaces, the reveals are plain and parallel and should not be marked or damaged. For these, it is frequently necessary to place a packing between the end of the reveal tube and the surface so that damage does not occur. Timber packs should be thin so as to reduce shrinkage (a thickness of 10 mm is desirable). It is not expected that they should spread and load over the surface of the reveal but that they should grip it and protect it at the same time.

The preferred method is to use a reveal pin at one end of the reveal tube. This consists of a small plate on which is mounted a threaded bar and nut. The assembly should be placed inside the bore of the reveal tube and the nut adjusted until the reveal tube is expanded into the opening, gripping it with considerable force.

The tie tube should be fixed to the reveal tube with a right angle coupler as near as possible to the end opposite to the reveal pin and in all cases within 150 mm of the face of the opening. It should also be fixed to the scaffold in two places with right angle couplers (see Fig. 21) but other arrangements may also be satisfactory.

For a putlog scaffold, a bridle tube attached to two putlog tubes can provide a second fixing point. There are other methods of providing reveal ties, for instance by utilizing props and struts.

Because reveal ties rely on friction and are usually packed with timber, they should be frequently checked for tightness during the life of the scaffold.



**Notes:**

- 1) This drawing should be read in conjunction with the text.
- 2) The tube in the reveal can be in the vertical or horizontal position.

**REVEAL TIE**  
**Fig. 20**

## 13.5 Anchorage and Allied Components

### 13.5.1 Selection

An anchorage can be provided by casting in or subsequently fixing something, normally a threaded socket, into a part of the structure itself. Various components are then used to attach the scaffold. The appropriate anchorage and tie should be selected from the principal types described in Clauses 13.5.2 to 13.5.5. Anchorages and allied components should have a safe working capacity of 6.25 kN in tension and compression.

### 13.5.2 Cast-In and drilled anchorages

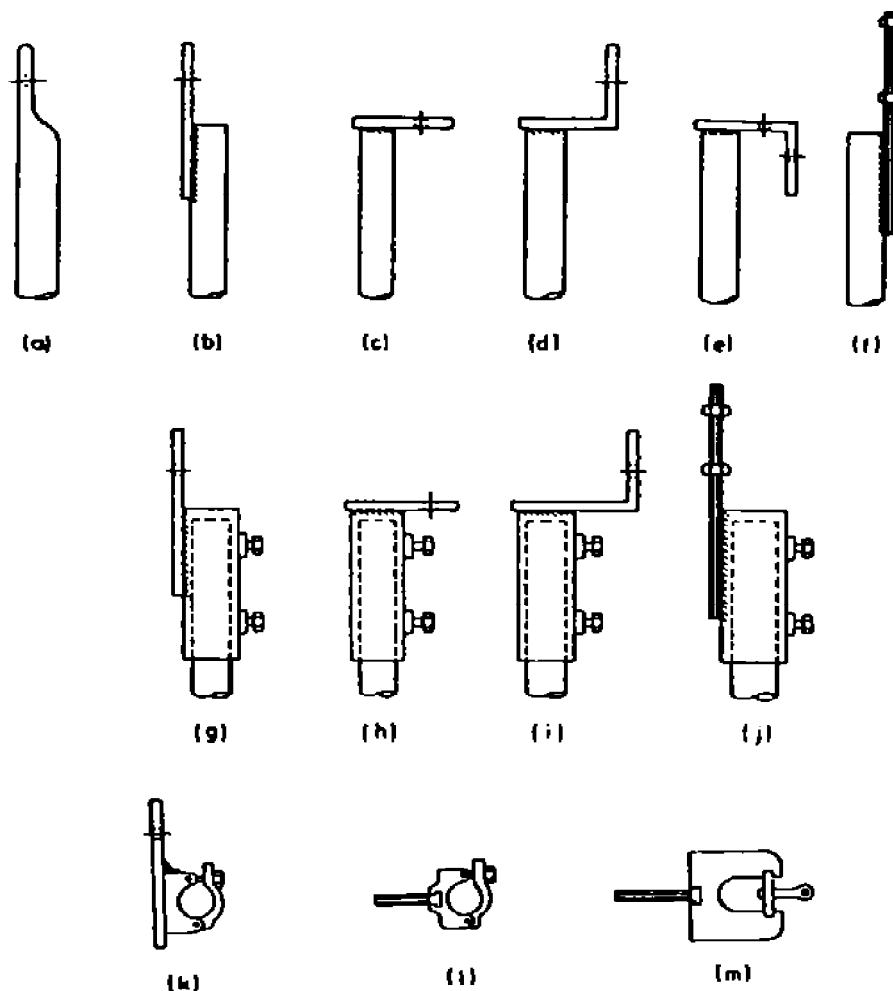
A variety of screwed plates, sockets and nuts are available for setting into the concrete during pouring, in a similar manner to framework anchors, for subsequent use as scaffold ties. The attachment of the tie to the anchorage should be either by bolts welded to scaffold tubes or by use of special scaffold fittings (see Fig. 21) Ring Bolts can also be used (see Fig. 23).

A variety of anchor sockets are available intended for fixing into holes drilled into hardened concrete or sound brickwork. The attachments are similar to cast-in anchors. Specialist advice should be sought before using resin anchors. When drilling into brickwork, the anchor should be placed in the solid portion of the brick.

If the brickwork has been rendered, the location of the center of the bricks should be found by drilling test holes and inspecting the location of the courses and brick ends through the holes. Care should be taken that the facade material is an integral structural material and not a surface cladding.

Holes for anchor sockets should be drilled to the correct depth and diameter as recommended by the manufacturer and be clean and normal to the surface. Some cavity walls and thin cladding panels may be unsuitable for supporting tie loads in which case other tying methods should be used. When intending to fix anchorages, data provided by manufacturers and based on tests carried out with substrates comparable to that of the structure may be used, applying a minimum factor of safety of 2.0 on the failure load quoted to determine the safe working load.

The capacity of the anchorages should be established either by a proof load test or by test to failure on a representative sample chosen on an acceptable statistical basis. The Manufacturer's recommendations in this respect should normally be adopted.



**TYPICAL END DETAILS FOR TIE TUBES**  
Fig. 21

### 13.5.3 The tube adaptors

Tubes fitted with end plates (see Fig. 21) can be used when it is possible to drill the element of the building to which the tie is to be attached and fix the end plate to it with expanding bolts. On new work, cast-in sockets can be used.

The tube welded to the drilled end plate can be vertical scaffold tube, or tube of 60.3 mm external diameter able to receive vertical scaffold tube inside it, the two tubes being fixed together with friction bolts.

Offset ties [such as shown in Fig. 21(d)] enable fixing of the scaffolding to the building so that the window frames can be placed between the tie tube and the column.

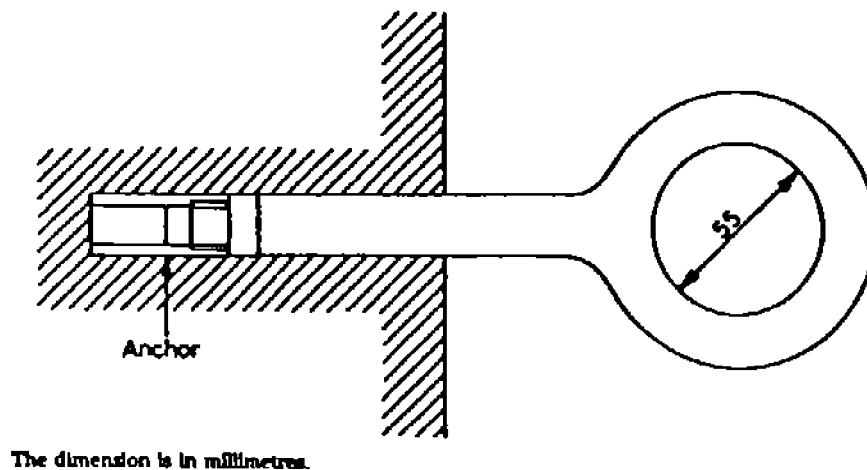
A variety of scaffold fittings and half fittings may be adapted, by securely welding on bolts or drilling bolt holes, to become satisfactory tie fittings.

### 13.5.4 Ring bolts

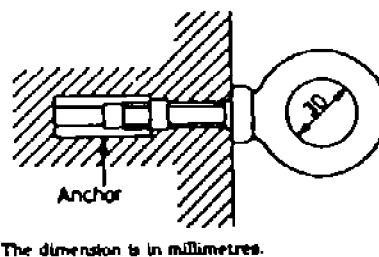
Typical ring bolts are shown in Figs. 22 and 23. They may be of two sizes:

- a) with rings of between 50 mm and 55 mm internal diameter through which scaffold tube may be passed to form a tie assembly;
- b) with smaller rings for use with wire or steel banding ties;

In case (b), the tube and fittings assembly should be such that it prevents the scaffold from moving inwards or outwards.



**TYPICAL RING BOLT TIE**  
Fig. 22



**TYPICAL WIRE OR BAND TIE ANCHORAGE**  
Fig. 23

### 13.5.5 Wire and steel banding ties

Where the small ring anchorages shown in Fig. 23 are used, the scaffold may be attached to the building or structure with 6 mm wire rope threaded through the ring and round a member of the scaffold with a minimum of three turns. Steel banding of equivalent strength may also be used. When wire or banding is used, the tie does not prevent the scaffold from moving inwards to the building and accordingly such ties should be accompanied by adjacent butting and sway transoms.

Many elements of a building will afford opportunities for the attachment of wire ties and can be used provided they are of adequate strength. However, it should be realized that the anchorage value of these elements is frequently negligible. The strength and pull-out capabilities of these elements, which will include rainwater pipes, parapets and other architectural features should be verified before any use is made of them. Where there is any doubt as to the suitability of such features, alternative attachment points should be found. Rainwater guttering should never be used for the attachment of ties.

### **13.6 Attachment of the Scaffold to the Anchorage Point**

In plan, tie tubes or banding ties should be set at right angles to the building unless they are intended to plan brace the scaffold against lateral movement. In the latter case, they can be set at an angle to the plan perpendicular to the building but should be fixed in pairs at opposing angles so as to afford lateral stability in both directions and should be accompanied by ties at right angles to the building to prevent outward movement.

In elevation, tie tubes should be horizontal or sloping downwards away from the building. They should not slope upwards away from the building. Ties should be attached to both the inside and outside ledgers or vertical tubes at a point not more than 300 mm from a ledger braced standard, and as near to a node point as possible. Where this hinders access along a platform, attachment to the inside ledger or upright only is permissible.

The couplers for ties set horizontally and at right angles to the building should be right angle couplers or another such arrangement of couplers which gives similar or adequate strength. The couplers for ties set at an angle to the building may be swivels.

