

Australian Standard®

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**Fixed platforms, walkways,  
stairways and ladders — Design,  
construction and installation**

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## PREFACE

This Standard was prepared by the Standards Australia Committee on Platforms, Gangways, Stairways and Ladders, to supersede AS 1657-1985.

Changes to the Standard include —

- (a) reducing the minimum wall thickness of steel piping which may be used;
- (b) incorporating a minimum tensile yield stress requirement for aluminium alloys;
- (c) deleting references to specific aluminium alloys and tempers;
- (d) updating the dimensions of steel sections other than piping, to reflect current manufacturing practices; and
- (e) provision of test methods to determine the integrity of guardrail systems, and the strength of the connection between guardrail posts and the supporting structure.

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## STANDARDS AUSTRALIA

## Australian Standard

**Fixed platforms, walkways, stairways, and ladders —  
Design, construction and installation**

## SECTION 1 SCOPE AND GENERAL

**1.1 SCOPE** This Standard sets out requirements for the design, construction, and installation of fixed platforms, walkways, stairways, and ladders which are intended to provide means of safe access to and safe working at places normally used by operating, inspection, maintenance, and servicing personnel.

The Standard does not apply to situations where special provision is made in appropriate building or other regulations, e.g. means of escape from fire. Requirements for portable ladders are not included in this Standard.

**1.2 APPLICATION** The design, construction, and installation of a platform, walkway, stairway, or ladder shall comply with the appropriate requirements of Section 2 and the specific requirements for the type of structure, as follows:

- (a) Platforms and walkways: Section 3.
- (b) Stairways: Section 4.
- (c) Fixed ladders: Section 5.

The application of the relevant Sections and the limits of slope are illustrated in Figure 1.1.

Where it is not reasonably practicable to meet the full requirements of this Standard, advice should be sought from the regulatory authority.

## NOTES:

- 1 Some structures and vehicles will be unable to comply with all the requirements of this Standard. Special structures include radio masts, towers, portable on farm light-weight silos, and the like. Vehicles include road tankers, waste disposal trucks, and the like.
- 2 Structures and vehicles which are unable to comply with all the requirements of this Standard should comply with the relevant design Codes for loading.

**1.3 REFERENCED DOCUMENTS** The following documents are referred to in this Standard:

## AS

1170	SAA Loading Code
1170.1	Part 1: Dead and live loads and load combinations
1170.2	Part 2: Wind loads
1192	Electroplated coatings — Nickel and chromium
1538	SAA Cold-formed Steel Structures Code
1554	SAA Structural Steel Welding Code
1554.1	Part 1: Welding of steel structures
1604	Preservative treatment for sawn timber, veneer and plywood
1650	Hot-dipped galvanized coatings on ferrous articles
1664	SAA Aluminium Structures Code
1665	SAA Aluminium Welding Code
1720	SAA Timber Structures Code
1720.1	Part 1: Design methods
1734	Aluminium and aluminium alloys — Flat sheet, coiled sheet and plate
1782	Flooring milled from Australian-grown conifers (softwoods) (excluding radiata pine and cypress pine)
1789	Electroplated coatings — Zinc on iron or steel
1790	Electroplated coatings — Cadmium on iron or steel
1810	Flooring milled from cypress pine
1866	Aluminium and aluminium alloys — Extruded rod, bar, solid and hollow shapes
1892	Portable ladders
1892.2	Part 2: Timber
2105	Inorganic zinc silicate paint

2269	Structural plywood
2796	Timber — Seasoned hardwood — Milled products
3600	Concrete structures
3700	SAA Masonry Code
3990(Int)	Steelwork for engineering applications
4024	Safeguarding of machinery
4024.1(Int)	Part 1: General principles
4100	Steel structures

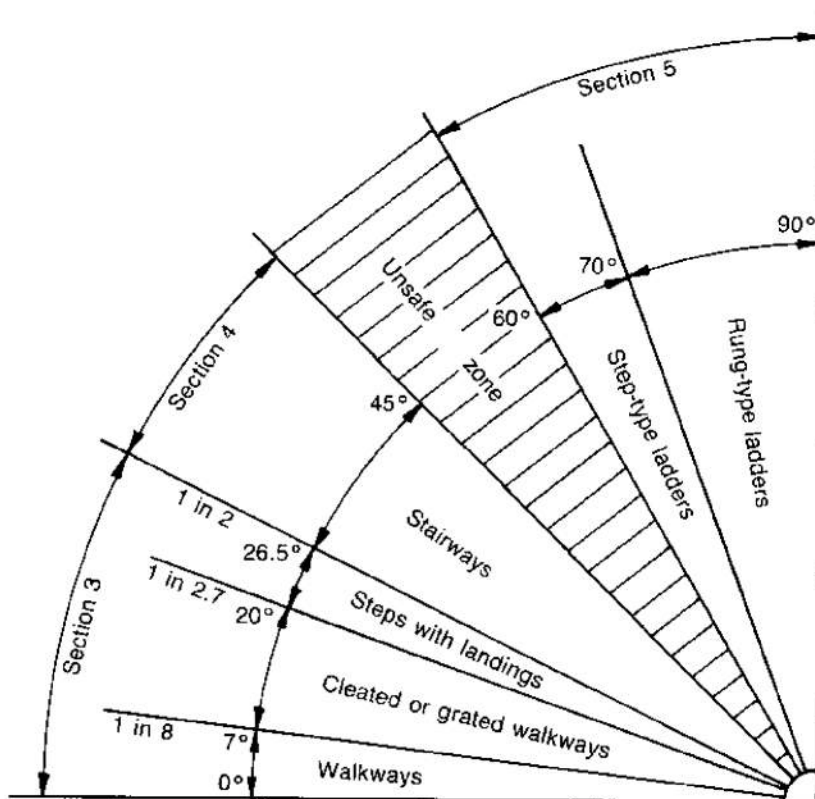


FIGURE 1.1 LIMITS OF SLOPE

**1.4 DEFINITIONS** For the purpose of this Standard, the definitions below apply.

**1.4.1 Accepted** — accepted by the authority having jurisdiction.

**1.4.2 Floor** — the surface of a platform, walkway, or landing.

**1.4.3 Going** — in a stair, the horizontal distance from the nosing of one tread to the nosing of the next tread.

**1.4.4 Guardrailing** — a structure to prevent persons from falling off any platform, walkway or landing.

**1.4.5 Handrail** — a rail to provide handhold on a platform, walkway, stairway, or step ladder. It may form part of a guardrailing.

**1.4.6 Individual-rung ladder** — a ladder without stiles, each rung of which is individually attached to a structure or equipment.

**1.4.7 Ladder** — a structure with treads or rungs, with or without stiles and handrails.

**1.4.8 Ladder cage** — a fixed enclosure which encircles the climbing space of a ladder.

**1.4.9 Landing** — a level area used to provide access to a stairway or ladder, or located at an intermediate level in a system of stairways or ladders.

**1.4.10 Nosing** — the rounded edge of the tread projecting over the riser.

**1.4.11 Pipe** — a tubular product made as a production item for sale. It may be round, oval, square, or rectangular in section.

NOTE: For the purpose of this Standard, the word 'pipe' is synonymous with 'tube' or structural hollow section (circular, square, or rectangular) although these words are used for different types of products by different industries.

**1.4.12 Platform** — an area provided for access or working, which is elevated above the surrounding floor or level.

**1.4.13 Reasonably practicable** — practicable having regard to —

- (a) the severity of the hazard or risk in question;
- (b) the state of knowledge about that hazard or risk, and any ways of removing or mitigating that hazard or risk;
- (c) the availability and suitability of ways to remove or mitigate that hazard or risk; and
- (d) the cost of removing or mitigating that hazard or risk.

**1.4.14 Regulatory authority** — a Minister of the Crown, a government department, commission or other authority having power to issue regulations, orders or other instructions having the force of law in respect of any subject covered by this Standard.

**1.4.15 Rise** — the vertical height from the top of one tread to the top of the next; also refers to the total height of a flight or series of flights, taken from the top of one floor to the top of the next floor.

**1.4.16 Rung ladder** — a ladder consisting of stiles and rungs.

**1.4.17 Shall** — indicates that a statement is mandatory.

**1.4.18 Should** — indicates a recommendation.

**1.4.19 Stairway** — a sloping stepped structure having not less than three rises and having a slope within the range of 26.5 degrees to 45 degrees inclusive.

**1.4.20 Step ladder** — a ladder consisting of stiles, treads and handrails.

**1.4.21 Stile** — a side member that supports the treads or rungs of a ladder. The terms 'side rail', and 'stringer', are often used synonymously.

**1.4.22 Walkway** — a passageway that is either level or sloping from the surrounding floor or level. A walkway may be a continuous structure or steps with landings.

## SECTION 2 STRUCTURAL DESIGN, MATERIALS AND WELDING

### 2.1 DESIGN

**2.1.1 General** The design of the structural work comprising the platform, walkways, stairways, ladders, and guardrailing shall comply with the relevant requirements of the following Standards:

- (a) For aluminium: [AS 1664](#).
- (b) For concrete: [AS 3600](#).
- (c) For masonry: [AS 3700](#).
- (d) For timber: [AS 1720.1](#).
- (e) For steel: [AS 1538](#), [AS 3990\(Int\)](#) or [AS 4100](#).

#### 2.1.2 Design loadings

**2.1.2.1 Floors** Floors shall be designed for the dead load of the structure plus a superimposed live loading of not less than 2.5 kPa uniformly distributed, or a concentrated loading of not less than 1 kN at any point, whichever produces the most adverse effect.

Where the floor of the platform or walkway or landing is likely to be loaded in excess of the above requirements, the design loading shall be based on the requirements of [AS 1170.1](#).

In special cases, where large floor areas or concentrated loads (or both) have to be considered, variation of the design load specified above may be referred to the regulatory authority.

**2.1.2.2 Guardrails** The guardrailing shall be designed to withstand whichever of the following live loadings produces the most adverse effect:

- (a) A force of 550 N acting outwards or downwards at any point on the top rail, edge or post.
- (b) A force of 330 N per linear metre acting outwards or downwards on the top rail or edge.

Where appropriate, wind loadings in accordance with [AS 1170.2](#) shall be added to the above live loadings.

Where extra severe loading conditions are likely to be encountered, i.e. at points of assembly or where mechanical equipment is used, the guardrailings shall be designed in accordance with the loading conditions set out in [AS 1170.1](#) and [AS 1170.2](#).

#### NOTES:

- 1 Recommended minimum dimensions for typical components of guardrailing comprising posts and rails are given in Appendix A.
- 2 Recommended maximum spacing of posts dependent on the material or section of the post and the method of fastening are given in Appendix A.
- 3 Where the guardrailing may be called upon to restrain people under panic conditions a load of up to 3 kN/m may be exerted.

**2.1.2.3 Handrails** Each handrail which is not part of a guardrail shall be designed to withstand the following non-simultaneous forces:

- (a) A force of 550 N applied outwards at the centre of the span.
- (b) A force of 550 N applied downwards at the centre of the span.

**2.1.2.4 Stairways** Stairways and integral landings shall be designed for the dead load of the structure plus a superimposed live loading of not less than 2.5 kPa uniformly distributed. Where the stairs are likely to be loaded in excess of the above requirements, the design loading shall be based on the requirements of [AS 1170.1](#).

Treads shall be designed for a distributed loading of not less than 2.2 kN per linear metre of stairway width or a concentrated loading of not less than 1 kN, whichever loading produces the more adverse effect.

