

Australian/New Zealand Standard[®]

Portable ladders

Part 3: Reinforced plastic

AS/NZS 1892.3:1996

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Composites Institute of Australia
Department of Consumer Affairs, N.S.W.
Department of Occupational Health Safety and Welfare, W.A.
Federal Bureau of Consumer Affairs
Ladder Manufacturers' Association of Australia
Metal Trades Industry Association of Australia
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Part 3: Reinforced plastic

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee SF/34 on Portable Ladders, as a first edition in Australia, and to supersede (in part) NZS 5233:1986, *Specification for portable ladders (other than timber ladders)*.

It is one of a series of Australian Standards covering the safe design, manufacture and use of portable ladders and accessories. Other Standards in the series are the following:

AS

1892.2 Part 2: Portable ladders—Timber

AS/NZS

1892.1 Part 1: Portable ladders—Metal

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

During the development of this Standard, reference was made to ANSI A14.5—1992 *Ladders—Portable reinforced plastic—Safety requirements*. Acknowledgment is made of the assistance received therefrom.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Portable ladders****Part 3: Reinforced plastic**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard sets out safety requirements for the design and construction of portable reinforced plastic ladders. The Standard provides for ladders of two duty ratings, industrial ladders and domestic ladders, which are assigned minimum load ratings.

The Standard covers single and multiple-section ladders, multipurpose ladders, stepladders and combination ladders.

The Standard does not cover ladder accessories, including ladder levellers, ladder stabilizers or stand-off devices, ladder jacks, or ladder straps or hooks, that may be installed on, or used in conjunction with, ladders.

1.2 OBJECTIVE The objective of this Standard is to provide designers, manufacturers and regulatory authorities with the minimum performance and dimensional requirements for portable reinforced plastic ladders, in order to minimize risks to the health and safety of portable ladder users.

1.3 APPLICATION The requirements listed herein specify certain minimum dimensions, strength, stability and durability criteria deemed necessary for the safe use of portable reinforced plastic ladders, thereby providing a set of performance and dimensional requirements against which portable reinforced plastic ladders may be evaluated.

1.4 PARTICULAR REQUIREMENTS Portable reinforced plastic ladders shall comply with the relevant requirements of Section 2, General requirements, and with the specific requirements of the Section(s), appropriate to the type of ladder as follows:

- (a) Single ladders: Section 3.
- (b) Extension ladders: Section 4.
- (c) Stepladders: Section 5.
- (d) Trestle ladders: Section 6.
- (e) Multi-purpose ladders: Section 7.
- (f) Special purpose ladders: Section 8.

1.5 REFERENCE DOCUMENTS The following documents are referred to in this Standard:

AS
2089 Sheave blocks for lifting purposes

AS/NZS
1892 Portable ladders
1892.1 Part 1: Metal

AS/NZS

4142 Fibre ropes

4142.2 Part 2: Three-strand, hawser-laid and eight-strand plaited

ASTM

D 149 Test methods for dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies

D 229 Standard test methods for rigid sheet and plate materials used for electrical insulation

D 709 Specification for laminated thermosetting materials

D 790 Test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials

D 792 Test methods for density and specific gravity (relative density) of plastics by displacement

D 903 Test method for peel or stripping strength of adhesive bonds

D 1499 Practice for operating light- and water-exposure apparatus (carbon-arc type) for exposure of plastics

D 2565 Practice for operating xenon arc-type light-exposure apparatus with and without water for exposure of plastics

D 2583 Test method for indentation hardness of rigid plastics by means of a Barcol impressor

G 23 Practice for operating light-exposure apparatus (carbon-arc type) with and without water for exposure of nonmetallic materials

G 26 Practice for operating light-exposure apparatus (xenon-arc type) with and without water for exposure of nonmetallic materials

G 53 Practice for operating light- and water-exposure apparatus (fluorescent UV-condensation type) for exposure of nonmetallic materials

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

1.6.1 Articulation—a hinge which is capable of being locked in one or more positions.

1.6.2 Composite—a homogeneous material created by the synthetic assembly of two or more materials (a selected filler or reinforcing elements and a compatible matrix binder), to obtain specific characteristics and properties.

1.6.3 Domestic ladder—a ladder designed to be used by a householder for construction, maintenance and repairs carried out at a private dwelling for non-commercial purposes.

1.6.4 Double-sided stepladder—a self-supporting portable ladder of fixed length with two pairs of stiles which are—

- (a) hinged or fixed; and
- (b) each fitted with treads for ascent and descent.

1.6.5 Dual-purpose stepladder—a self-supporting stepladder where the back section is fitted with rungs or treads, and which can be further adjusted to provide an extension of the front section as a non-self-supporting portable ladder (in the extended position).

1.6.6 Duty rating—the rating assigned to the ladder, i.e. industrial or domestic, which indicates the service capability of the ladder.

1.6.7 Effective length—the working length of a ladder less end caps and feet, where fitted.

1.6.8 E-glass—a borosilicate glass, the type most frequently used for glass fibre for reinforced plastics, suitable for electrical laminates because of its high resistivity.

1.6.9 Extension ladder—a non-self-supporting portable ladder consisting of two or more sections travelling in guides including interlocking stiles or brackets arranged in order to permit adjustment of working length.

1.6.10 Fibreglass—a glass-reinforced plastic, where the most common plastic encountered would be polyester. The composite possesses directional properties, as well as specific mechanical, electrical, anti-corrosion and weathering characteristics.

1.6.11 Industrial ladder—any ladder other than a domestic ladder.

1.6.12 Load rating—the maximum load, including the weight of the user, materials and tools, which the ladder is intended to carry, in kilograms.