Where wire or bonding ties are used, they should be turned round a node point of the scaffold or otherwise prevented from slipping along the ledger or upright by fixing safety couplers. A tube butting against the structure will be required in order to provide inwards strength.

### **13.7 Capacity of Tie Systems and Alternatives**

#### **13.7.1 Inwards/outwards capacity**

Providing that the instructions of Clauses 13.4 and 13.5 are followed, each tie assembly should be considered as having the following safe working capacity.

##### **a) Box ties, lip ties and through ties**

6.25 kN inwards and outwards for all the ties shown in Figs. 16, 17, 18 & 19.

##### **b) Reveal ties**

3.5 kN inwards and outwards where ties rely solely on friction there is no mechanical interlock and construction is in accordance with Fig. 20.

6.25 kN outwards where the reveal tube goes behind a load-bearing feature and the tie tube is tight to that feature, and there is a butt tube.

##### **c) Cast-in and drilled anchorages**

In accordance with Clause 13.5.2, i.e. the manufacturer's stated safe working load with an appropriate factor of safety or a value determined by site tests inwards and outwards.

**d) Tie tube adaptors**

6.25 kN inwards and outwards.

**e) Ring bolts**

6.25 kN inwards and outwards.

**f) Wires and steel bands**

6.25 kN outwards.

**13.7.2 Lateral and vertical capacity**

Except in special cases, the design should not call for vertical or lateral capacity. But in the event of damage to the scaffold below, some vertical or lateral strength will prove advantageous.

**13.7.3 Equivalent tying value of scaffold returns, buttresses and rakers**

The stability of a scaffold can be achieved by means other than ties fixed to the surface of the building.

Returns of scaffolds which are themselves effectively tied round the ends of building facades should be regarded as providing an adequate attachment of the scaffold to the facade for a 3 m length of the scaffold, measured from the end of the building.

Specially designed buttresses, either side of a scaffold, should be regarded as providing adequate stability for a 3 m length of the scaffold on either side of the buttress.

Single unjointed raking tubes of up to 6 m in length, at 6 m centers coupled at the top to the ledger at the second lift and tied back to the scaffold at the foot, should be considered as providing adequate stability for scaffolds up to 6 m high. The raking tube should be external to the scaffold and at an angle of not more than 2 vertical to 1 horizontal.

For other applications they should be designed in accordance with Table 14 of BS 5973 taking the self weight into account.

**13.8 Special Details****13.8.1 First working lift**

When a working lift is required at 1.35 m height, as in a putlog scaffold, or at 2 m height, as in an independent tied scaffold, and no firm part of the building has been constructed to attach a tie, a scaffold should be temporarily stabilized by raking tubes or other means. Such tubes should also be fixed during dismantling if low level ties are impracticable. Movement of the lower end should be prevented by a foot tie to the main scaffold or other suitable means.

**13.8.2 Ties for small scaffolds without returns**

When only two ties are required, it is preferable to place the ties towards the ends of a straight run of scaffold.

## **13.9 Abnormal Facades**

### **13.9.1 General**

Where the tying arrangements of the previous clauses are inapplicable, the facade is considered abnormal and any such scaffold requires special consideration. Such facades will have no holes or possibilities for making them. Even if reveal ties are possible tying should not be reliant on such ties and they should not exceed 50% of the total (see Table 10).

Where tying can only be provided by reveal ties these should only be adopted after careful consideration of their ability to carry the load and where their physical condition will be regularly maintained.

### **13.9.2 Weak structure**

If the material is too weak to support an anchor, or if the structure as a whole is too weak, other means of access should be considered. These include tower mounted scaffolds, and hydraulic platforms.

### **13.9.3 Limited facade size**

Where the facade concerned is not large, suitable methods of restraint include the use of raking tubes, buttresses, wire ties over the roof or round the sides, struts from other buildings and additional width of the scaffold.

If the ends of buildings are without windows and are unsuitable for fixing ties, consideration should be given to return scaffolds at the front and the back, or to wire ties along the front and the back. Where the untied facade is longer than 6 m, plan bracing across the corners of the scaffold and its front and back returns should be fixed at intervals of height not more than 8.50 m. Where the untied facade is longer than 10m, additional plan bracing should be fixed across the full length of the untied structure at intervals of height of not more than 8.50 m. For lengths greater than 15 m, other methods should be considered.

Where a complete hollow structure is fully scaffolded internally or a structure of small plan area is completely surrounded outside by scaffolding, consideration should be given to dispensing with ties and placing reliance on butting transoms. In this case the lateral stability of the scaffold should be ensured by face bracing.

## **14. BRACING**

### **14.1 General**

Bracing should be provided to stiffen the scaffold. The plan to be braced should, wherever practicable, be divided into a complete series of triangles by braces. These should be fixed as close as possible to intersections. A check should be made on the reduction in strength of the scaffold where a brace has to be omitted or where it cannot be fixed within 300 mm of an intersection.

### **14.2 Ledger Bracing**

Independent tied access scaffolding should contain ledger bracing which should generally be on alternate pairs of standards. Any pair of standards which are ledger braced should be made into a complete series of triangles.

The direction of ledger bracing is immaterial for the structural stability of the scaffold but it should be pre-planned to take account of the intended use of the scaffold.

In scaffolding over footpaths, it is not possible to ledger brace the lowest lift. Ledger bracing should be omitted from this lift provided the lengths of the vertical tubes in the lift area are not in excess of 2.7 m. In this case account should be taken of the reduced loading capacity of this lift.

When the height of the lowest lift is in excess of 2.7 m, a knee brace should be inserted across the top corner of the lower lift, commencing at approximately 1.8 m from the ground.

One such knee brace should occur on every pair of vertical tubes and be fixed with alternate slopes. On large scaffolds it is sometimes desirable to insert cross knee braces on every pair of vertical tubes. To be effective, a ledger should be fixed adjacent to where the knee brace meets the vertical tubes.

When the bay length is 1.6 m or less, the ledger bracing can be fixed to every third pair of standards.

The ledger bracing should preferably be fixed from ledger to ledger with right angle couplers when the lift is not to be boarded but may be fixed to the vertical tubes using swivel couplers.

The bracing on boarded lifts should be from under the outside ledger of a boarded lift down to the inside ledger of the lift below so as to avoid the toeboard. This arrangement may require an extra width on the scaffold to accommodate the brace. Ledger bracing from the inside ledger to the guardrail level of the lift below may be used provided that every pair of standards is so braced instead of every alternate pair.

### **14.3 Facade Bracing**

Longitudinal bracing should be provided to all scaffolds in which the movement along the facade of the building is not prevented by other means. It need not be fixed where the scaffold is securely butted between opposing outside or inside faces of returns or recesses, provided that no length greater than 10 m is so fixed against movement in both directions.

When longitudinal bracing is omitted, the lateral movement of both the inside and outside lines of the vertical tube at every lift should be prevented either by both lines being adequately butted or by adequate plan bracing onto firm points inserted at every level.

Longitudinal bracing should be achieved by tubes set at between 35° and 55° to the horizontal, reaching from bottom to top of the facade. The principal forms are:

- a)** individual tubes set in zig zag pattern, the top of a tube and the bottom of the next preferably being attached to the same transom;
- b)** continuous tube, extended as necessary to cover the whole facade, only possible for wider facades;
- c)** individual tubes as in (a), but all sloping the same way; the top of one is connected at a ledger/vertical tubes intersection, and the bottom of the next is attached to the same pairs of vertical tubes.

A combination of these may be appropriate.

In all cases, the bracing tubes should be connected either:

- 1)** to every lift of the extended transoms with right angle couplers; or
- 2)** to every vertical tubes with swivel couplers.

Arrangement (1) is to be preferred.

One such brace assembly should be provided at intervals along the scaffold not exceeding 30 m. The longitudinal bracing should be fixed as near to the vertical tubes as possible. When the brace is fixed to extended transoms, the latter should be fixed to the outside ledgers with right angle couplers.

The longitudinal bracing should include the lower lift being started from the base of one of the outside vertical tubes. In the lower lift, when the bracing is started a guardrail should be placed through the braced bay to prevent people passing. The joints in continuous diagonal bracing should be made by overlapping the two lengths of the tube by a distance of at least 300 mm and joining them together with two parallel couplers. Alternatively, the two tubes may be joined by a sleeve coupler or other coupler capable of sustaining the applied load or by an expanding joint pin lapped with a butt tube with one fitting either side of the joint.

#### **14.4 Plan Bracing**

Plan bracing should be provided to all portions of an access scaffold which are not otherwise stabilized against lateral distortion. It may be joined by the same type of couplers used for longitudinal bracing and the same rules with regard to strength apply.

#### **14.5 Couplers for Fixing Braces**

Right angle couplers should be used to fix braces to ledgers or transoms and swivel couplers should be used for the attachment to vertical tubes. Other couplers may be used provided that they are capable of sustaining a safe working load of 5 kN.

### **15. FOUNDATIONS**

#### **15.1 General**

The foundations for a scaffold should be adequate to carry and dispose the load imposed both locally at each standard and, in general, to carry the whole weight of the scaffold.

The foundation for a scaffold should be maintained in an adequate condition during the life of the scaffold.

#### **15.2 Hard Surfaces**

On surfaces such as steel and concrete which are even and level and where there is adequate hardness and thickness to prevent the scaffold tube penetrating into the surface, the uprights of a scaffold can be placed directly on the surface, although it is generally preferable to use a base plate.

#### **15.3 Pavements and Other Surfaces of Intermediate Hardness**

On surfaces such as hard asphalt, timber and flooring, where there is a possibility of the vertical tubes deforming the surface, base plates or metal packing plates should be used at the bottom of the vertical tubes.

#### **15.4 Other Surface**

On soil, ash, hoggin, gravel, soft asphalt and any type of flooring or paving which would be penetrated by a vertical tube with a base plate beneath it or if there is doubt about the surface, there should be a further spreading of the load by a sole plate of timber or other suitable material.

#### **15.5 Sole Plate Area**

When a sole plate is used, the sole plate area beneath any one vertical tube should be at least 1000 cm<sup>2</sup>, with a least dimension of 219 mm, and if the sole plate is of timber, it should not be less than 35 mm thick. On sites where the ground is soft, or has been disturbed, the sole plate area should not be less than 1700 cm<sup>2</sup> when individual sole plates are used, e.g. under hoist towers, and not less than 3400 cm<sup>2</sup> when two are combined together under two vertical tubes. In this case, if the sole plate is of timber, it is necessary to use one with a total thickness in excess of 35 mm. Sole plates should support two vertical tubes.

#### **15.6 Soil Compaction**

The soil or ground beneath the sole plate should be well compacted and free from irregularities which would make the sole plate unstable or poorly bedded.