**2.1.2.5 Fixed ladders** Every ladder and its fixing shall be designed for a concentrated live loading of not less than 1 kN, or a number of concentrated live loadings of 1 kN, the number of loads and their spacing being dependent upon the expected usage of the ladder. Timber ladders shall also comply with Clause 2.2.3.2.

**2.1.3 Fixing of components** All components shall be securely fixed so that guardrails, posts, and intermediate rails or infill form an integral structure or system.

The system shall be designed so that joints will withstand the design load and the method of fixing or assembly does not weaken the intrinsic strength of the structure or system.

### 2.2 MATERIALS

**2.2.1 General** The materials used shall comply with the relevant Australian Standard specifications, where such exist, or in their absence with British Standard specifications, or with other recognized specifications.

All timber to be used for any purpose under the terms of this Standard shall either be non-lyctus susceptible or be treated against lyctus attack in accordance with [AS 1604](#).

Where it is desired to use material not in accordance with a recognized Standard specification, the use of such material shall be subject to the approval of the regulatory authority.

NOTE: Attention is drawn to the corrosion which can occur when dissimilar metals are brought into close proximity with one another under certain conditions.

## 2.2.2 Piping

**2.2.2.1 General** Where pipe is used for guardrails or posts, it shall be of seamless, welded, or drawn welded manufacture. Split pipe shall not be used.

**2.2.2.2 Galvanized pipe** Where galvanized pipe is used, the wall thickness shall be not less than 2.0 mm (see Note). Pipe shall be hot-dip galvanized internally and externally in accordance with the requirements of [AS 1650](#) for hollow sections.

Where galvanized pipes are welded, care shall be taken to minimize damage to the internal and external galvanizing. Damage to the galvanizing shall be made good by cold galvanizing, the application of a zinc-rich paint, or equivalent protection.

NOTE: Attention is drawn to the minimum design loads given in Section 2.1.2.2.

**2.2.2.3 Ungalvanized pipe** The ends of ungalvanized pipe should be sealed to prevent the ingress of moisture. Sealed pipe shall have a wall thickness of not less than 2.0 mm (see Note).

Unsealed pipe shall have a wall thickness of not less than 4.0 mm.

NOTE: Attention is drawn to the minimum design loads given in Section 2.1.2.2.

## 2.2.3 Timber materials

**2.2.3.1 Platforms, walkways and stairways** Solid timber shall be standard grade or better, complying with [AS 1782](#), [AS 1810](#) or [AS 2796](#).

Solid timber exposed to the weather or to other conditions of high decay hazard shall be of Class 1 or Class 2 durability as defined in [AS 1684](#), or be suitably treated in accordance with [AS 1604](#).

Plywood shall comply with [AS 2269](#). Plywood exposed to the weather or to other conditions of high decay hazard shall be suitably treated in accordance with [AS 1604](#).

**2.2.3.2 Ladders** The quality of the timber and the species used in the construction of fixed ladders and step ladders shall comply with the appropriate requirements of [AS 1892.2](#).

**2.2.4 Bolts** The permissible working stresses and sizes for bolts shall be as specified in [AS 4100](#).

Bolts of a diameter less than 12 mm shall not be used for attaching guardrailing posts, supports, or brackets to platforms, walkways, or stairways, or for attaching ladders to the main supporting structure. Where the form of attachment places a tensile load on the bolts or where there is eccentricity of loading on the bolts, not less than two bolts shall be used in the connection.

For external applications, or hazardous environments, bolts and nuts for aluminium rails and posts shall be hot-dip galvanized in accordance with [AS 1650](#) or be of austenitic stainless steel.

**2.2.5 Concrete** Concrete materials shall comply with the relevant requirements of [AS 3600](#).

**2.2.6 Protective coating** Where a protective coating is applied, such coating shall comply with the appropriate Standard.

### NOTES:

- 1 The purpose is to inhibit corrosion.
- 2 Although any suitable protective coating may be used, the coating shall be applied using good commercial practice.
- 3 Some examples of suitable protective coatings are specified in [AS 1192](#), [AS 1789](#), [AS 1790](#) and [AS 2105](#).

**2.3 WELDING** All welding for attaching guardrailing posts, supports, or brackets to platforms, walkways, or stairways, or for attaching ladders to the main supporting structures, shall be continuous.

Welding of steel components shall be in accordance with [AS 1554.1](#).

Welding of aluminium components shall be in accordance with [AS 1665](#).

CAUTION: CARE MUST BE EXERCISED FOR WELDED APPLICATIONS IN THE DESIGN OF ALUMINIUM STRUCTURES TO ENSURE ADEQUATE WELD JOINT STRENGTH.



## SECTION 3 PLATFORMS, CONTINUOUS WALKWAYS, AND STEPS WITH LANDINGS

### 3.1 GENERAL REQUIREMENTS

**3.1.1 Platforms** Platforms shall be nominally horizontal. Where drainage is required, the slope shall not exceed 1 in 35.

Where the level of a platform above an adjacent platform or floor is not more than 300 mm, access from one level to the other may be gained without the provision of an intermediate step. Where the change of level is greater than 300 mm but does not exceed 450 mm, one intermediate step shall be provided. Access between adjacent levels where the difference exceeds 450 mm shall be in accordance with the requirements of Section 4 or Section 5 or by a sloping walkway in accordance with Clause 3.1.2.

**3.1.2 Continuous walkways** Walkways may have a slope up to and including 20 degrees. Where the slope of a walkway exceeds 1 in 8 (7 degrees), the walkway shall be of -

- (a) grating (expanded type metal, metal grating);
- (b) metal plate fitted with cleats;
- (c) timber complying with Clause 2.2.3.1 fitted with cleats; or
- (d) other acceptable material.

Where grating is used, it shall be subject to acceptance by the authority having jurisdiction.

Where cleats are used, they shall be fixed across the walkways to provide a safe foothold. Cleats shall be not less than 50 mm × 25 mm timber or 10 mm square metal bar fixed to the walkway and evenly spaced at intervals (see Table 3.1).

NOTE: It is recommended that provision be made for drainage.

**TABLE 3.1  
SPACING OF CLEATS ON WALKWAYS  
STEEPER THAN 1 IN 8**

Slope of walkway	Recommended cleat spacing, mm	
	Where load is carried by users	Where no load is carried by users
1 in 6 (9.4°)	360	450
1 in 5 (11.3°)	330	420
1 in 4 (14.0°)	300	390
1 in 3 (18.4°)	270	360

**3.1.3 Steps with landings** Where the slope of the walkway is greater than 1 in 2.7 (20.3 degrees) and is less than 1 in 2 (26.5 degrees), steps complying with Clause 4.3.1, with one or more level landings at intermediate levels, shall be provided. Landings shall comply with Clause 4.4.

**3.1.4 Minimum vertical clearance** Except where otherwise approved by the regulatory authority, the vertical clearance above platforms and walkways shall be not less than 2000 mm.

#### 3.1.5 Width

**3.1.5.1 Platform** The clear width of every platform shall be not less than 600 mm.

**3.1.5.2 Walkways** Where guardrailing is provided on both sides of a walkway, the clear width of the walkway measured between the inner edge of the guardrails shall be not less than 550 mm.

Where there is a fixed structure not more than 100 mm distance from one side of a walkway, the clear width of the walkway measured between the structure and the inner edge of the guardrail shall be not less than 600 mm.

Where there is a fixed structure not more than 100 mm distance from both sides of a walkway, the clear width of the walkway measured between the two structures shall be not less than 600 mm.

### 3.2 PROTECTION AT SIDES, ENDS, EDGES, AND OPENINGS

#### 3.2.1 Sides and ends

**3.2.1.1 Guardrailing** Continuous guardrailing complying with Clause 3.4 shall be provided on the sides and ends of all platforms and walkways, except at points of access from a stairway or ladder, or where there is a permanent structure not more than 100 mm distance from the edge of the platform or walkway which will give protection equal to or greater than that prescribed in Clause 3.4.

**3.2.1.2 Toe-board** A toe-board complying with Clause 3.4.3 shall be provided at the edge of a platform, walkway, or landing, which is greater than 10 mm distant from a permanent structure and where an object could fall more than 2000 mm.

**3.2.1.3 Exceptions** Guardrailing need not be provided on the sides and ends of a platform the level of which is not greater than 300 mm above that of an adjacent platform or floor. The unprotected edges of such platforms shall be marked so that they are clearly visible in their surroundings and the following conditions apply:

- (a) The least dimension of the higher platform is not less than 1200 mm.
- (b) The lower platform or walkway on which there is protection in accordance with the requirements of Clause 3.4, is not less than 1000 mm from any unprotected edges of such upper platform.

Where the requirements of Item (b) do not apply, the edges shall be protected as described in Clause 3.2.1.1 and the minimum height of the guardrailing at the edge of the lower platform or walkway shall be increased by 300 mm.

**3.2.2 Unguarded edges and openings** Where it is impracticable to provide fixed guardrailing in accordance with Clause 3.2.1, hinged or sliding guardrailing or effective removable protection shall be provided at all unguarded openings in guardrailings or unguarded openings in floors and shall be maintained in position at all times when such openings are not in use. It is not acceptable to use a warning sign to fill in such openings. Edges protected by removable barriers shall be marked so that they are clearly visible in their surroundings.

NOTE: The above requirements are subject to the acceptance of the regulatory authority.

### 3.3 DESIGN

#### 3.3.1 Floors

**3.3.1.1 General** Where persons may be required to be or work on a frequent basis underneath a particular platform, walkway, or landing, the floor of such platform, walkway, or landing shall be designed, or provided with protection, so as to prevent objects falling through the floor to the area below.

Protection typically takes the form of a lightweight false floor suspended beneath the platform, walkway or landing.

Where the floor is likely to become wet and collect liquids, provision shall be made for the removal of liquid from the floor by drainage or other means. Boards and plates shall be securely fixed to the supporting structure and shall not rely on adjacent sections of flooring for the prevention of lateral movement. They shall be fixed so that the removal of any section of flooring will not affect the security of the remaining sections.

All floors should be evenly laid, and variation in height between adjacent boards or plates which could form a tripping hazard shall be avoided.

**3.3.1.2 Protection** Where the protection for a platform, walkway, or landing is constructed from one or more of the following products, the size of openings in the products shall not exceed the dimensions specified.

- (a) Expanded metal — the minor axis shall not exceed 10 mm.
- (b) Grid/wire mesh — the openings in square mesh shall not exceed 12 mm × 12 mm.
- (c) Punched plate — the hole diameter shall not exceed 20 mm.

**3.3.1.3 Timber floors** The flooring of platforms, walkways and landings may be of dressed or undressed timber or plywood, and every precaution shall be taken to render the surface of the floor slip-resistant. Any gap between floorboards after shrinkage shall not exceed 10 mm. Timber floors exposed to the weather shall comply with Clause 2.2.3.1.

**3.3.1.4 Metal plate floors** Metal plate shall be of chequered, indented, or other suitable slip-resistant type. Any gap between plates shall not exceed 10 mm.

**3.3.1.5 Grated floors** Grated floors shall be constructed in such a form as will provide a slip-resistant surface. The smaller dimension of any opening shall not exceed 40 mm and the area of any opening shall not exceed 5000 mm<sup>2</sup>. Any gap between adjacent made up sections of grated floors shall not exceed 10 mm and may be of any length.

**3.3.1.6 Concrete floors** The surface of a concrete floor should be wood-float finished or rendered slip-resistant by other suitable means.

### 3.4 GUARDRAILING

**3.4.1 Design** Guardrailing may be monolithic or a framed structure, and shall be constructed in accordance with one of the following requirements;

- (a) A top rail, supported by posts, parallel to the floor or slope of a walkway at a vertical height of not less than 900 mm nor more than 1100 mm above the standing level of such platform or walkway.