## **15.7 Sloping Foundations**

On slopes exceeding 1 vertical to 10 horizontal, a check have to be made on the foundations to ensure the stability of the scaffold.

## **16. VERTICAL TUBES**

### **16.1 Foundations**

Vertical tubes should be founded as detailed in Clause 15.

### **16.2 Erection Tolerances**

Erection tolerances should not exceed the Figures detailed in Clause 25.1 of BS. 5973.

### **16.3 Joints**

The joints in vertical tubes should be staggered. Joints in vertical tubes of access scaffolds tied to a building should be made with either joint pins or sleeve couplers. Sleeve couplers are preferred. As these types of couplers have limited load capacity in tension, in scaffolds which are free standing or projecting above the level of a building or otherwise subject to forces which would produce tension in the uprights, the vertical tubes should be joined in a manner capable of resisting the applied tension.

No more than three out of the four vertical tubes the corner of any bay should have joints in the same lift except in the case of the bottom 6.5 m or a scaffold where an extended base life is necessary for pedestrian access or other reason, when a joint in all four of the vertical tubes at the corner of any one bay is permissible provided that one of the joints is lapped with a short length of tube.

### **16.4 Lift Heights**

The vertical intervals at which vertical tubes are linked to one another, i.e. the lift height, is the most important dimension in scaffolding. This dimension should be measured on site and maintained in accordance with the requirements of the design. Where any of the vertical tubes in a scaffold are founded in a light well or at a level lower than the remainder of the tubes, the extension downwards should be stiffened by horizontal tubes, in two directions at right angles and fixed at lift heights not greater than that of the foot lift of the remaining scaffold. Where access for the public is required under the first lift, a height of up to 2.7 m is permissible, provided that the load in the tubes does not exceed those given in Table 9.

## **17. LEDGERS**

### **17.1 Attachments**

Ledgers should be fixed to vertical tubes with right angle couplers, except in the case referred to in Clause 17.3, and should be horizontal except that a foot lift should follow the slope of the ground at the base of a scaffold. In this case, the transoms can be attached to the vertical tubes and the ledgers to the transoms.

### **17.2 Joints**

Joints in ledgers can be made with sleeve couplers or expanding joint pins. Where tension is likely to occur, only sleeve couplers should be used. Joints in ledgers on the same lift and in adjacent lifts should not normally occur in the same

bay. However, when guardrails are to remain permanently in place, the absence of a joint in the guardrail in any bay will be accepted as giving sufficient continuity to the scaffold to permit joints in the ledgers above and below it in the same bay. Where joints are necessary they should be positioned at a distance not greater than  $\frac{1}{3}$  of the span between adjacent vertical tubes.

### **17.3 Curved Building Surfaces**

In the case of curved scaffolds, fittings other than right angle couplers can be used to join the ledgers to the vertical tubes, provided that they are of adequate strength or otherwise supplemented by a right angle check coupler. If under-slung transoms are used to modify the height of one platform, these transoms should be joined to the ledgers with right angle couplers. For large radius curves, separate scaffolds with platforms of the same height can be used.

## **18. TRANSOMS AND PUTLOGS**

### **18.1 Length of Transom and Putlogs**

The length of transoms and putlogs will vary according to the intended use of the scaffold and should be such that the widths of scaffolds given in Table 11 are obtained.

Transoms should be extended inwards and outwards, as necessary, for the purpose of butting the face of the building and fixing the longitudinal bracing.

### **18.2 Couplers**

Transoms should be fixed to the inside and outside ledgers with right angle or putlog couplers, except in the cases referred to in Clauses 14.3 and 17.1, when only right angle couplers should be used.

Attachment to braces should be in accordance with Clause 14.

### **18.3 Spacing**

#### **18.3.1 Boarded lifts**

The spacing of transoms and putlogs for boarded lifts should be in accordance with Table 8, except that the distance between transoms should not result in bay lengths greater than those given in Table 7. Board end transoms should be fixed so that the end overhang of a board does not exceed that given in Table 8. In no case should the overhang be less than 50 mm.

#### **18.3.2 Non-Boarded lifts**

Transoms and putlogs for non-boarded lifts should be fixed at one per pair of vertical tubes, including the pair at each end of the scaffold, and should be fixed within 300 mm of the vertical tube.

On scaffolds of a height greater than 50m, the transoms on unboarded lifts, when fixed at the frequency of one transom per pair of vertical tubes, should be fixed to the ledgers or uprights with right angle or other suitable couplers provided they are capable of sustaining a safe working slip load of 5 kN.

When a boarded platform is moved to a new level, the transoms on the lift from which the boards have been taken can be re-arranged to comply with the requirements for a non-boarded lift.

## 18.4 Putlog Blades

A putlog should generally be fixed with its blade horizontal (but see Clause 12.2).

## 19. PLATFORM UNITS (WOOD SCAFFOLD PLANKS, SCAFFOLD DECKS, AND FABRICATED PLANKS AND PLATFORMS)

### 19.1 General

Scaffold platforms should be of the widths given in Table 11 for the purposes given.

### 19.2 Decking

Any group of boards across the width of the scaffold should be of the same length, with all boards of the same thickness.

### 19.3 Supports

The spacing of the transoms to support the boards should vary according to the thickness and length of the boards as given in Table 8.

The overhang of the boards of any thickness should not exceed four times their thickness and should not be less than 50 mm (see Table 8).

**TABLE 11- WIDTHS OF ACCESS SCAFFOLD PLATFORMS**

<b>PURPOSE</b>	<b>MINIMUM WIDTHS</b>	<b>PRACTICAL WIDTHS USING 225 mm NOMINAL WIDTH BOARDS</b>
For access, inspection, gangways and runs	440 mm	2 boards
Working platforms for men without materials or only for the passage of materials	640 mm	3 boards
For men and materials provided there is 440 mm left clear for the passage of men or 640 mm if barrows are used	870 mm	4 boards
For carrying trestles or other similar higher platforms	1.07 m	5 boards
For use in dressing or <sup>1)</sup> roughly shaping stone	1.3 m	6 boards
For use to support a <sup>1)</sup> higher platform where the supporting scaffold is also used for dressing and roughly shaping stone	1.5 m	7 boards
<b>1) These scaffolds should be specially designed.</b>		

Boards which are nominally 38 mm thick are the most commonly used and are customarily supplied in lengths of 3.90 m. When these are used, there should be four transoms to each board. Boards which are nominally 38 mm thick and less than 3.35 m long can be supported on three transoms. Boards which are nominally 38 mm thick and less than 2.13 m long should not be used unless they are fixed down to prevent tipping.

Boards which are less than 1.80 m long can be supported on two transoms, but should be fixed down at both ends. Such boards occur adjacent to ladder openings and provision should be made to prevent them from moving under impact and vibration. Boards which are used on small static and mobile access towers and on other small platforms, where the platform is surrounded by a guardrail and posts and there are no end joints in the boards, need not be fixed down but should be prevented from moving.

## 19.4 Gaps in Decking

Gaps between boards should be as small as is reasonably practicable. Scaffolds should be erected as near to the building as is reasonably practicable, except when it is required for workmen to sit on the edge of the boarded deck in which case the gap should not exceed 300 mm.

## 19.5 Toeboards

Toeboards and end toeboards should be suitably fixed to all working platforms where a person may fall more than 1.98 m. They should be of such a height that the gap between the top of the toeboard and the guardrail does not exceed 762 mm and have a minimum height of 152.5 mm. They should be placed inside the vertical tubes.

## 19.6 Guardrails

Working platforms from which a person may fall more than 1.98 m should have a guardrail and end guardrails fixed inside the vertical tubes at a height of between 915 mm and 1150 mm above the level of the decking.

If the guardrails are set higher than 915 mm, a second lower guardrail or higher toeboard should be provided to limit the gap to 762 mm. Suitably added brick guards or retaining boards are an acceptable alternative for a second or intermediate guardrail.

## 19.7 Brick Guards

Brick guards or other suitable vertical protection are desirable in cases where materials may fall from the scaffold. These screens can be hung from the guardrails and should be prevented from outward movement. Toeboards may be incorporated within the screen and the screens should be capable of preventing the materials being used passing through.

## 19.8 Length of Decking

The ends of a working platform should, where possible, extend beyond the end of the wall or working face by a distance of 600 mm when work is to be carried out up to the end of the wall.

## 19.9 Slope of Decking

Gangways and working platforms should preferably be horizontal but may slope at an inclination of up to 1 vertical to 4 horizontal without stepping laths. At slopes steeper than this they should be provided with stepping laths to provide a firm foothold. These may incorporate gaps not exceeding 100 mm in width for wheels of barrows.

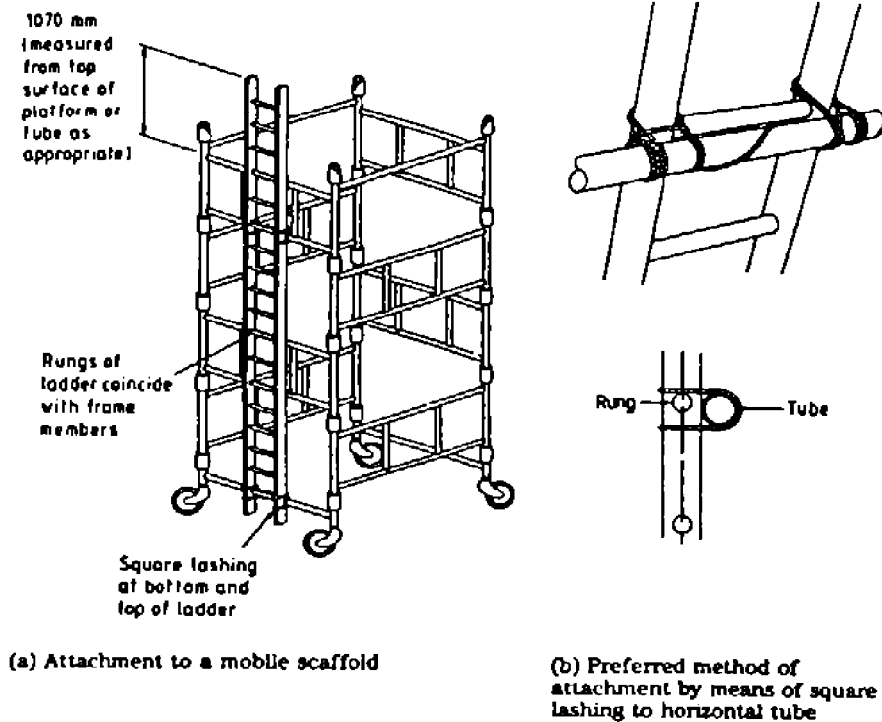
# 20. LADDER ACCESS TO AND IN SCAFFOLDS

## 20.1 General

Every sloping ladder should stand on a firm and level base and be supported only by the stiles. Where practicable, it should be set at an angle of 4 vertical to 1 horizontal. The stiles should be securely fixed to the scaffold at the top by lashings, as shown in Fig. 24, or by other attachments.

Ladders should preferably project at least 1.07 m above the top landing place with the landing rung level with or slightly above the level of the landing platform.

Ladders should not be extended by lashing two lengths together.



**LADDER FIXINGS**  
Fig. 24

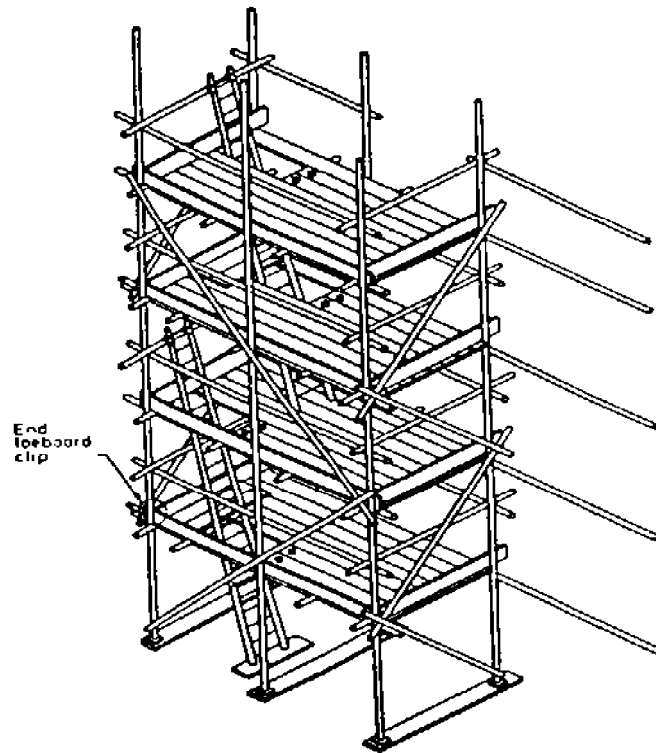
## 20.2 Landings

The vertical distance between two successive landing places should not exceed 9.0 m. The landing places should be provided, where necessary, with access holes for the user which should not exceed 500 mm in width and should be as small as practicable in the other direction. The landing places should be kept clear of all material and should be provided with guardrails and toeboards.

## 20.3 Ladder Towers

Where practicable, the ladder access to the scaffold should be with its own ladder tower fixed to the outside of the main scaffold. Fig. 25 is a typical example of such a tower.

On large construction sites consideration should be given to the use of staircase towers and ramps.



**Note:**

Boards marked with an asterisk should be fixed down to a piece of 600 mm board.

**LADDER ACCESS TOWER**

**Fig. 25**

## **21. RAISING AND LOWERING MATERIAL**

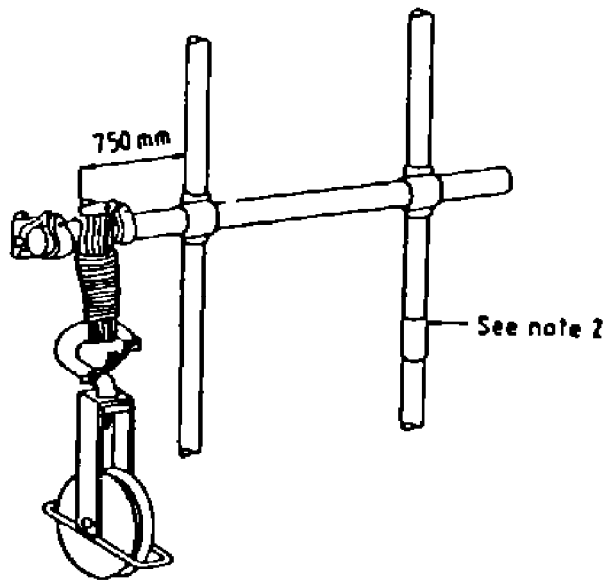
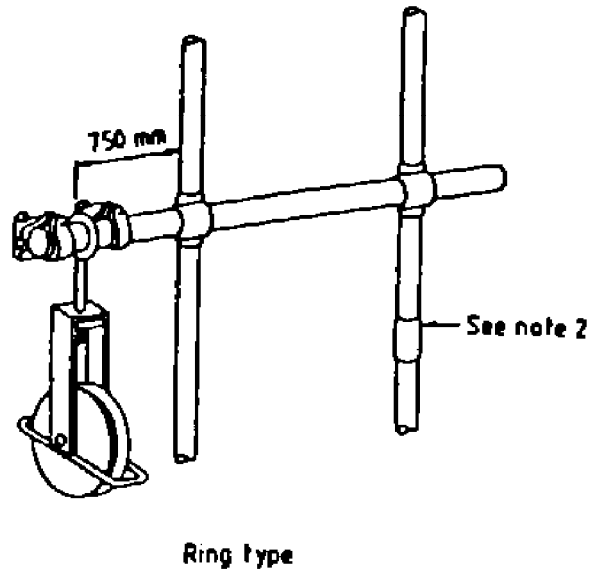
### **21.1 Gin Wheels**

Gin wheels can be fixed to scaffolding for the purposes of raising and lowering materials during the construction of the scaffold and for the user of the completed scaffold.

The gin wheel should be mounted on a cantilever tube projecting outwards from the scaffold to a suitable distance, which should be kept to a minimum and preferably not greater than 750 mm. The horizontal tube holding the gin wheel should be fixed with right angle couplers to two uprights in the case of an independent tied scaffold. In the case of a putlog scaffold, a puncheon should be fixed near to the wall from a suitable putlog at a lower level to a putlog at the working level and extending upwards. The gin wheel tube should be fixed to this and to the outer vertical tube. A diagonal brace from the gin wheel tube to the outer end of a lower putlog may alternatively be used to brace the vertical tube carrying the gin wheel.

A ring type gin wheel is preferable (see Fig. 26). If a hook type gin wheel is used it should not be hooked through a coupler but, it should be lashed to the supporting tube and the hook moused, unless it is provided with a safety catch. In either case the gin wheel fixing to the tube should be prevented from slipping towards or from the building by one fitting mounted on either side of the fixing.

Materials should be firmly attached to the gin wheel rope and should not exceed 50 kg in mass. Gin wheel ropes should be of the correct size to suit the gin wheel (usually 18 mm) and should be marked with an identification tag and the safe working load.



**Notes:**

- 1) This drawing should be read in conjunction with the text.
- 2) If there is a joint in the inner standard of a lift, a sleeve coupler should be used in order to resist uplift.

**GIN WHEEL FIXINGS**  
**Fig. 26**

## 21.2 Scaffold Jib Cranes and Hoists

Scaffold jib cranes should be attached to a vertical tube in a scaffold by the means recommended by the manufacturer. Special consideration should be given to the strengthening of the scaffold in the location of the crane and its attachment to the building at this point.

## 21.3 Hoist Towers

When a hoist is used, it is usual to construct a special hoist tower. This may be attached to the outside of a scaffold and may also utilize one of two of the standards of the scaffold as corners of the hoist tower. A hoist tower should be constructed in accordance with Clause 30.1 of BS. 5973.

## 21.4 Multiple Rope Blocks

The attachment of multiple rope blocks to scaffolding should be made the subject of special design in respect of the scaffold itself and its attachment to the building in the location of the upper block.

## 21.5 Impact Loading

Where mechanical handling is used, special allowance should be made in the design of the loading area for the additional loads due to the impact of placing.

# 22. STRUCTURAL CALCULATIONS FOR SCAFFOLDS

**22.1** Technical data, tables and notes on calculation are given in Section 6 of BSI 5973.

**22.2** Worked examples of scaffold design are attached in Appendix A.

# 23. TEMPORARILY INSTALLED SUSPENDED SCAFFOLDS AND ACCESS EQUIPMENT

## 23.1 Description

### 23.1.1 Systems of attachment to structure

Suspended scaffolds and access equipment can be subdivided into two classes according to the means of attachment to the building:

- a)** those which rely on counterweights for their stability;
- b)** those which are structurally attached to the roof or top part of the building or structure.

Either type can be fixed or traversing. The two methods of attachment may occasionally be combined.

### 23.1.2 Suspension System

A further subdivision of the types is between those having roof mounted winches and those having platform mounted winches or climbing devices. Two types of lifting appliances are in common use:

- a)** winches, which reel the wire rope on to a drum;
- b)** devices which 'climb' up the wire rope leaving the tail end of the rope hanging or reeled below the machine.

### 23.1.3 Types of platform

Four main types of platform are considered in this code and shown in Fig. 27.

#### **Type 1. Hinged continuous platforms**

The working area may be a single deck or several decks beneath each other. There may be either one or two ropes at each end and at each hinge.

#### **Type 2. Individual platforms**

These may have a single deck or several below one another. Each end may be suspended by either one or two wire ropes.

#### **Type 3. "Painter's" cradles**

These may be suspended on a fibre rope at each end passing through blocks if the length of the cradle is less than 3.2 m or on one wire rope at each end if the length is greater.

#### **Type 4. Suspended safety chairs (bosun's chairs)**

These may be suspended by a single fibre rope passing through blocks or on a wire rope when a mechanical lifting appliance is used.

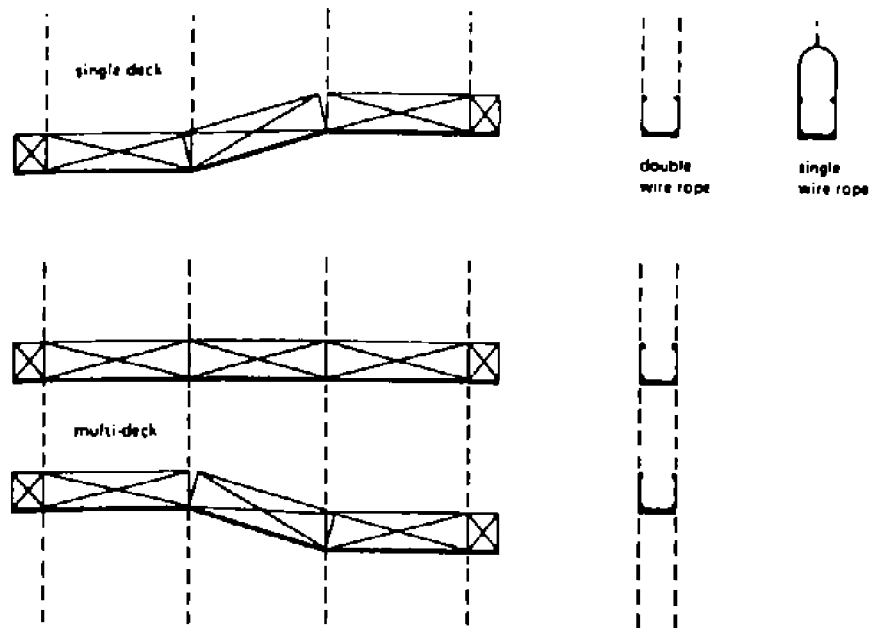
All four types can be manually or power operated. When power operated, Types 1, 2 and 3 should have the lifting appliance mounted on either the roof or the platform. Type 4 is not customarily used with a roof mounted winch. Types 2 and 3 should be designed to be traversed horizontally.