In such case, one or more intermediate rails shall be provided parallel with the top rail and the floor having a maximum distance of 450 mm between rails or between the lowest rail and the top of the toe-board where fitted. Where a toe-board is not fitted, the maximum distance between the lowest rail and the floor shall be not greater than 560 mm. Alternatively, the space between the top rail and the floor may be provided with suitable infill (see Clause 3.4.2) fixed to the top rail and to the floor, toe-board, or a bottom rail not more than 80 mm above the floor.

- (b) Welded mesh, supported by posts and provided with a reinforced top edge capable of withstanding the prescribed design loads (see Clause 2.1.2.2).
- (c) Where curvature of a stairway is such that a falling person would not land on the platform below, the guardrailing shall—
  - (i) have a maximum spacing between rails of 300 mm; or
  - (ii) be fitted with infill.

**3.4.2 Infill** Infill may be fabricated from pipe, bar, solid or perforated plate, expanded metal, metal mesh, or any other material.

Pipes or bars may be arranged vertically, horizontally, or in any other configuration, provided that the smaller of the two maximum dimensions of any opening (or diameter in the case of circular openings) does not exceed 450 mm and the area of any opening does not exceed 0.2 m<sup>2</sup>.

Expanded metal shall be not less than 3 mm in thickness and shall not have any sharp cutting edges. Metal mesh may be woven, chain, or welded wire of sizes not less than those specified in Table 3.2. Where metal mesh is used, a rigid rail shall be provided at the top edge except where the mesh is reinforced on the top edge to give performance equivalent to the top rail.

Where metal mesh or expanded metal serves a dual purpose of edge protection and a guard for moving parts, such mesh or expanded metal shall be selected to prevent access to the danger points. (See AS 4024.1 (Int) for guidance.)

**TABLE 3.2**  
**EXPANDED METAL, WOVEN OR WELDED WIRE MESH GUARD**

Description	Minimum nominal diameter of wire or strand, mm	Maximum size of opening (length × width), mm
Woven or chain	2.5	80 × 80
Woven or chain	3.5	100 × 100
Welded	3.5	300 × 80 or 200 × 200
Expanded metal	3.0	80 × 80

NOTE: If the mesh is diamond-shaped, the specified dimensions are measured along the side of the diamond.

**3.4.3 Toe-board** The toe-board shall be firmly attached to the floor or posts, and any gap between the toe-board and the floor shall not exceed 10 mm. The top of the toe-board shall be not less than 100 mm above the top of the floor.

**3.4.4 Testing** Guardrail systems constructed using the materials and dimensions given in Appendix A are deemed to comply with the requirements of this Standard.

When tested in accordance with Appendix B, the connection between the guardrail posts and the supporting structure shall withstand the loads given in Clause 2.1.2.2.

All other guardrail systems shall be designed and constructed to withstand the loads given in Clause 2.1.2.2, and type tested in accordance with Appendix B and Appendix C.

## SECTION 4 STAIRWAYS

**4.1 WIDTH AND ANGLE OF SLOPE** Stairways shall be not less than 600 mm wide measured between the inside edges of the handrails. The angle of slope between the stiles and the horizontal shall be not less than 26.5 degrees and not greater than 45 degrees (see Figure 1.1).

### 4.2 FLIGHTS

**4.2.1 Shape** Stairways may be constructed in straight flights or in flights curved horizontally, i.e. curved in plan, and shall comply with Clause 4.2.2 or Clause 4.2.3, as appropriate.

**4.2.2 Straight flights** The number of rises in any flight of stairs shall not exceed 18, and where there is more than one flight, adjacent flights shall be connected by a landing complying with Clause 4.4. Except where suitable means such as a barrier or an increase in the length of the landing to not less than 2000 mm is to be provided to prevent a person from falling more than 36 steps, there shall be not more than 36 rises without a change of direction.

**4.2.3 Curved stairways** The radius to the centre-line of the stairway shall be not less than 600 mm. Where the radius to the centre-line of the stairway is less than 3000 mm, the maximum width of the curved stairway shall be 750 mm. The dimensions of rises and goings measured at the centre-line of the stairway shall comply with the dimensions specified in Clause 4.3.1 (see Figure 4.1).

Except where the flight of a curved stairway would terminate in such a position as would cause a landing or stairway access to be situated in close proximity to a potentially dangerous location, the number of rises in any flight of a curved stairway shall not exceed 18 without the provision of an intermediate landing. Where there is more than one flight, adjacent flights shall be connected by a landing complying with Clause 4.4.

### 4.3 STAIRS

**4.3.1 Rises and goings** The constructional details of treads shall comply with Clause 3.3.1. The surface of every tread shall extend across the full width of the stairway and shall be slip-resistant. Rises and goings shall conform to the following dimensions:

- (a) All rises and all goings, in the same flight of stairs shall be of uniform dimensions within a tolerance of  $\pm 5$  mm.
- (b) Each rise shall be not less than 150 mm and not greater than 215 mm.
- (c) Each going shall be not less than 215 mm and not greater than 305 mm.
- (d) The product of the going, measured in millimetres, and the rise, measured in millimetres, shall be not less than 45 000 and not greater than 48 000.
- (e) The tread width shall be not less than the going and there shall be a minimum overlap of 10 mm (see Figure 4.2).

Figure 4.3 shows graphically the principles specified in Items (b), (c) and (d) above.

**4.3.2 Minimum vertical clearance** Unless otherwise approved by the regulatory authority, the head clearance shall be not less than 2000 mm measured vertically from the nosing of the tread.

**4.3.3 Nosing** The nosing should be such that the edge of the stairs is highlighted, especially where the stairs may be used in a variety of lighting conditions.

**4.4 LANDINGS** Landings at points of access to the stairway and any intermediate landing in the stairway shall be designed and constructed in accordance with the requirements of Clause 3.3 and with the following:

- (a) The length and width of the landing shall be not less than the width of the stairway.
- (b) The landing shall have a minimum vertical clearance of not less than 2000 mm.
- (c) Every access landing shall provide standing space of at least 600 mm clear of cross-traffic or door swing.

**4.5 GUARDRAILING** Except where there is a fixed structure at a distance not greater than 100 mm from the stairway stile, stairways and stairway landings shall be provided with guardrailing on any exposed side. Guardrailing shall comply with the requirements of Clause 2.1.2.2 and Clause 3.4, except that the requirement for a toe-board (Clause 3.4.3) shall apply only to stairway landings. (See also Clause 3.2.1.)

### 4.6 HANDRAILING

**4.6.1 Provisions of handrails** Every stairway shall be provided with at least one handrail which shall have a smooth continuous top surface throughout the length of each stairway flight. Where the width of the stairway exceeds 1000 mm, a handrail shall be provided on each side. Ball stanchions may be used.

Handrails not more than 750 mm apart are also required on both sides of curved stairways where the radius to the centre-line of the stairway is 2000 mm or less. (See Figure 4.1.)

**4.6.2 Dimensions and clearance** Notwithstanding Clauses 4.6.1 and 2.1.2.3, a pipe handrail shall be of not less than 30 mm outside diameter, and a timber handrail shall be dressed to not less than 70 mm × 45 mm.

The handrail shall be parallel to the angle of slope of the stairway and the height measured vertically above the nosing of the tread shall be not less than 800 mm and not greater than 1000 mm.

The handrail shall be supported so as to allow unrestricted movement of the hand along, its upper surface, and there shall be a hand clearance of not less than 60 mm.

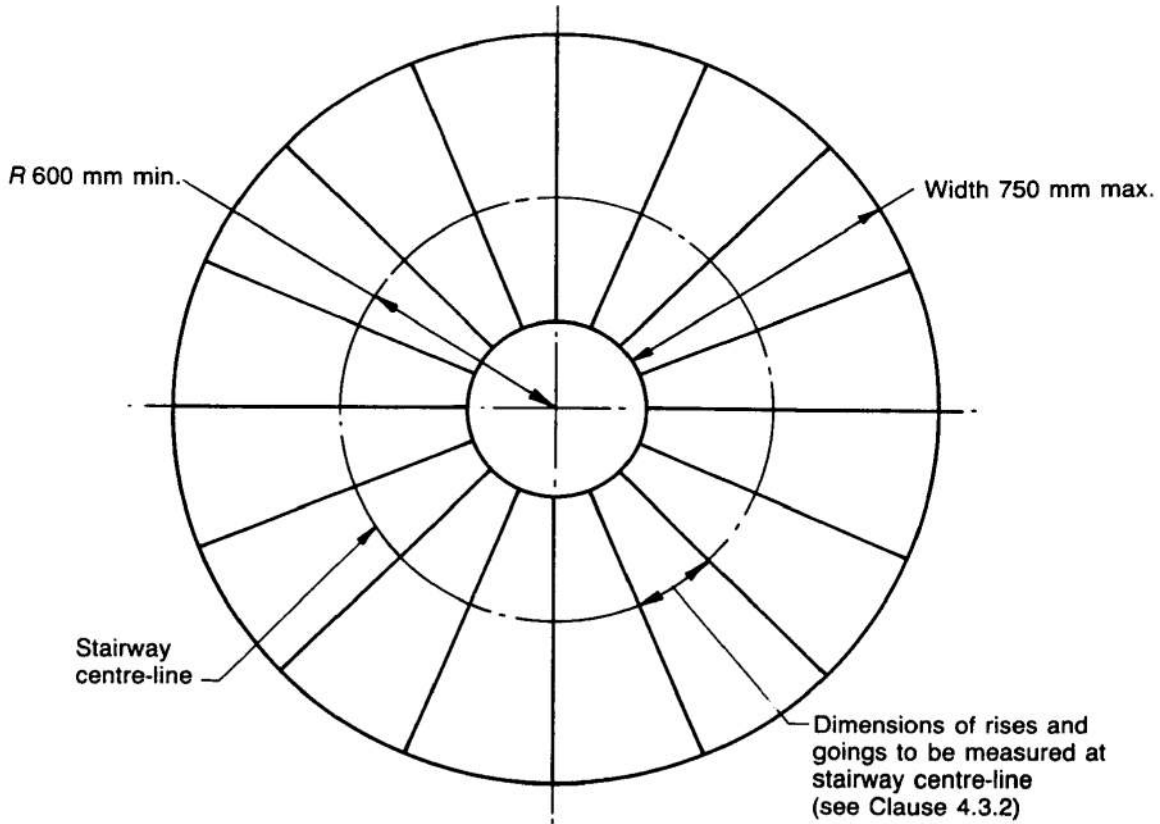


FIGURE 4.1 MINIMUM DIMENSIONS FOR CURVED STAIRWAYS

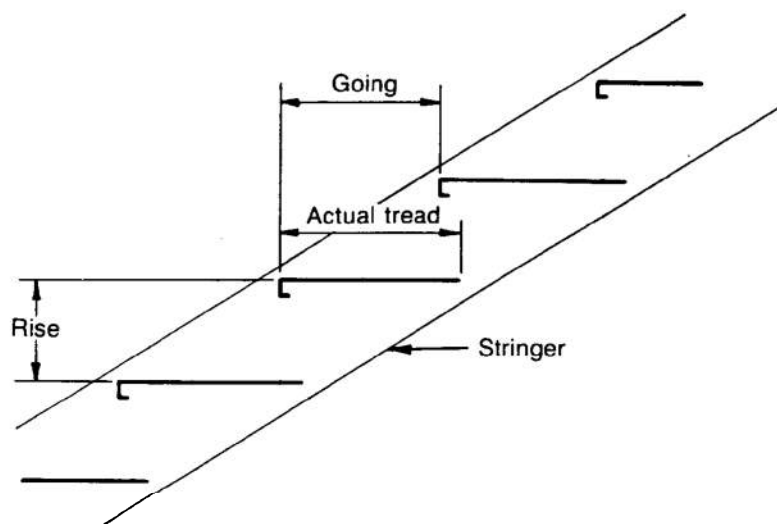
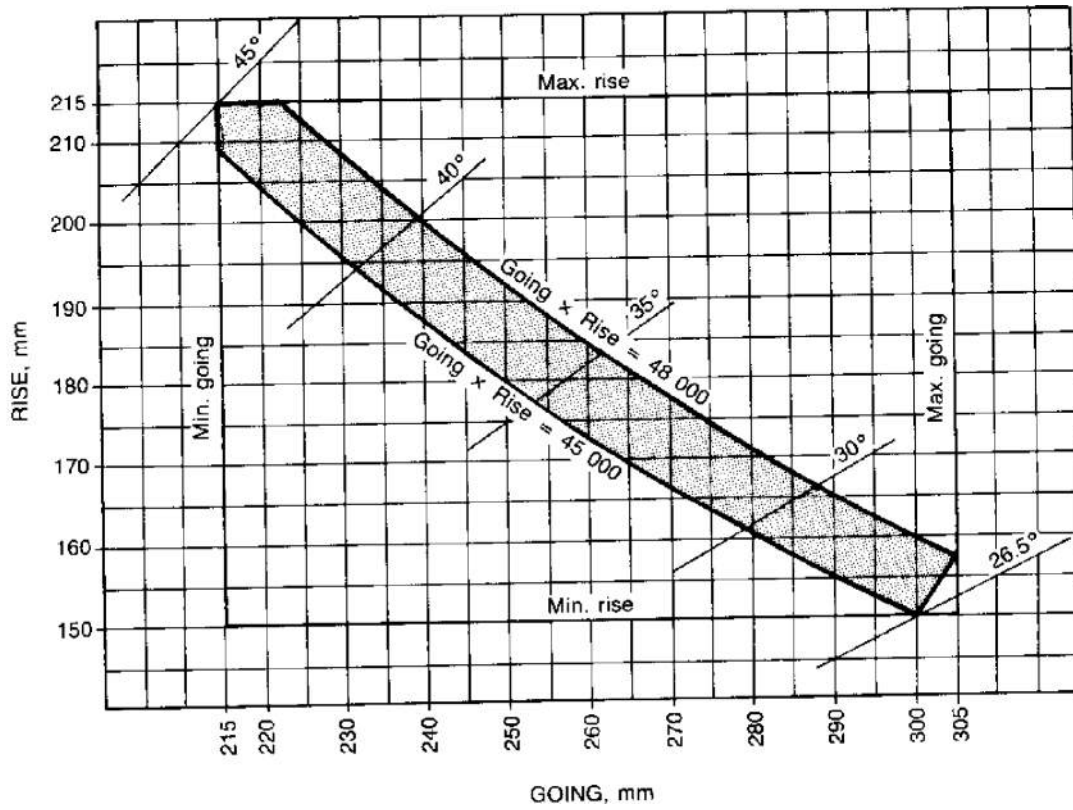


FIGURE 4.2 RISE, GOING, AND ACTUAL TREAD DEPTH



NOTE: The combination of dimensions of going and rise must lie within the shaded area, i.e. the product of going  $\times$  rise must be not less than 45 000 nor more than 48 000. For example, for a 250 mm going a suitable rise would lie between 180 mm and 192 mm, and for a 170 mm rise a suitable going would be between 265 mm and 282 mm. Maximum slope for a stairway is 45 degrees and minimum slope 26.5 degrees. The diagram also shows slope lines and indicates the range of dimensions applicable to a given slope.

FIGURE 4.3 STAIRWAY RISES AND GOINGS

## SECTION 5 FIXED LADDERS

**5.1 CLEARANCES** Clearances between the ladder and all permanent objects not being part of the ladder installation shall be not less than the following:

- (a) At the back edge of the rung of a rung ladder, 200 mm. (See Figure 5.1.)
- (b) From the nosing of the tread in step ladders, 150 mm. (See Figure 5.3.)
- (c) In front, from the nosing of the rung measured normal to the slope of the ladder, 750 mm when the ladder is vertical or inclined at not less than 75 degrees to the horizontal, increasing proportionately to 1000 mm when the slope of the ladder is 60 degrees to the horizontal.
- (d) At the sides, 450 mm from the centre-line of the ladder, except as provided in Item (e) below.

NOTE Where accepted by the regulatory authority, the 450 mm may be reduced to 300 mm.

- (e) From a line drawn from the stile, or from the end of the rung for individual-rung ladders, at an angle of not less than 135 degrees to the front of the tread or rung, as shown in Figure 5.1. The hand clearance for stiles shall be not less than 60 mm.

Notwithstanding the above, where a ladder is provided with a cage, the minimum clearance dimensions specified in Items (c) and (d) above shall be modified in accordance with the requirements of Clause 5.6.7.

**5.2 ACCESS THROUGH HORIZONTAL OPENINGS** When access is provided through a horizontal opening, the stiles or handrails shall extend not less than 900 mm above the opening, or handgrips above the level of the opening shall be provided in other cases.

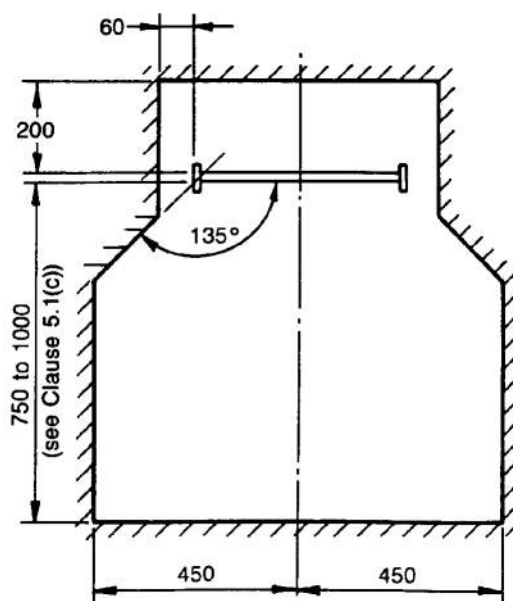
Where access is provided through an opening which is normally kept closed, the stiles or handrails may be terminated below the opening. Equivalent protection shall be provided above the opening for example by using retractable handgrip stanchions (see Figure 5.2).

Where it is necessary for a person to open a trapdoor while standing on a ladder, provision shall be made, either by a platform or by suitable guards, for the adequate support of that person.

**5.3 LADDER LANDINGS** The foot of the ladder should rest on the platform or landing and the first rung should be within the projected area of the landing. The width of any landing shall be not less than the width of the ladder or 450 mm, whichever is the greater. See Clause 5.6.1.2 for the length of platforms.

Notwithstanding the above, every access landing shall provide standing space at least 600 mm clear of cross traffic or door swing, or any other structure.

**5.4 GUARDRAILING** Exposed edges of access openings and landings other than for access from a ladder shall be provided with guardrailing complying with Clause 3.4.



DIMENSIONS IN MILLIMETRES

FIGURE 5.1 MINIMUM CLEARANCES FOR RUNG TYPE LADDERS

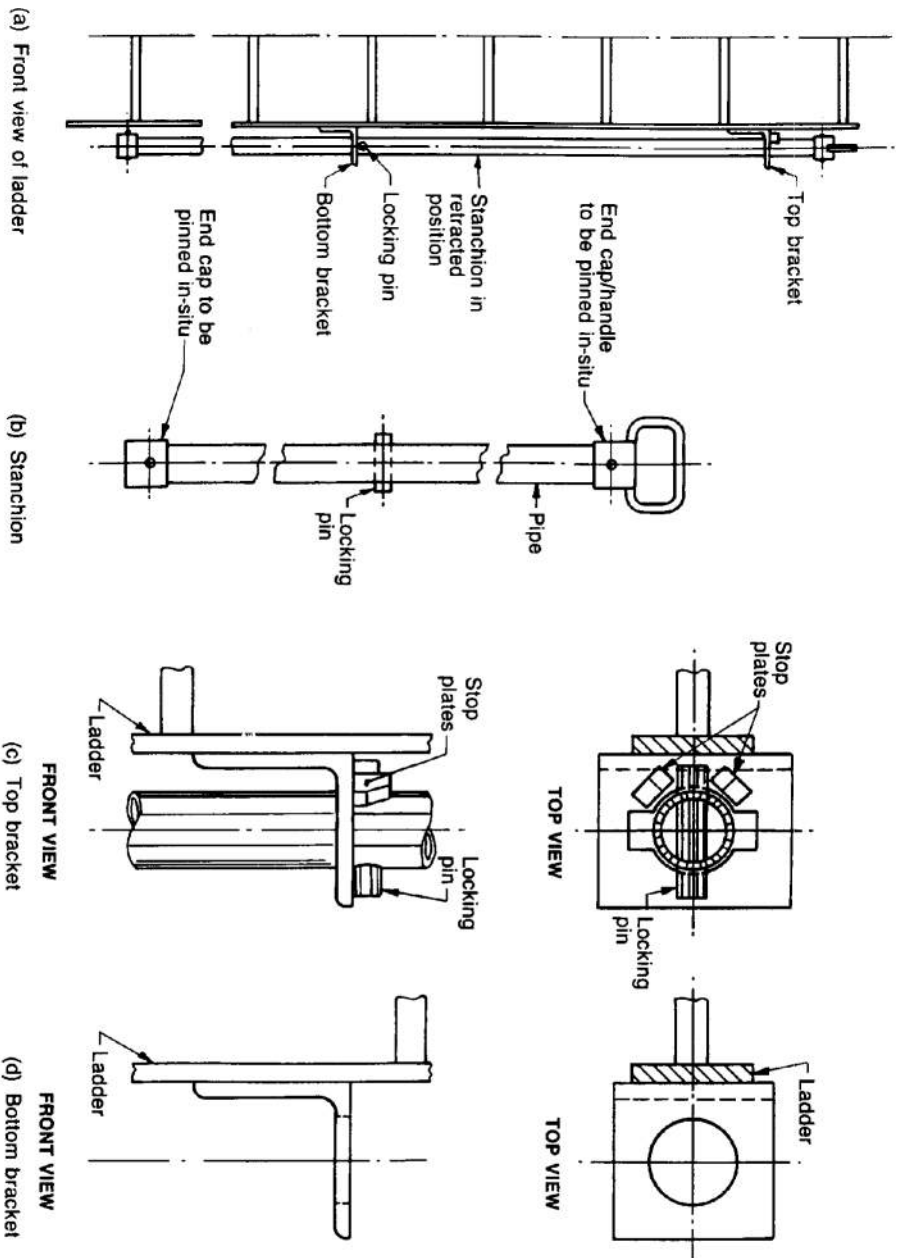


FIGURE 5.2 TYPICAL RETRACTABLE HANDGRIP STANCHIONS



## 5.5 STEP LADDERS

NOTE: Step ladders are not universally accepted and an approach should be made to the regulatory authority to ascertain if this type of ladder is acceptable for the application.

**5.5.1 General** The angle of slope of step ladders shall be not less than 60 degrees nor more than 70 degrees to the horizontal. It is preferable that the angle of slope should not exceed 65 degrees (see Figures 1.1. and 5.3).

Provision shall be made to prevent persons from descending a step ladder in a forward direction.