Types 1 and 2 can be mounted below the soffits of bridges or from special structures on the parapets of the bridge.

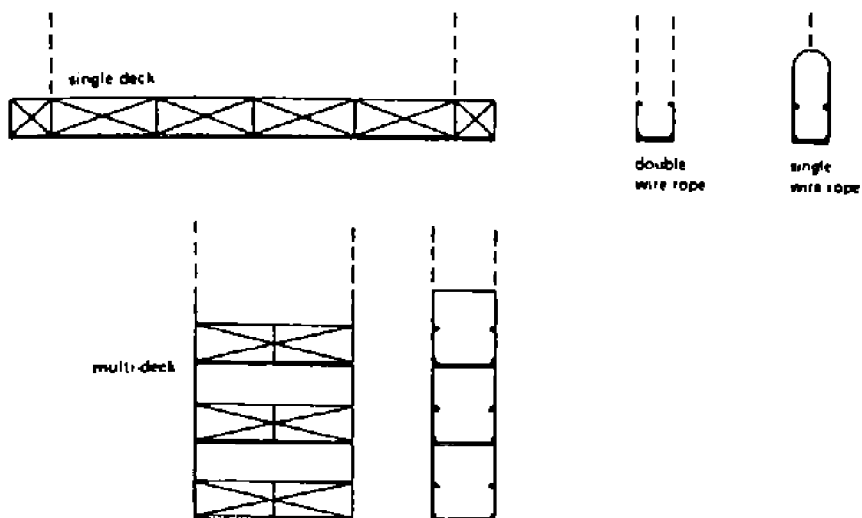
#### **Note:**

**For suspended scaffold structures intended for use in shipyards, reference should be made to the Shipbuilding and Ship-Repairing Regulations, 1960 and other appropriate regulations.**

Special safety precautions are required for scaffolds suspended from wire ropes used in the construction of metal structures where electric arc welding and cutting is employed.



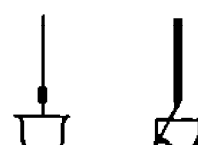
Type 1. Hinged continuous platforms



Type 2. Individual platforms



Type 3. Painter's cradles on fibre or wire ropes



Type 4. Bosun's chairs on fibre ropes

TYPES OF SUSPENDED SCAFFOLDS  
Fig. 27

## 23.2 Design Loads

### 23.2.1 Structural design of the equipment

The structural design of the platform, the suspension points and the members of the suspension systems should be based on the rope tensions and load outputs of the suspension systems, taking into account the load output of any pulley system used in the suspension system (see Clause 23.3.1.9(a) ). The roof rig should be designed so that the permissible stresses appropriate to the material(s) of construction are not exceeded when the maximum total suspended load (see Clause 23.2.5 is applied to the suspension point. In addition, the design should ensure that the minimum yield stress of the materials used is not exceeded when the maximum rope tension is developed as a result of the operation of slipping clutches, load limiting devices, stalling torques, etc.

### 23.2.2 Grouping of the loads at one end of a platform or bay

In the case of an individual platform with the suspension points at the ends the design of all parts of the installation should take account of the possible grouping of the persons using the platform at one end of the platform either adjacent to a point of suspension or centred outside this point when cantilevered end extensions are fitted.

Consideration should be given to ensuring the balance of the platform when one cantilevered end is loaded by applying an adequate factor of safety against overturning of the platform, based on the safe working load.

In the case of a hinged continuous platform the load applied to the suspension system at the hinge between two bays should be calculated from the safe working loads of both adjacent bays added together on the assumption that they have accumulated beneath the suspension system supporting the hinge between the bays.

### 23.2.3 Safe working load of the platform

The safe working load on an individual platform is the maximum load which can be placed on the platform having regard to its strength and to the value and distribution of the load and to the counterweighting of the roof rig. It should be marked on the platform in kilograms and the maximum number of persons should also be marked.

The safe working load on a hinged continuous platform having a series of suspension points is the maximum load which is placed in any one bay having regard to its strength and to the value and distribution of the load and to the counterweighting of the roof rig. It should be marked on the platform in kilograms and the maximum number of persons should also be marked with the words added 'per bay'.

### 23.2.4 Rope tension

The rope tension on which the choice of the suspension rope is made should be based on the summation of the following:

- a)** That portion of the self-weight of the platform and any lifting appliances attached to it acting on the suspension rope, plus the self-weight of that portion of the suspension rope hanging below its upper point of contact with the roof rig including that portion of it reeled on to a winch on the platform or hanging beneath it through a climbing device and any stabilizing weight attached thereto;
- b)** the maximum load resulting in the suspension rope from the approved number of operatives and associated imposed loads grouped together or adjacent to it or in a cantilevered portion of the deck;
- c)** an allowance for impact resulting from the operation of the winch or climbing device of such impacts as are recommended by the manufacturers but with a minimum factor as indicated below:

Type of Suspension	Impact Factor Expressed as A Percentage of the Sum of (a) and (b)
Manually operated on fiber ropes	10
Manually operated winches or lifting devices on wire ropes	10
Power operated winches or climbing devices on wire ropes	25

The above criteria should also be used when choosing a safety rope, with the exception that the following allowance (d) should replace that in (c) above in those cases where the value of (d) is higher than that of (c):

- d)** an allowance for the impact load imposed by the operation of any safety device.

Where the suspension rope is reeved through pulleys calculation of the rope tension should take into account the cumulative friction losses arising from the rope reeving system and the number of parts of rope in the purchase, and the location of the lifting machinery which can be on the platform, or on the roof, or on the ground. (See also Clause 23.3.1.9(a)).

### 23.2.5 Maximum total suspended load

Whatever the arrangement of the suspension rope or its pulley system or its travelling track assembly the maximum total suspended load is the maximum load at the top of the system which can apply an overturning moment or a direct pull on a roof rig.

The maximum total suspended load should be calculated from the rope tension calculated as in Clause 23.2.4, and modified where necessary to take account of pulley systems incorporated in the system as recommended in Clause 23.3.1.9(a) with the further additions listed below:

- a)** the weight of the travelling track and trolleys and its suspension gear;
- b)** the additional loads which may result from the difference in spacing of the outriggers from the spacing of the suspension ropes which may occur in travelling systems;
- c)** the increased loads derived from two suspension ropes from two platforms travelling together under one outrigger (this situation may be avoided by fitting intermediate stop ends on the trolley track and mounting two outriggers above them each with its own counterweights as structural attachments).

The suspension gear above the trolley track need not be designed to take into account the redistribution of loads due to the continuity of the travelling track beams.

### 23.2.6 Maximum overturning moment

The maximum overturning moment, see Fig. 28, should be calculated from the summation of the moment about the fulcrum point of the maximum total suspended load at its projection length and the moment about the fulcrum point of the self-weight of the outboard portion of the roof rig acting at its centre of gravity.

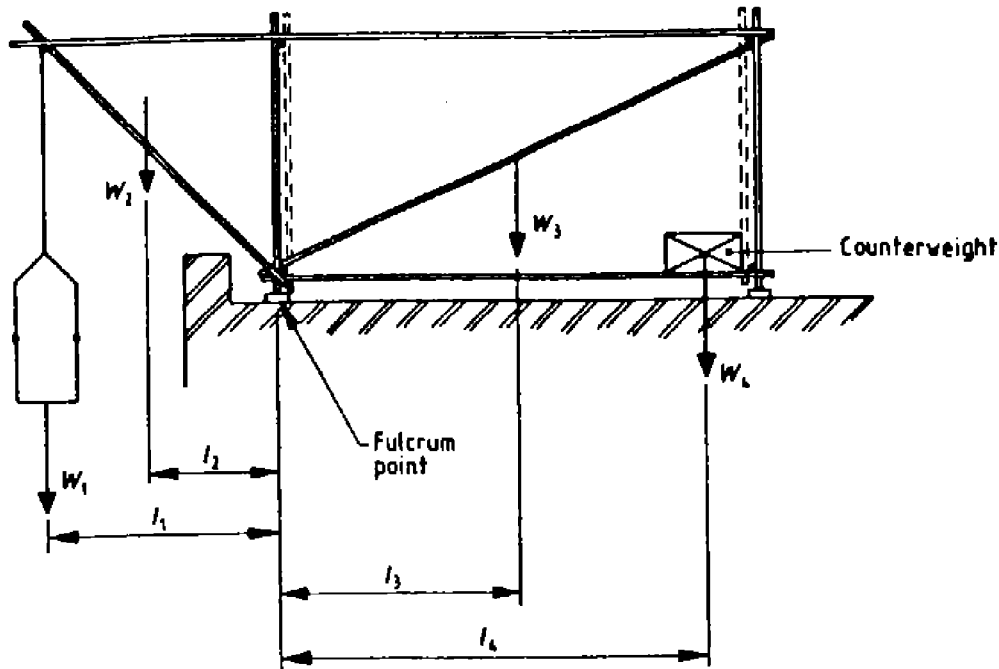
### 23.2.7 Righting moment

#### 23.2.7.1 Counterweighted roof rigs

The righting moment, see Fig. 28, for roof rigs depending for their stability on weight only should be calculated from the summation of the moment about the fulcrum point of the self-weight of the inboard portion of the roof rig acting at its center of gravity and the moments of any counterweights acting at their lever arms.

### 23.2.7.2 Structurally attached roof rigs

The righting moment of roof rigs depending for their stability on bolted or other structural fixings of the inboard section of the roof rig to the building should be calculated from the summation of the moment of the self-weight of the inboard portion of the roof rig acting at its centre of gravity and the moments of the safe working loads of the structural fixings acting at their lever arms.



The overturning moment =  $(W_1 \times l_1) + (W_2 \times l_2)$

The righting moment =  $(W_3 \times l_3) + (W_4 \times l_4)$

Where:

$W_1$  is the maximum suspended load at lever arm  $l_1$

$W_2$  is the weight of the outboard portion of the roof rig at lever arm  $l_2$

$W_3$  is the weight of the inboard portion of the roof rig at lever arm  $l_3$

$W_4$  is the counterweights at lever arm  $l_4$

### THE RIGHTING AND OVERTURNING MOMENTS

Fig. 28

### 23.2.8 Stability

#### 23.2.8.1 Stability against overturning

The following sub-clauses describe the means of ensuring stability.