In a step ladder installation, the vertical distance between landings shall not exceed 6 m. Where the vertical height of the installation exceeds 6 m, and the installation consists of more than one ladder, succeeding ladders should change direction or, if this is not practicable, be staggered, at each landing level. Where compliance with the requirement for staggering is impracticable, other suitable means such as a guardrailing or a landing not less than 1.5 m long shall be provided to prevent a person from falling more than 6 m. The ladders shall not extend more than 12 m measured vertically without a change of direction.

Where a person could fall more than 6 m, the ladder system should be fully enclosed.

The dimensions of all treads and of all rises in the same ladder shall be uniform and within a tolerance of  $\pm 5$  mm.

The material used in the construction of timber step ladders shall comply with Clause 2.2.3.

Timber ladders should not be used in situations exposed to the weather or under other conditions likely to promote decay.

**5.5.2 Treads** Treads shall be not less than 100 mm wide. The surface of every tread shall be slip-resistant. Multi-rung treads shall not be used.

**5.5.3 Spacing of treads** The treads shall be equally spaced and not less than 200 mm, nor greater than 250 mm apart. The top tread shall be level with, and may be integral with, the landing.

**5.5.4 Width** The width of the ladder between the stiles shall be not less than 450 mm.

**5.5.5 Handrails** Metal handrails, not less than 30 mm diameter, shall be provided on each side of the ladder and shall be substantially supported. The clear space between the handrails shall be not less than 550 mm nor more than 750 mm. A hand clearance of not less than 60 mm shall be provided around each handrail.

The clear distance, normal to the slope of the ladder, between the handrails and the plane through the nosing of the tread shall be not greater than 250 mm when the slope of the ladder is 60 degrees, decreasing proportionately to not less than 150 mm when the slope of the ladder is 70 degrees.

The bottom of the handrails shall commence at a point not greater than 900 mm above the floor or lower landing and, except as provided in Clause 5.2, the handrails shall extend above the upper landing to a height of not less than 900 mm and be connected to the guardrailing of the landing. There shall be no hand-pinch points at this connection between components.

## 5.6 RUNG LADDERS

### 5.6.1 General

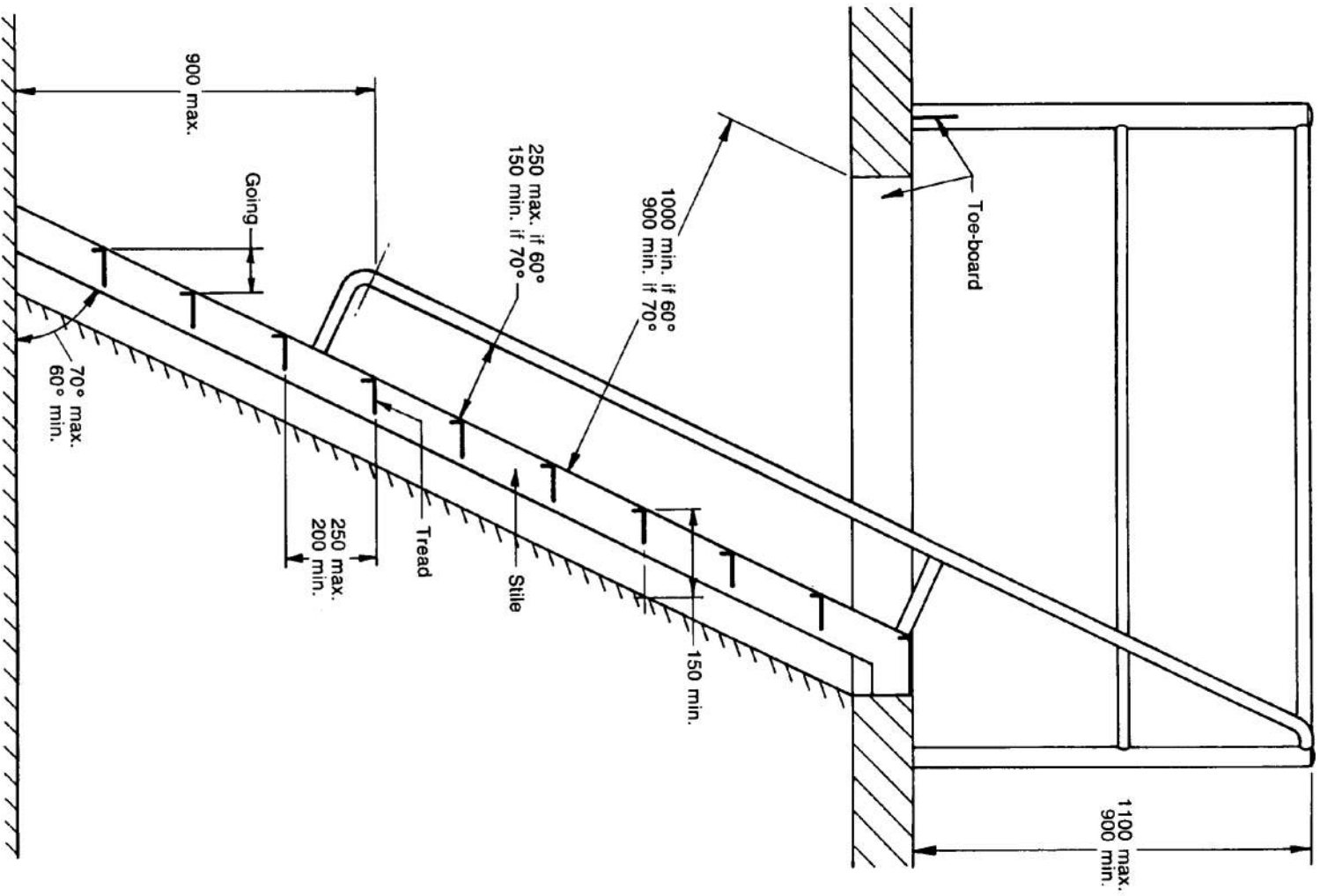
**5.6.1.1 Angle of slope** The angle of slope of rung ladders shall be not less than 70 degrees to the horizontal (see Figure 1.1). It should be not greater than 75 degrees to the horizontal. In no case shall the ladder overhang the person climbing the ladder.

NOTE: Ladders with a slope in excess of 75 degrees are not universally accepted and an approach should be made to the regulatory authority to ascertain if the proposed ladder slope is acceptable.

**5.6.1.2 Distance between landings** Except where it is not reasonably practicable to provide an intermediate landing, the vertical distance between landings in a rung ladder installation shall not exceed 6.0 m. Where the vertical height of the installation exceeds 6.0 m, and the installation consists of more than one ladder, succeeding ladders shall change direction at each landing, or, if this is not practicable, be staggered at each landing level. The minimum length of this platform shall be not less than 900 mm from the front of the ladder. Where compliance with the requirements for staggering is not practicable, other suitable means such as a barrier or a landing not less than 1.5 m long shall be provided to prevent a person from falling more than 6.0 m. The vertical distance between landings in multiple-flight ladders shall be approximately equal.

**5.6.1.3 Ladder cage** A ladder cage complying with Clause 5.6.7 shall be provided where a person could fall from a ladder more than 6.0 m irrespective of landings; however, the regulatory authority may accepted the fitting of a protective device on the ladder to take the place of the ladder cage. Where a protective device is fitted, a guard shall be placed over the first 2.5 m of the ladder, which shall be locked to prevent use by unauthorized personnel. It shall also be provided with the following notice:

‘This ladder shall be used only by personnel using the approved protective device.’



DIMENSIONS IN MILLIMETRES

FIGURE 5.3 CLEARANCES FOR STEP LADDERS

**5.6.2 Timber ladders** The material used in construction of fixed timber ladders shall comply with Clause 2.2.3. Timber ladders shall not be used in situations exposed to the weather or under other conditions liable to promote decay. They shall not be coated with a material which may disguise defects in the ladders.

The construction and dimensions of timber ladders, other than the distance between stiles and the spacing of rungs, shall comply with the requirements for single ladders in AS 1892.2.

### 5.6.3 Extension above landings

**5.6.3.1 Step-through ladders** Where it is necessary for a person to step through a ladder, the stiles shall extend not less than 900 mm or to the height of the handrail, if provided, above the platform landing or top rung where the top rung is level with the platform. (See Figure 5.4.)

The width between the extended stiles shall, at the top, be not less than 525 mm and not more than 675 mm and the stiles shall be rigid. The top rung shall be level with, or one full rise below, the landing. (For stile clearance, see Clause 5.1(e).)

Where the top rung is level with the landing, the distance between the centre of the stile at the level of the landing and the edge of the landing shall be 60 mm to 100 mm, or there shall be no gap at all (see Figure 5.5(b)). Where the top rung is one full rise below the landing, there shall be a gap not greater than 50 mm between the centre of the stile at the level of the landing and the edge of the landing (see Figure 5.5(a)).

Except where it is not reasonably practicable, a guardrail or gate shall be fitted across the access to a step-through ladder from a working platform. Typically, this would take the form of a landing platform not less than 1.5 m long leading to the opening guardrail or gate, and then to the working platform. The opening guardrail or gate may be either sliding or hinged.

Toe-boards shall not extend across ladder openings.

**5.6.3.2 Side access ladders** Where it is necessary for a person to step sideways from a ladder, the ladder and its rungs shall extend not less than 900 mm, or to the height of the handrail, if provided, above the landing, and there shall be a rung level with the landing. (See Figure 5.6.)

The horizontal distance from the nearest stile to the landing shall be not less than 175 mm nor more than 300 mm.

Toe-boards shall not extend across ladder openings.

**5.6.4 Fastenings** Where flat metal stiles or timber stiles are used, the ladder shall be secured with fastenings at the top and at the foot of the ladder, and should be secured at intervals of not more than 3500 mm. For other types of stile, the design of the ladder shall determine the distance between the fastenings. The fastenings should be on the back of the rung ladders, and should be designed to provide the necessary hand clearance.

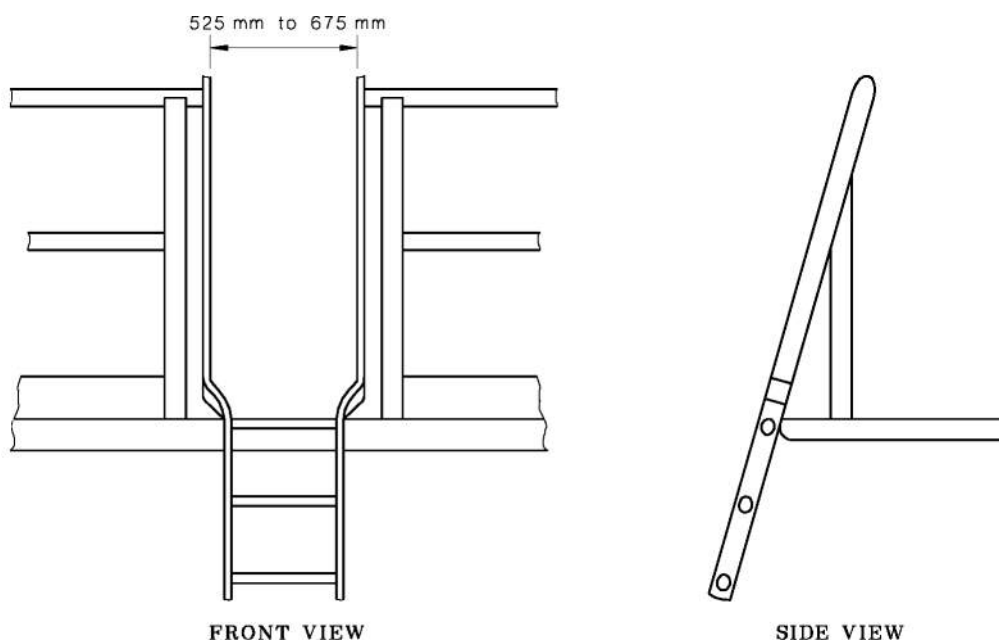
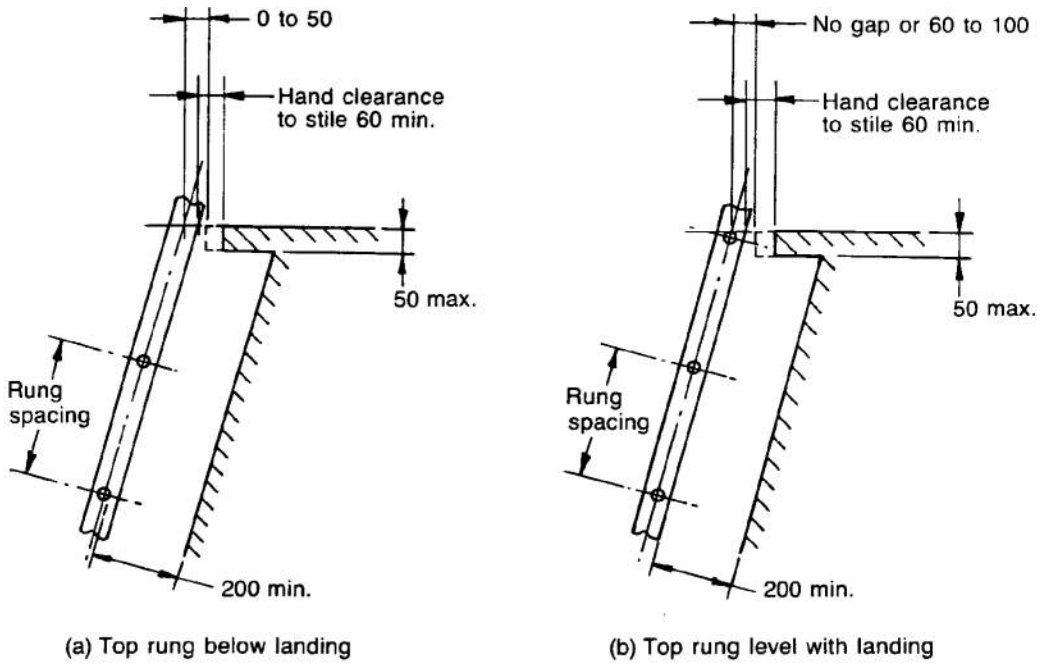


FIGURE 5.4 STILES FOR STEP-THROUGH LADDERS



DIMENSIONS IN MILLIMETRES

FIGURE 5.5 GAP BETWEEN LANDING AND LADDER

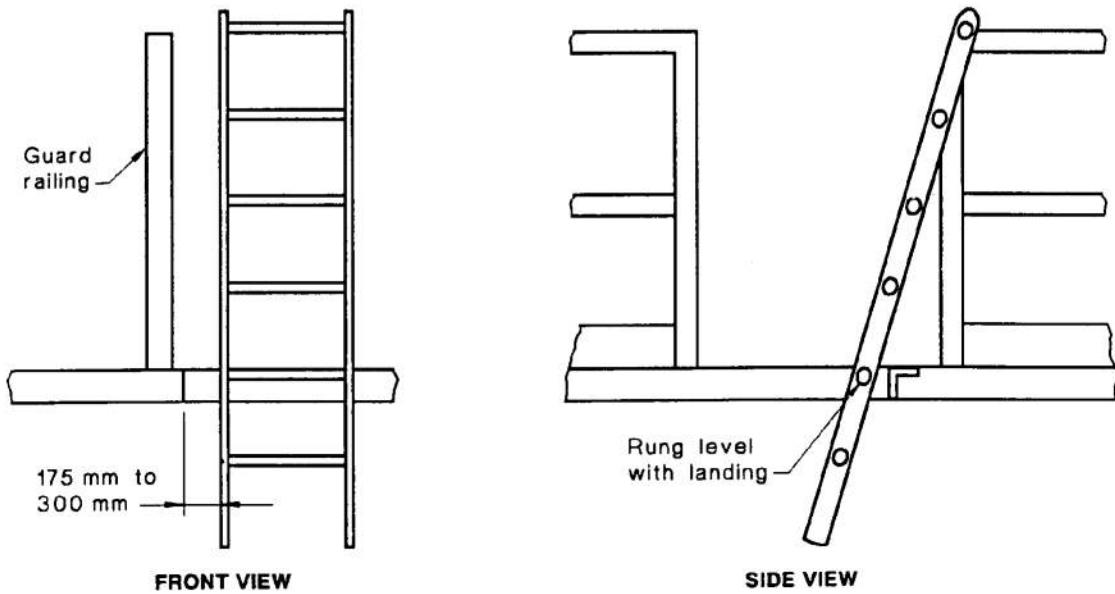


FIGURE 5.6 SIDE ACCESS LADDERS

**5.6.5 Stiles**

**5.6.5.1 Width** The clearance between stiles shall be not less than 375 mm nor more than 525 mm.

**5.6.5.2 Cross-section** Stiles of flat material shall be not less than 50 mm nor greater than 80 mm wide and not less than 6 mm nor more than 30 mm thick. Circular stiles shall be not less than 40 mm nor greater than 65 mm outside diameter.

### 5.6.6 Rungs

**5.6.6.1 Rungs** Rungs shall comply with Clause 2.1.2.5. Rungs shall be of material giving equivalent performance to 20 mm diameter solid low-carbon steel, and shall be not less than 20 mm outside diameter. The rungs shall be securely fastened to the stiles (e.g. by welding or swaging). In corrosive areas, the rungs shall be completely sealed at the point where they enter into or contact the stiles.

Where tubular rungs are used, they shall be swaged or welded into the stiles, and the ends of the rungs left open. Where the ladder is of steel construction and tubular rungs are used, the completed ladder shall be hot-dip galvanized.

The point of attachment to the stile shall be smooth and free from projections likely to cause injury to the hands.

NOTE: Some applications will demand the use of slip-resistant rungs, or slip-resistant coatings on rungs.

**5.6.6.2 Spacing of rungs** The rungs shall be spaced not less than 250 mm nor greater than 300 mm apart, except that ladders having a length of less than 1.5 m may have spacings closer than 250 mm but not less than 200 mm.

**5.6.6.3 Rung dimensions** The rung dimensions of all rungs and the distance between rungs in the same ladder shall be uniform and within a tolerance of  $\pm 5$  mm.

**5.6.7 Ladder cages** Where a ladder cage is provided, it shall comply with the following (see Figures 5.7 and 5.8):

- (a) The inside of the cage shall be free from projections. The smaller dimension of the openings shall not exceed 150 mm.
- (b) The cage shall extend not less than 900 mm or to the height of the handrail, if provided, above the top of the platform landing, unless other adequate protection is provided. It shall terminate at not less than 2 m nor more than 2.2 m above the base of the ladder. The bottom portion of the cage may be flared out.
- (c) Where the bottom of the ladder terminates at a platform fitted with a guardrail which is less than 900 mm from the front of the ladder, or from the centre of the ladder to either side, the area between the cage and the top of the guardrailing shall be guarded.
- (d) The rear half of the cage shall be approximately semicircular and the sectional dimensions of the cage shall be such as will provide an internal width of 700 mm and a clearance of 750 mm between the back of the cage and the front of the rungs measured normal to the slope of the ladder.
- (e) Cage hoops shall be not less than 50 mm  $\times$  5 mm low carbon steel flat or other component having comparable performance spaced at not more than 2000 mm centres.
- (f) Cage verticals shall be not less than -
  - (i) 25 mm  $\times$  5 mm low carbon steel or other component having comparable performance spaced in accordance with Clause 5.6.7(a);
  - (ii) welded wire mesh not less than 4 mm with openings not exceeding 100 mm  $\times$  100 mm; or
  - (iii) chain mesh conforming to Table 3.2, supported by not less than five vertical bars around the circumference of the cage.

**5.6.8 Handrails** Handrails shall not be used for rung ladders.

## 5.7 INDIVIDUAL-RUNG LADDERS (STEP-IRONS)

**5.7.1 General** A step-iron ladder should only be used where the vertical rise does not exceed 6 m and it is not reasonably practicable to use any other type of ladder.

Where a person could fall more than 6 m from such a ladder, a ladder cage complying with Clause 5.6.1.3 should be fitted. The dimensions and the spacing of the rungs shall be uniform throughout the ladder.

**5.7.2 Rungs** The rungs shall be of material giving equivalent performance to 24 mm diameter solid low-carbon steel, and shall have a tread depth of not less than 24 mm. Rungs shall comply with Clause 2.1.2.5 and the maximum deflection shall not exceed 3 mm. The rungs shall be shaped so that the foot cannot slip off the end of the rung (see Figure 5.9).

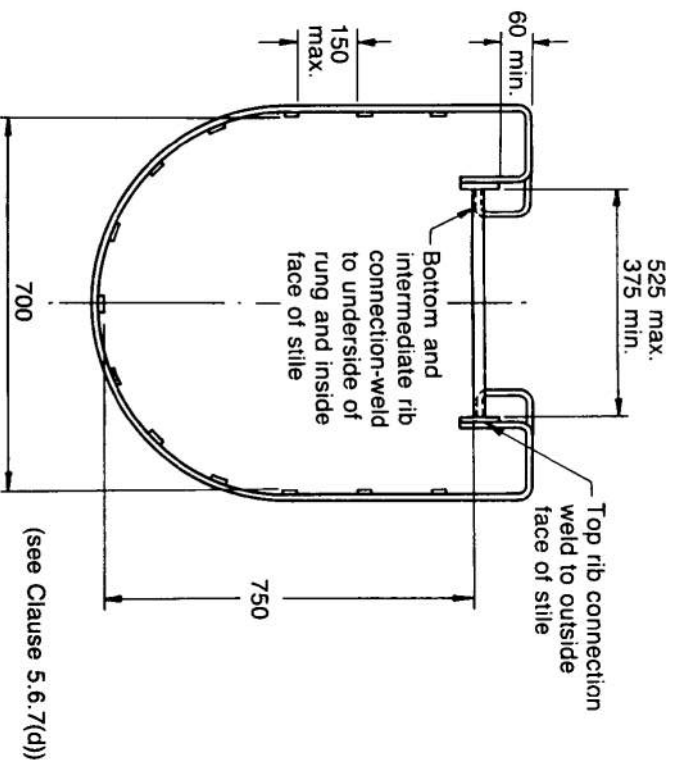
**5.7.3 Spacing of rungs** The rungs shall be evenly spaced not less than 250 mm nor greater than 350 mm apart, except that ladders having a length of less than 1.2 m may have spacings closer than 250 mm. The spacing of rungs in the same ladder should be uniform within a tolerance of  $\pm 8$  mm.