These sub-clauses and types of roof rigs are included in BS 5974. Appendix C shows worked examples of stability calculations in the same BS Standard.

## 23.3 Suspension System

### 23.3.1 Ropes

#### 23.3.1.1 Lashings

##### - General

Only lashings which comply with Fig. 28 should be used.

- A lashing should never be used as a single suspension rope a lifting rope, a tie wire or in a single turn. Application should be with a minimum of three turns (i.e. six parts).

##### - 6 mm diameter wire rope scaffold lashings

When new, a 6 mm diameter scaffold lashing has a breaking load of approximately 1100 kg.

##### - 9 mm diameter wire rope for lashing

When new, such 9 mm diameter lashings have a breaking load of approximately 4400 kg.

#### 23.3.1.2 Attachment of suspension ropes by lashings

Lashings between suspension ropes and pole rigs should either attach the top of the rope block or suspension wire directly to a pole outrigger, or should attach a girder clip to the pole when a travelling track is required. When intermediate lashings are made on to the front ledger of a pole rig, this ledger should be above the outriggers. Suspension wire lashings should never be carried over the front ledger and tied off on some other part of the roof rig.

#### 23.3.1.3 Padding

Lashings on structural steel work should be padded to prevent damage to the lashing, and this padding should be prevented from falling from the structural steel work when there is no load on the lashing.

#### 23.3.1.4 Mousing

The tail end of lashings should be secured with cord.

#### 23.3.1.5 Lashing on to tubes

Lashings should not be used on steel tubes unless they are across node points at the intersection of two tubes or are prevented from slipping either way by scaffold fittings.

#### 23.3.1.6 Attachment of suspension ropes to scaffold tube roof rigs

An attachment is best achieved by using a shackle which should be prevented from slipping either way along the tube by means of scaffold fittings.

Steel flats with 50 mm holes may be used to slip on to the tubular work. These also should be prevented from slipping either way.

Proprietary fittings are also available to attach ropes to scaffold tube roof rigs.

Any edges over which the rope passes should be so finished or protected as to prevent damage to the rope.

When a trolley track is to be slung beneath outriggers the girder clip may have a 50 mm diameter hole in the upper portion so that it may be slipped on to the scaffold tube and prevented from displacement either way along the tube by scaffold fittings.

#### **23.3.1.7 Wire rope terminations**

Wire rope terminations should be suitable for their purpose and should have a strength of not less than 80% of the minimum breaking load of the rope. Any free end of rope should be finished to prevent unlaying.

#### **23.3.1.8 End fixing of wire ropes**

The end of the suspension rope other than that on or through the lifting device or winch should be fixed to the suspension point on the roof rig or on the platform with a thimble eye splice or ferrule secured eye termination or bulldog grip fixing or other rope coupling device giving a strength of not less than 80% of the breaking load of the wire rope.

The end of a suspension rope which does not reach the ground passing through a climbing device should be stopped off with a nipple or fitted on site with a clip suitable to prevent the climbing device being worked off the end of the rope.

The end of a suspension rope feeding into a reeling winch should be fastened on to the drum of the winch in the manner specified by the manufacturer and in addition should preferably have at least three turns left on the drum when the platform is at its lowest level, but in no circumstances less than two turns.

If the platform can be lowered to the end of the rope without coming to the landing ground the end of the rope fixed to the drum should be painted red for a distance of two turns and two meters, so that a warning is given to an operator that the lowest safe level has been reached.

#### **23.3.1.9 Rigging of fiber suspension rope systems**

##### **a) Methods**

Fig. 24 shows two methods of rigging. The forces shown assume either that the person applying the pull is standing on the floor outside the suspended platform, or that the platform has been obstructed by a snag during ascent and the person pulling raises his own weight from the platform.

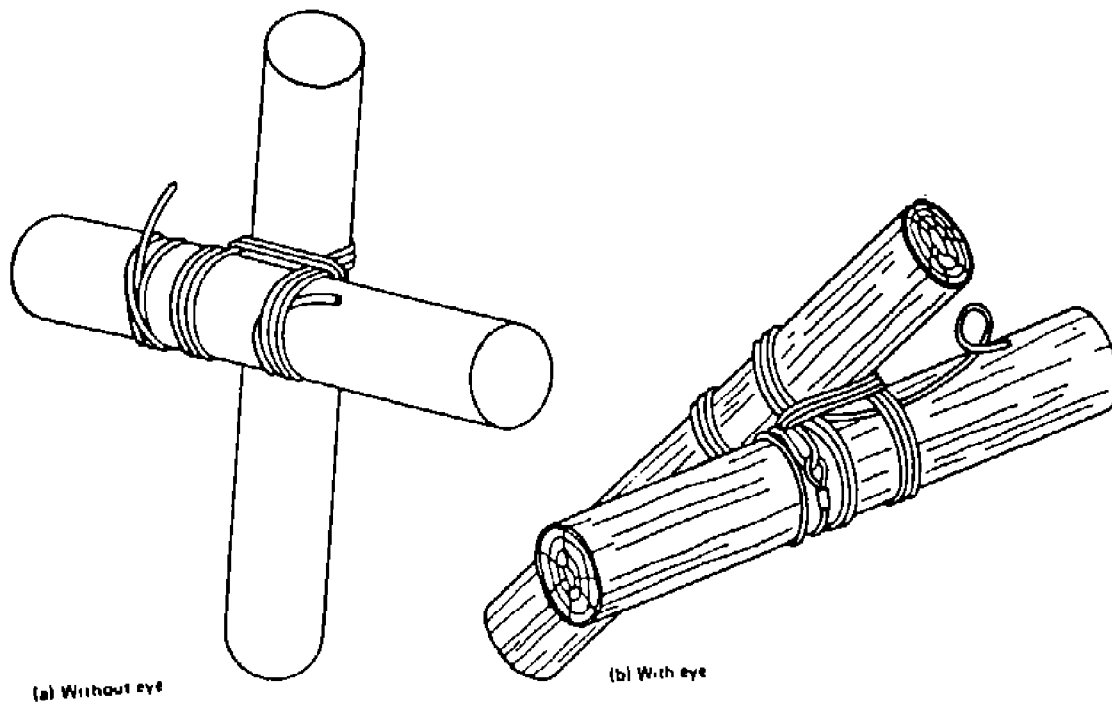
##### **b) Choice of rope type**

Careful attention should be given to the choice of rope type.

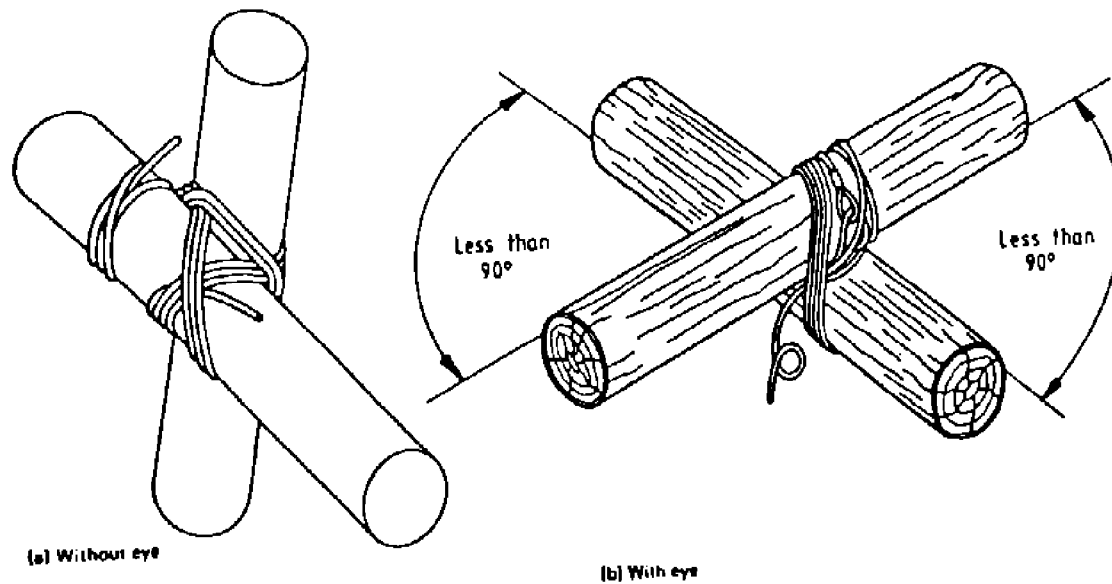
##### **c) Hooks and knots**

The rope hook on the lower block of either of the two block systems should be of the long tail type to facilitate the formation of the knot on the fall rope.

Fig. 31 show alternative methods of tying the fiber rope to the cradle.



**SQUARE LASHING**



**Note:**

When using this variant of lashing it is essential that the ends of the poles are securely retained in position.

**DIAGONAL LASHING**

**Fig. 29**

### 23.3.1.10 Rigging of wire suspension ropes

#### a) General

In all types of mechanical systems and for platforms longer than 3.2 m only wire suspension ropes, terminated with thimbles, should be used.

The wire used should be of the type specified by the manufacturer of the winch or climbing device and should also be suitable for use with the safety device which works on it.

#### b) Pulley sizes

When wire ropes pass over pulleys or round drums in winches and climbing devices, such pulleys or drums should have a pitch circle diameter of not less than 19 times the diameter of the rope.

Guide pulleys, external to the winch or climbing device, should have a pitch circle diameter of not less than 11 times the diameter of the rope.

Reverse bending around pulleys and/or drums at close centres should be avoided wherever possible.

#### c) Inspection and registration

Wire ropes should have been inspected and registered in accordance with statutory regulations within the previous six months and marked with the safe working load and means of identification. If the rope is not detachable from the winch or climbing device the inspection testing and registering of the machine should include the rope, and if this has been done within the last six months the rope need not be treated separately.

### 23.3.1.11 Safety ropes

a) It is strongly recommended that safety ropes consisting of steel wire should be fitted, where reasonably practicable, on all suspended scaffolds except where.

- The platform is supported on two independent suspension wire ropes at each end of a single platform or at each hinge of a continuous platform such that, in the event of the failure of one suspension rope, the other is capable of suspending the platform.
- The introduction of a secondary safety wire rope would introduce overriding safety hazards.
- A painter's cradle is suspended on fiber ropes (see Sub-clause (b)).