**5.7.4 Width** The clear width of the tread of each rung shall be not less than 150 mm nor more than 550 mm.

**5.7.5 Fixing** Every rung shall be permanently fixed to the adjoining structure or equipment and shall provide a clearance to the back edge of the rung as follows:

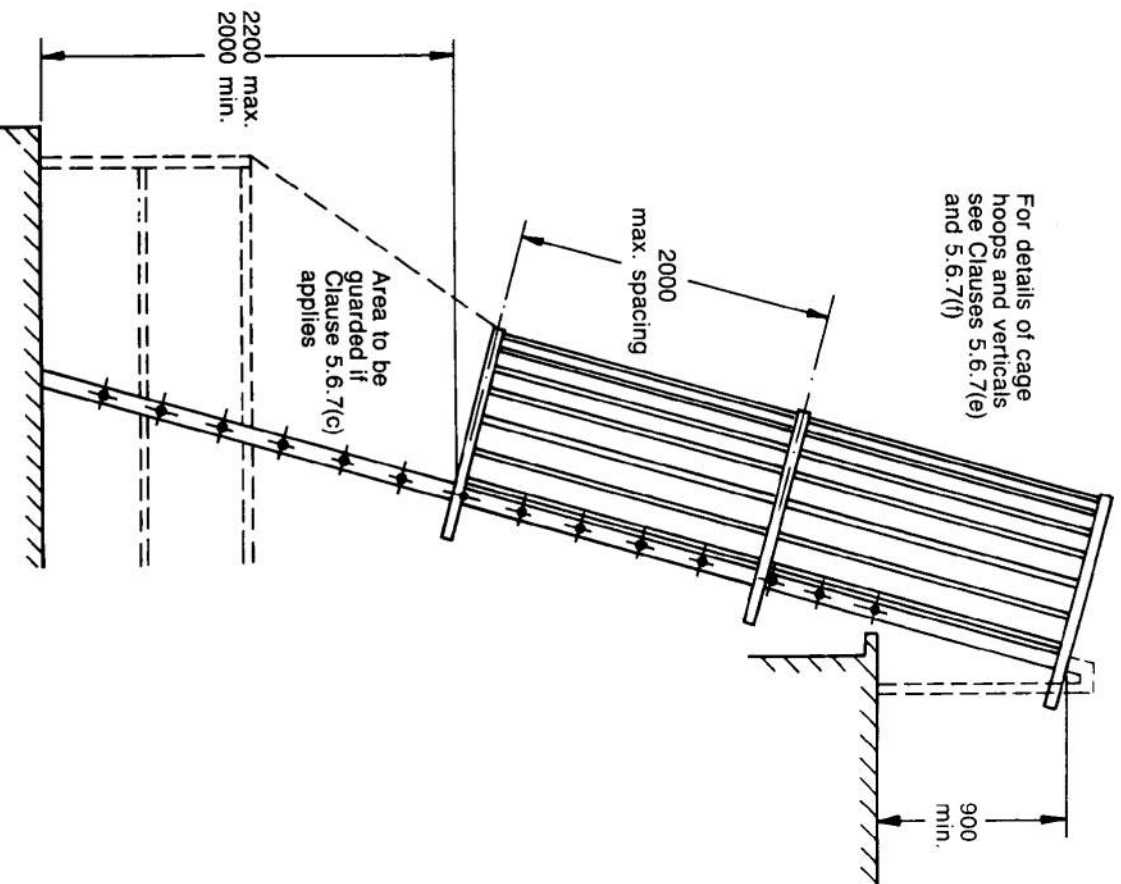
- (a) Where the ladder access is less than 750 mm; not less than 150 mm.
- (b) Where the ladder access is greater than 750 mm, not less than 200 mm.

Rungs should be fixed so as to be coplanar (see Figure 5.10). The used of cranked rungs on circular or curved walls is permitted.



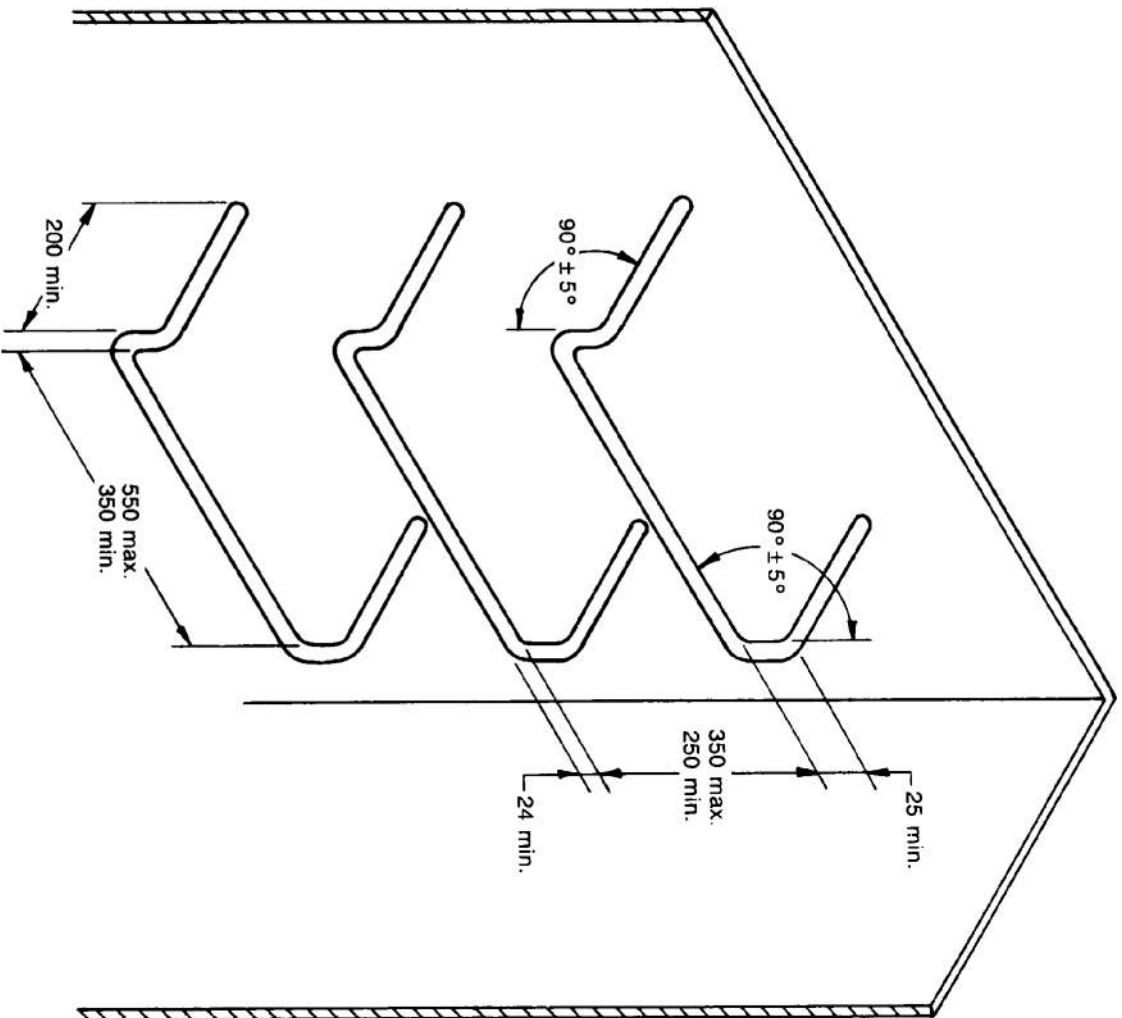
DIMENSIONS IN MILLIMETRES

FIGURE 5.7 CLEARANCE DIAGRAM FOR LADDER CAGE



DIMENSIONS IN MILLIMETRES

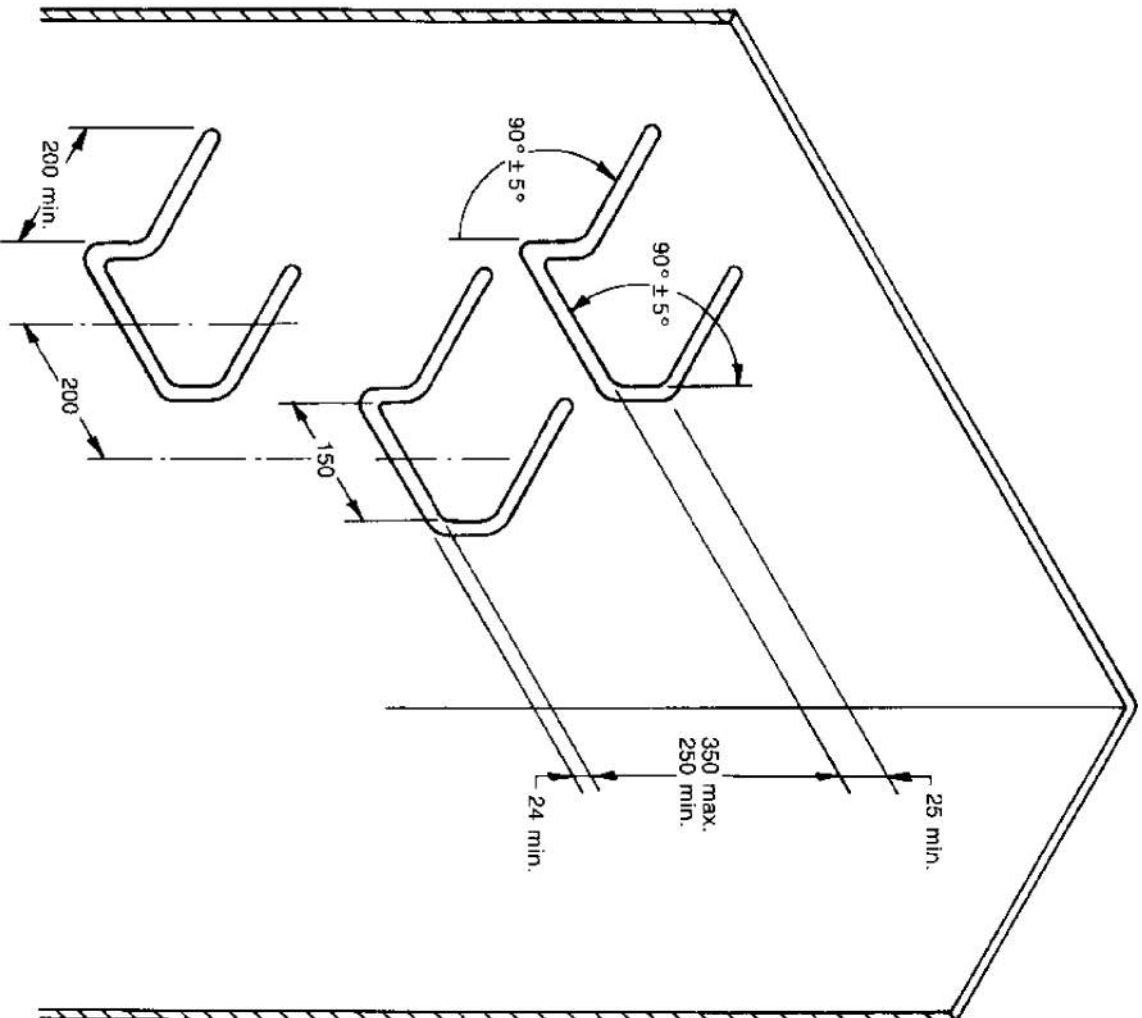
FIGURE 5.8 LADDER CAGE



DIMENSIONS IN MILLIMETRES

FIGURE 5.9 TYPICAL INDIVIDUAL-RUNG LADDER





DIMENSIONS IN MILLIMETRES

FIGURE 5.10 TYPICAL INDIVIDUAL-RUNG LADDER WITH COPLANAR RUNGS

APPENDIX A  
TYPICAL COMPONENT DIMENSIONS AND SPACINGS  
FOR GUARDRAILING  
(Informative)

**A1 SCOPE** This Appendix provides additional information and recommended minimum dimensions of components as well as maximum spacings for guardrailing (see Tables A1 to A4).

The information provided may be used where guardrailing is not specifically designed and tested in accordance with Clause 3.4.

**TABLE A1**  
**RECOMMENDED MINIMUM DIMENSIONS FOR TYPICAL STEEL AND**  
**TIMBER COMPONENTS OF GUARDRAILING**

Component	Steel shapes mm	Steel pipe (outside diameter) (See Clause 2.3) mm	Timber (actual sizes) mm
Posts	65 × 65 × 5 angle	48.3	90 × 90
Top rail	50 × 50 × 5 angle	33.7	70 × 45
Intermediate members (parallel to handrail, or vertical)	40 × 40 × 5 angle 50 × 5 flat	26.9	75 × 35
Toe-boards	100 × 6 flat	—	100 × 25

**TABLE A2**  
**RECOMMENDED MINIMUM DIMENSIONS AND PROPERTIES FOR TYPICAL**  
**ALUMINIUM COMPONENTS OF GUARDRAILING**

Component	Aluminium shape	Minimum tensile yield stress MPa
Posts	60 mm OD tube × 2.0 mm wall thickness	172
Top rail	50 mm OD tube × 3.0 mm wall thickness	110
Intermediate members	38 mm OD tube × 2.0 mm wall thickness	110
Toe-boards	100 mm wide × 5 mm deep corrugated extrusion	110
Toe-boards	100 mm wide × 5 mm thick bar	—

**TABLE A3**  
**RECOMMENDED MAXIMUM SPACING OF STEEL POSTS FOR GUARDRAILING**  
**ON PLATFORMS AND WALKWAYS**

Section of steel posts mm	Fastening* to platform or bracket	Height of handrail above top of platform mm	Maximum recommended spacing of posts (See Note 1) mm
65 × 65 × 5 angle	Welded	900 1 000	2 500 2 100
	Bolted	900 1 000	2 400 2 000
65 × 65 × 6.5 angle	Welded	900 1 000	2 500
	Bolted	900 1 000	2 500
48.3 OD pipe 3.2 thick	Welded	900 1 000	2 300 2 000
60.3 OD pipe 3.2 thick	Welded	900 1 000	2 500

\* Method of fastening should provide a strength not less than that of the post.

NOTES:

- These spacings are based on a projecting length of the post extending from a point not greater than 50 mm below the top of the platform, and a minimum material yield stress of 250 MPa.
- Where other sections are used, the maximum spacing may be designed by calculation.
- The upper limit of the handrail height given in Column 3 should not be exceeded.

**TABLE A4**  
**RECOMMENDED MAXIMUM SPACING OF ALUMINIUM POSTS FOR GUARDRAILING**

Section of aluminium post mm	Fastening* to platform or bracket	Height of handrail above top of platform mm	Maximum recommended spacing of posts (See Note 1) mm
60 OD tube × 2 thick	Bolted (side mounted)	900	2 000
	Bolted (side mounted)	1 000	1 800
	Bolted (deck mounted)	1 000	2 000

\* Method of fastening should provide a strength not less than that of the post.

NOTES:

- 1 These spacings are based on a projecting length of the post extending from a point 50 mm below standing level.
- 2 Where other sections are used, the maximum spacing may be designed by calculation.

APPENDIX B  
 TESTING OF GUARDRAIL POSTS  
 (Normative)

**B1 SCOPE** This Appendix sets out a method for determining the performance of guardrail posts forming part of a guardrail system.

**B2 PRINCIPLE** A guardrail post is fixed to a rigid foundation using the mounting method intended for installation. A force is applied to the guardrail post, and any subsequent permanent deflection is measured.

**B3 APPARATUS** The following apparatus is required:

- (a) A rigid foundation to which the guardrail post may be fixed in the manner intended for installation.
- (b) A means of applying to the guardrail post a force of 550 N.
- (c) A means of measuring a time interval of  $60 \pm 1$  s, e.g. a stopwatch.
- (d) A steel rule graduated in millimetres.

**B4 GENERAL GUIDANCE** Where the guardrail post is —

- (a) unsymmetrical in cross-section such that application of the test load would cause lateral instability; and
- (b) this instability is normally restrained by the guardrail or kneerail,

then three guardrail posts may be erected at their maximum intended centre distances, and be connected by guardrailing or kneerailing as appropriate. This will provide support against buckling, adjacent to holes bored in the guardrail post for the purpose of assembling guardrailing, or failure resulting from the heat affected zone in welded aluminium fabrications. The test loads shall be applied to either of the end guardrail posts.

Where a single guardrail post is to be tested, it is recommended that short sections of guardrail and kneerail be assembled to the post prior to testing.

**B5 PROCEDURE** The procedure shall be as follows (see Figure B1):

- (a) Securely fix the guardrail posts to the rigid foundation using the means intended for installation.
  - (b) Mount or assemble any guardrailing to the posts.
- NOTE: Where a single post is under test, then sections of guardrailing of any convenient length may be used.
- (c) Apply the load in the horizontal sense to the top of the guardrail post for a period of  $60 \pm 1$  s.
  - (d) Remove the load.
  - (e) Measure any permanent deflection in the guardrail post.

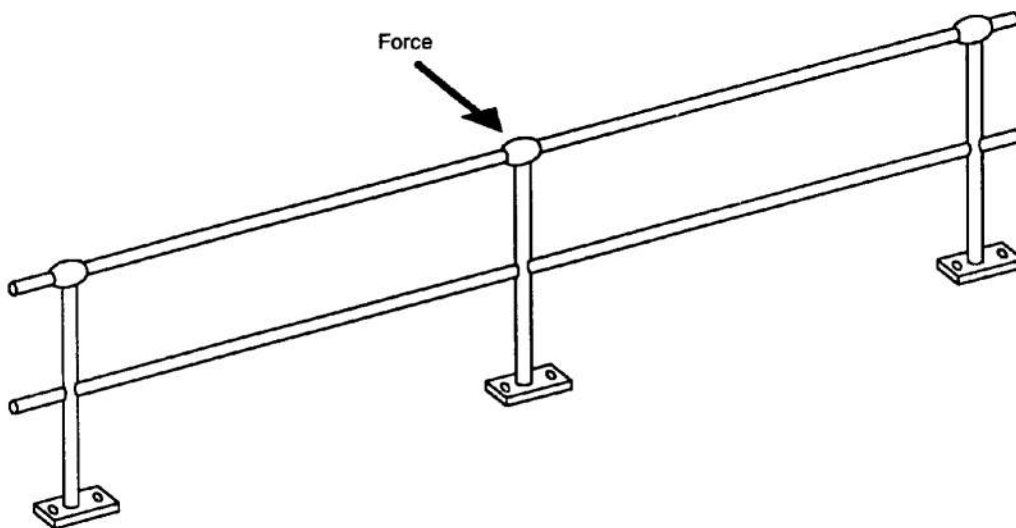


FIGURE B1 TYPICAL GUARDRAIL POST TEST

APPENDIX C  
TESTING OF GUARDRAILS  
(Normative)

**C1 SCOPE** This Appendix sets out a method for determining the performance of guardrails forming part of a guardrail system.

**C2 PRINCIPLE** A section of guardrail is mounted between supports, and non-simultaneous forces are applied horizontally and vertically to the guardrail. Any permanent deflection of the guardrail is subsequently measured.

**C3 APPARATUS** The following apparatus is required:

- (a) A means of supporting the guardrail at two points separated by the maximum intended centre distance of posts in the guardrail system.
- (b) A means of applying to the guardrail whichever of the following loads produces the most adverse effect:
  - (i) 550 N acting vertically or horizontally.
  - (ii) 330 N per linear metre vertically or horizontally.

NOTE: A concentrated load producing a bending moment equivalent to 330 N per linear metre of guardrail span may be applied at the midpoint of the guardrail span.

- (c) A steel rule, graduated in millimetres.

**C4 PROCEDURE** The procedure shall be as follows (see Figure C1):

- (a) Separate the two supports by a distance equal to the maximum design span of the guardrail system.
- (b) Securely fix the supports in place.
- (c) Install a section of guardrail to the supports, using the means of fixing to be used in the guardrail system.
- (d) Determine the position of the span midpoint in both the horizontal and vertical planes relative to a convenient reference point.

NOTE: This point may be conveniently determined by stretching a thin wire between the two supports and adjacent to the guardrail.

- (e) Apply the load in the vertical sense to the midpoint of the span. The load shall be applied so as to avoid shock loads.
- (f) Remove the load.
- (g) Measure any permanent deflection in the guardrail.
- (h) Apply the load in the horizontal sense to the midpoint of the span. The load shall be applied so as to avoid shock loads.
- (i) Remove the load.
- (j) Measure any permanent deflection in the guardrail.

NOTE: There may be both a horizontal and vertical component in the permanent deflection, which are added vectorially to determine the resultant permanent deflection.

**C5 CRITERIA** The resultant permanent deflection shall not exceed 1/90 of the span between the two supports.

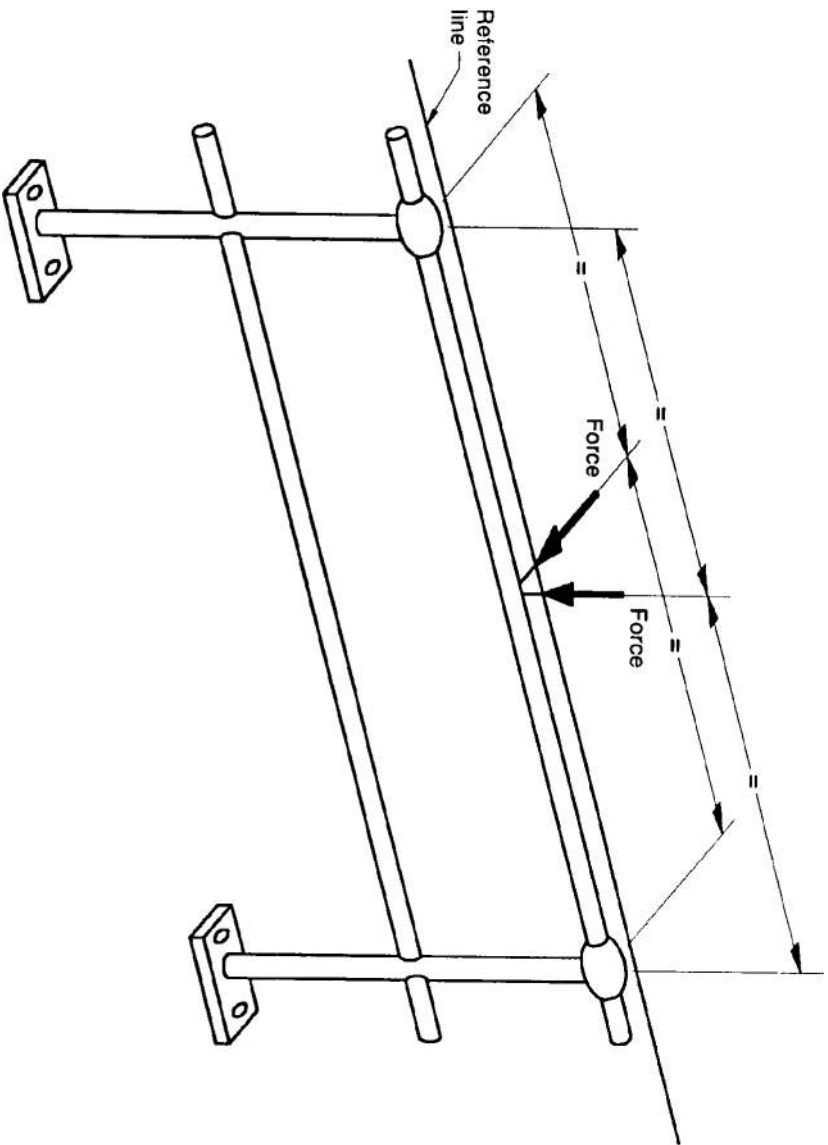


FIGURE C1 TYPICAL GUARDRAIL TEST