#### b) Alternative safety arrangements

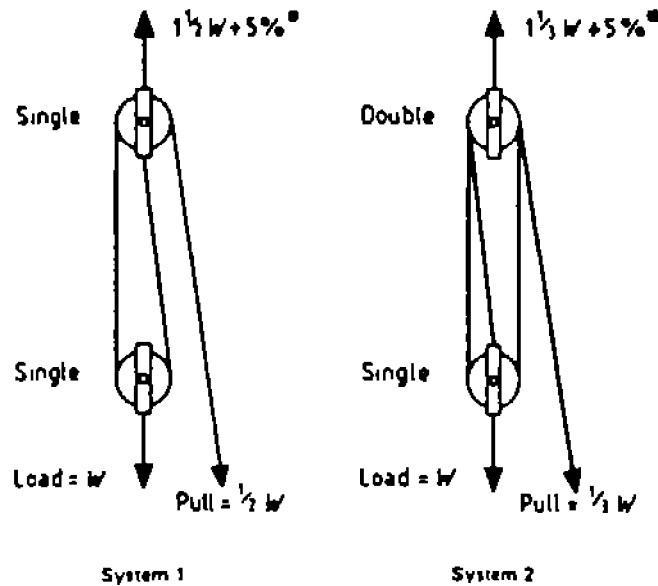
It is strongly recommended that in the situations detailed in Clause 23.3.1.11 where a safety wire rope is not fitted one or more of the following safety precautions should be taken.

- When the suspension wire rope is terminated at the point where it is joined to the roof rig it should be supplemented by a second short length of wire rope attached to the suspension wire rope and separately to the roof rig by-passing the suspension wire rope attachment.
- In the case of a platform mounted winch or lifting device, there should be a second short length of wire rope attached to the platform and to an automatic safety device mounted on the suspension wire rope above the winch or lifting device by-passing the winch or lifting device.
- Provision should be made for the adequate attachment of a safety harness to the platform or to an independent safety line.

The by-pass ropes referred to in above should be at taut as practicable in order to obviate undue snatch loads. Their design and installation should be appropriate to the particular equipment in use.

### c) Safety rope anchorage points

The safety rope should have separate anchorage points from those of the suspension rope for its terminations.

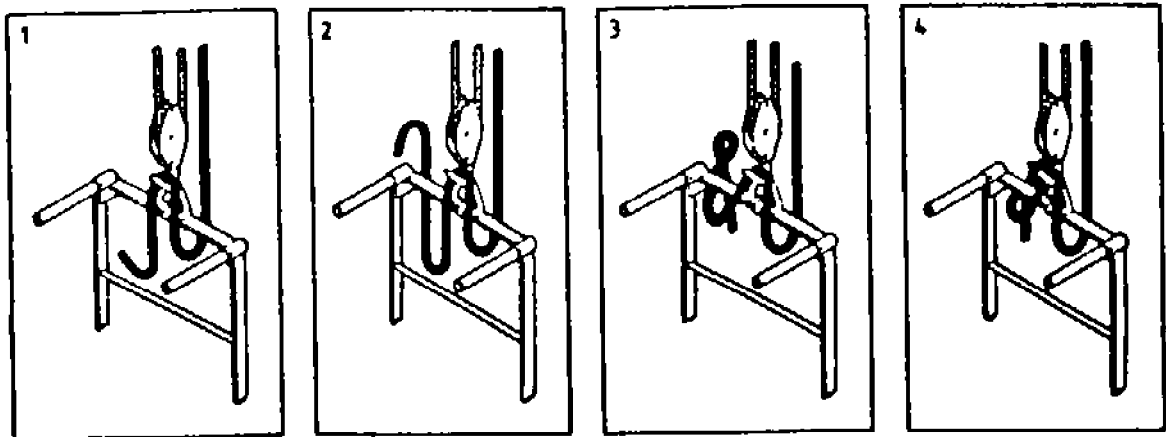


Note:

The above Figs. shows the relative mechanical advantage between various pulley systems, where  $W$  equals the total applied load. The output at the top of the system has been increased by 5% to cover frictional losses in the system.

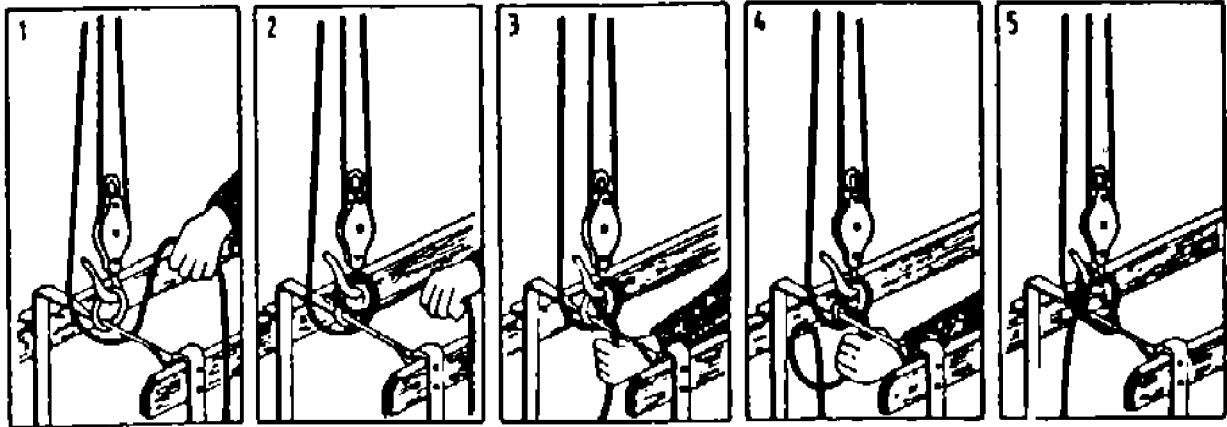
### THE ROPE TENSION AND ITS EFFECT

Fig. 30



### TYPICAL METHOD OF SECURING FIBER ROPES TO CRADLES

Fig. 31



**ALTERNATIVE METHOD OF SECURING FIBRE ROPES TO CRADLES**

**Fig. 32**

### **23.3.2 Winches and climbing devices**

Petrol or diesel winches should not be used for suspended scaffolds. Hydraulic, pneumatic and electrically operated climbing devices or winches are admissible. Mechanical speed changing devices should not be fitted, and the cradle should be both raised and lowered under power.

**Note:**

The electrical requirements of these appliances are given in Clause 23.3.3.

Power driven winches or climbing devices should incorporate a mechanical means of manual operation for use in the event of power failure or electrical fault.

The appliance should be of good construction and adequate to raise and lower the platform and its safe working load at a speed not in excess of 10 m/min.

The means of attaching the appliance to the roof rig or to the platform should be properly designed and adequate to carry the forces resulting from the operation of the platform.

It is advisable that safeguards, e.g. slipping clutches or load sensing devices, be incorporated to limit the maximum load in the suspended rope to a nominal 50% above the safe working load of the winch (see also Clause 14.1).

### **23.3.3 Electrical requirements**

#### **23.3.3.1 Equipment**

The equipment should comply with the requirements of the Iranian Petroleum Electrical Standards.

All equipment and wiring should be suitable for use with 3-phase 380/440 V, 50 Hz or single phase 110 V or 240 V, 50 Hz as required. It should be capable of operating within the range of +6%, -8.5% of the nominal voltage supply. It should be protected against overloads and short circuits and no damage should occur from an interruption of the supply. It should be sufficiently robust to resist accidental and environmental damage.

### **23.3.3.2 Main power supply**

A power supply, of the appropriate type and voltage, should be provided at the place of work agreed with the supplier of the power operated suspended scaffold. A 'lock off' type isolating switch should be provided, and should be easily accessible at all times. It should be accompanied by a notice warning against unauthorized operation of the switch. Connections to this power supply other than by the use of normal plugs and sockets, should be by an electrician who is authorized by the building owner or construction site manager to do so.

Plugs and sockets should be so placed that they cannot be damaged by the intended movement of the platform or by the accidental swinging of the platform against the building.

The arrangement of the electric parts of the power operated suspended scaffold should be made clearly by instructions to the person erecting the equipment. The connections between the several parts should be such that they cannot be connected together in the wrong sequence.

### **23.3.3.3 Earthing**

The earth circuit of the equipment should be connected to the existing earth continuity system. Where mains voltage is fed to the cradles on structures and buildings under construction, either earth leakage protection or a circulating current earth monitoring system should be installed.

### **23.3.3.4 Cables**

It is important that wiring be carried out by an electrically competent person in accordance with the IP Electrical Standards.

Cables feeding power from the supply point to the suspended platform installation should be of such a nature and be so placed that they cannot cause a hazard or be subject to mechanical damage. They should be sufficiently robust to permit repeated use and should be inspected at the time of each installation of the suspended platform.

Cables which are passed over parapets or roofs or over the corners of beams or slabs should be protected from abrasion or other mechanical damage.

Adequate cable should be provided to allow for the planned movements of the suspended platform. Cables terminating in a control unit on the platform should be of such a length that the control unit is within easy reach of the operatives working on the platform.

### **23.3.3.5 Control units and pendant controls**

Control units and pendant controls should be so marked that there is no confusion between the various controls as to their purpose and the direction of travel resulting from their operation, whichever way up the units are handled or stored or attached to the platform.

The voltage in pendant controls should be limited to 55 V except class I pendants where circulating earth monitoring is used and for Class II all insulated pendants where 50 V maximum is preferred, but in any case the voltage should not exceed 125 V. A supply should not be taken from a transformer with a mid-point earth on the secondary circuit where contactors are used.

Pendant controls should be so placed or fixed that they cannot be damaged by the intended movement of the platform or by the accidental swinging of the platform against the building. The control button or levers should be robust and require continuous light pressure to maintain powered movements, and the control stations should be designed so as to prevent them being operated accidentally.

#### **23.3.3.6 Electrical safeguards**

The control system should be so designed that an electrical supply failure, or the failure or malfunction of any electrical component, would cause the system to fail to safety. Protection should also be provided against phase reversal in 3-phase systems.

No part of the installation should display exposed live parts under normal use. All circuit panels and other units should be housed and be only accessible to authorized persons.

#### **23.3.3.7 Electrical instructions**

Clear instructions should be given to persons erecting, testing and using power operated suspended scaffolds and access equipment with regard to the method of installation, and the use of its safety devices.

#### **23.3.3.8 Maintenance testing and inspection**

Maintenance instructions and spares should be available for the electrical installation.

Maintenance testing and inspection should be carried out by a competent person and should be in accordance with the IP Electrical Standards.

### **23.4 Types of Platform**

#### **23.4.1 Hinged continuous platforms**

##### **23.4.1.1 Description**

A hinged continuous platform is a series of demountable units hinged together at their ends in such a way that operatives have access past the hinges along the continuous platform. It is suspended at the hinges on one or two wire ropes in such a manner that the units can be raised or lowered either together or in an articulated manner to give access to different levels of a building. Provision can be made for additional decks one below the other provided the load ratings are suitably adjusted and taken into account and that the resulting configuration has been specifically so designed.

##### **23.4.1.2 Dimensions**

The width of the platform should be not less than 700 mm. Portions of the platform may be occupied by the lifting appliances provided these do not adversely impede the access from one unit to another.

Specially shaped units may be inserted to give access to buildings which do not have a plane face and to deal with corners, providing that the resulting configuration has been specifically so designed.

##### **23.4.1.3 Loading**

The loading adopted for calculation when this type of platform is to be used should be based on a safe working distributed load on the working platform of not less than 75 kg/m<sup>2</sup>.

##### **23.4.1.4 Decking, guard rails and toe boards**

The decking of the platform should have a sound, slip resistant surface. It should be fixed so that it cannot be accidentally displaced. Except to the extent necessary for drainage, the decking should be closely boarded, planked or plated. Gaps in the decking of separate units should not exceed 10 mm and those at the end of the units adjacent to the hinge

should not exceed 25 mm, but only if there is no risk of persons below any such platform being struck by materials or articles falling through the platform.

Guard rails should be fitted to the perimeter of the platform at not less than 915 mm and not more than 1.15 m above the platform. When the guard rail interferes with working its height may be reduced to not less than 690 mm on the working face while work is in progress.

Toe boards of at least 152 mm height above the decking should be provided to the perimeter of the platform and the space between the guard rail and the toe boards should not exceed 760 mm.

When the platform is fixed to the building and the building itself forms a barrier at that level, or alternatively when the workers sit at the edge of the platform to work and ropes or chains which afford all workers a safe and secure hand hold are provided, then the inner guard rail and toe board may be removed.

Guard rails and toe boards should be securely fixed to prevent accidental displacement either due to working or to the wind. No guard rail should fracture or show any permanent deformation when a mass of 50 kg is hung at any point between two points of support and the platform is tilted about its longitudinal axis at an angle of 30° from the horizontal.

### **23.4.2 Individual suspended platforms**

#### **23.4.2.1 Description**

An individual suspended platform is an isolated working platform suspended at or near each end. It may be fabricated in separate sections which are not hinged together but are assembled rigidly to become one structure.

The large length of independent working platforms in general enables them to be rigged without travelling gear, but they may sometimes be mounted either on a track or on a travelling roof trolley.

#### **23.4.2.2 Dimensions**

The width of the platform should be not less than 640 mm if used as a footing only and 870 mm if used additionally for the deposit of materials. However, if the work is of such a light nature that the suspended scaffold can be used with safety a smaller width can be used. In no case should it be less than 440 mm.

End units may be attached which project the working platform beyond the end point of support. These cantilever units should be limited in length to that allowed by the manufacturers and to that which will not overload the outriggers carrying the weight.

Provision may be made for adding additional decks one below the other provided the load ratings are adjusted and such installations are so designed.

#### **23.4.2.3 Loading**

The loading adopted in calculation when this type of working platform is used should be based on the safe working load of the platform (see Clause 23.2 to 23.2.3).

#### **23.4.2.4 Decking, guard rails and toe boards**

The decking, guard rails and toe boards should comply with the requirements of Clause 23.4.1.4.

#### **23.4.2.5 Protection**

At the request of the user protective covering may be fixed to the platform. This may consist of a single vertical sheet on the outside of the platform or a hood over the top or both.

The increased wind forces that will result from the use of such a covering should be taken into account.

#### **23.4.3 Painter's cradles**

##### **23.4.3.1 Description**

A "painter's cradle" is a working platform, not specifically confined to use by painters, for use by up to three men depending on its length. The normal use is for painting, window and stone cleaning and other light maintenance operations with equipment and materials of small weight. It is distinguishable from an individual working platform by its shape and size and by the fact that its platform or 'boat' is self sufficient without a structural beam between its end supports.

A "travelling" cradle is one which can be raised or lowered and made to traverse horizontally. A 'fixed' cradle is one which can only be raised or lowered.

Wire ropes should be used to suspend cradles longer than 3.2 m.

Consideration should be given to the use of power operated equipment in preference to manual equipment when the height of the building or facade being served exceeds 30 m.

##### **23.4.3.2 Dimensions**

The dimensions and form of construction should be as specified in BS 2830.

#### **Loading**

For the purpose of loading calculations, the safe working load of cradles of 2 m length or less should be taken as 225 kg, and of cradles of between 2 m and 3.2 m as 295 kg.

Where one man only is to use the cradle he should be assumed to be at one end for the purpose of assessing the suspended load.

In the case when more than one man is to use the cradle the loads resulting from them being grouped at one end should be taken into account. It is recommended that 75% of their total weight be assumed to act at either suspension point.

##### **23.4.3.3 Decking, toe boards and guard rails**

The decking, toe boards and guard rails should comply with the requirements of Clause 23.4.1.4.

#### **23.4.4 Suspended safety chairs (bosun's chair)**

##### **23.4.4.1 Description**

Bosun's chairs are for use by one man at a time and should comply with the requirements of BS 2830. They may be suspended on fiber ropes which should pass through two blocks or by wire ropes using mechanical means of raising and lowering.

#### **23.4.4.2 Loading**

For the purpose of loading calculations the safe working load of a suspended safety chair should be taken as 115 kg.

The factor of safety against overturning on a cantilevered outrigger stabilized by added weights for a bosun's chair should be four to allow for the use of multiple pulley blocks and the condition of a worker raising his weight off the chair if this should become hooked up on an obstacle.

#### **23.5 Masses and Strengths of Materials and Components**

Reference can be made to Appendix 'B' in BS 5974 which shows different tables on this subject.

#### **23.6 Stability Calculations**

Reference can be made to Appendix 'C' in BS 5974 which gives examples of calculations.

## APPENDICES

### APPENDIX A WORKED EXAMPLES OF SCAFFOLD DESIGN

#### A.1 Symbols and Formulas for Elastic Design of Scaffolds

For the purpose of the calculations outlined in this appendix the following symbols apply.

**s** is the self mass of the scaffold per lift/bay (in kg)

**w** is the extra mass of a working lift and its imposed loads (in kg)

**W** is the total extra mass of all the working lifts (in kg)

**P** is the allowable load in a standard (in kN)

**n** is the number of lifts

**h** is the calculated height of the scaffold (in m)

**C** is the safety coefficient

**H** is the recommended height of the scaffold after the application of the factor C (in m)

**W** **ns** = the required strength for two  
+ standards = 2P

$$n = \frac{2P - W}{s}$$

**h** = **n** × the lift height

$$H = \frac{h}{C}$$

#### A.2 Examples of Scaffold Design

**Note:**

All examples assume even loading of standards.

##### A.2.1 Very light duty scaffold

Calculate H for three lengths of bay, i.e. 2.1 m, 2.4 m and 2.7 m, of a very light duty scaffold with one working platform, rated at 0.75 kN/m<sup>2</sup>, three boards wide and in 2 m lifts.

<b>BAY LENGTHS (m)</b>	<b>2.1</b>	<b>2.4</b>	<b>2.7</b>
s (kg)	76	78	81
W (kg)	182	205	229
P (kN)	23.7	23.7	23.7
n	61.2	59.3	56.9
h (m)	122.4	118.6	113.8
C	1.61	1.60	1.57
H (m)	76.02	74.12	72.48

### A.2.2 Light duty scaffold

Calculate H for three lengths of bay, i.e. 2.0 m, 2.1 m and 2.4 m, of a light duty scaffold with two working platforms, rated at 1.50 kN/m<sup>2</sup>, four boards wide in 2 m lifts.

BAY LENGTHS (m)	2.0	2.1	2.4
s (kg)	75	76	78
⌘ (1st working lift) (kg)	357	374	426
⌘ (2nd working lift) (kg)	357	374	426
W (kg)	714	748	852
P (kN)	23.7	23.7	23.7
n	54.96	53.77	1.03
h (m)	109.92	107.54	102.06
C	1.55	1.54	1.51
H (m)	70.92	69.83	67.59

### A.2.3 General purpose scaffold

Calculate H for three lengths of bay, i.e. 1.8 m, 2.0 m and 2.1 m, of a general purpose scaffold with two working platforms rated at 2.00 kN/m<sup>2</sup> and one working platform rated at 0.75 kN/m<sup>2</sup>, all five boards wide and in 2m lifts.

BAY LENGTHS (m)	1.8	2.0	2.1
S (kg)	73	75	76
⌘ (1st working lift) (kg)	496	552	576
⌘ (2nd working lift) (kg)	496	552	576
⌘ (3rd working lift) (kg)	240	265	277
W (kg)	1232	1369	1429
P (kN)	23.7	23.7	23.7
n	49.39	46.22	44.80
h (m)	98.78	92.44	89.60
C	1.49	1.46	1.45
H (m)	66.30	63.31	61.79

### A.2.4 Heavy duty scaffold

Calculate H for three lengths of bay, i.e. 1.5 m, 1.8 m and 2.0 m, of a heavy duty scaffold with two working platforms rated at 2.50 kN/m<sup>2</sup> and two working platforms rated at 0.75 kN/m<sup>2</sup>, all five boards wide and in 2 m lifts.

BAY LENGTHS (m)	1.5	1.8	2.0
S (kg)	70	73	75
⌘ (1st working lift) (kg)	501	599	667
⌘ (2nd working lift) (kg)	501	599	667
⌘ (3rd working lift) (kg)	202	240	265
⌘ (4th working lift) (kg)	202	240	265
W (kg)	1406	1678	1864
P (kN)	23.7	23.7	23.7
n	48.7	43.0	39.35
h (m)	96.4	86.0	78.70
C	1.49	1.43	1.39
H (m)	64.70	60.14	56.61

### A.2.5 Masonry and special duty scaffold

Calculate H for three lengths of bay, i.e. 1.2 m, 1.5 m and 1.8 m, of a masonry and special duty scaffold with two working platforms rated at 3.00 kN/m<sup>2</sup> and two working platforms rated at 0.75 kN/m<sup>2</sup>, all six boards wide and in 2 m lifts.

<b>BAY LENGTHS (m)</b>	<b>1.2</b>	<b>1.5</b>	<b>1.8</b>
S (kg)	68	70	73
⌘ (1st working lift) (kg)	562	696	834
⌘ (2nd working lift) (kg)	562	696	834
⌘ (3rd working lift) (kg)	193	236	282
⌘ (4th working lift) (kg)	193	236	282
W (kg)	1510	1864	2232
P (kN)	23.7	23.7	23.7
n	8.66	42.20	5.42
h (m)	97.32	4.40	70.84
C	1.49	1.49	1.35
H (m)	65.32	59.44	52.47