1.6.13 Multipurpose ladder—a portable ladder having one or more pairs of articulations which allow the ladder to be rearranged to function as a single or extension ladder, with or without a stand-off, as a single or double-sided stepladder, scaffold or work platform.

1.6.14 Overlap—the distance by which each section of an extension ladder coincides with its matching section.

1.6.15 Platform stepladder—a single-sided stepladder with a specially designed substantial platform near the top, to provide a working area.

1.6.16 Polyesters—thermosetting resins produced by dissolving unsaturated, generally linear, alkyd resins in a vinyl-type active monomer including styrene, methyl styrene, or diallyl phthalate. Cure is effected through vinyl polymerization using either peroxide catalyst and promoters or heat to accelerate the reaction.

1.6.17 Pultrusion—the reversed ‘extrusion’ of resin-impregnated reinforcement in the manufacture of rods, tubes and structural shapes of a permanent cross-section. The reinforcement, after being properly wet-out by the resin application system, is drawn through a die to form a desired cross-section. This is one method of manufacturing reinforced plastic shapes.

1.6.18 Reinforced plastic—a plastic with strength properties greatly superior to those of the base resin as a result of high-strength fillers embedded in the composition. The reinforcing fillers include fibres, fabrics, or mats made of fibres.

1.6.19 Reinforced plastic ladder—a device whose stiles are constructed of reinforced plastics. The crosspieces, called steps, rungs or cleats, may be constructed of metal, reinforced plastics or other suitable materials.

1.6.20 Reinforcement—a strong inert material bonded into a plastic to improve its strength, stiffness and impact resistance. Reinforcements are usually fibres of glass, sisal, cotton, and the like, in woven or non-woven form. To be effective, the reinforcement material must form a strong adhesive bond with the resin.

1.6.21 Rungs and treads—cross-pieces joining the stiles and used by a person ascending or descending a ladder.

NOTES:

- 1 The terms ‘rung’, ‘step’ and ‘tread’ are used in industry. For the purpose of this Standard, the term ‘rung’ is used for single and extension ladders, and the term ‘tread’ for stepladders. The term ‘tread’ is also used as a general term, where applicable.
- 2 The terms ‘rung’, ‘tread’ and ‘step’ do not include the top cap.

1.6.22 Section

1.6.22.1 Bottom or base section—the lowermost section of a non-self-supporting portable ladder.

1.6.22.2 Middle or intermediate section—the section between the top (fly) and bottom (base), sections of a non self-supporting portable ladder.

NOTE: There may be more than one middle or intermediate section in a ladder.

1.6.22.3 Top or fly section—the uppermost section of a non-self-supporting portable ladder.

1.6.23 Single ladder—a non-self-supporting portable ladder, of fixed length, consisting of one section.

1.6.24 Single-sided stepladder—a self-supporting portable ladder, of fixed length, with flat treads for ascent and descent and a hinged back not intended for ascent or descent. Variations in designs of single-sided stepladders include platform stepladder and dual-purpose stepladder.

1.6.25 Special-purpose ladder—a ladder that represents either a modification or a combination of design or construction features of one or more of the general-purpose ladders herein defined, in order to adapt to special or specific uses.

1.6.26 Stile—a side member that supports the treads or rungs.

NOTE: The terms 'stile', 'side rail', 'string' and 'stringer' are used synonymously in industry. For the purpose of this Standard, the term 'stile' is used throughout.

1.6.27 Trestle ladder—a self-supporting portable ladder of fixed length, consisting of two sections hinged at the top to form equal angles with the base, each section being provided with cross-bearers, fixed between the stiles, on which a plank or planks may be supported.

1.6.28 Top cap—the uppermost horizontal member of a portable stepladder.

1.6.29 Working surfaces—the clear portion of steps, rung or treads on which a person may step while ascending or descending a ladder.

SECTION 2 GENERAL REQUIREMENTS

2.1 DESIGN AND CONSTRUCTION Specific design and construction requirements are not a part of this Standard, because of the wide variety of materials and design possibilities. However, the design shall have such characteristics as to produce a ladder of sufficient strength and stiffness to meet the performance requirements of this Standard and shall produce a ladder without structural defects or accident hazards, such as sharp edges or burrs.

2.2 RATING

2.2.1 Duty rating Portable plastic reinforced ladders shall be rated as either industrial or domestic, in accordance with their design service capability.

2.2.2 Load rating Portable plastic reinforced ladders shall have a load rating of—

- (a) not less than 120 kg, for industrial ladders; or
- (b) not less than 100 kg, for domestic ladders.

2.3 MATERIALS

2.3.1 General The material should be a fully cured composite consisting of a commercial grade thermosetting isophthalic polyester resin reinforced with glass fibres. The selection of polyester resin shall consider the following end use requirements:

- (a) Electrical.
- (b) Corrosion resistance.
- (c) Outdoor weathering.
- (d) Thermal conditions.
- (e) Structural integrity.

Resins and reinforcements, or combinations thereof, other than those specified in this Standard, may be used provided the ladder complies with the performance requirements given in Section 9.

NOTE: This option is allowed even when laboratory coupon test results do not comply with the values given in Appendix A, Tables A1 and A2, with the provision that the minimum percent retention of condition-A coupon values be 75 percent after either wet or weather-cycle tests and 60 percent after 66°C temperature tests.

2.3.2 Reinforcements Glass fibre reinforcements may consist of any combination of mat, roving, cloth, or fabric of 'E' glass with a silane or equivalent coupling agent. The quantity, selection, distribution and orientation of the glass reinforcements shall ensure compliance with the requirements of this Standard.

A complete enveloping surface layer of continuous strand mat, continuous filament reinforcing mat, surface veil, non-woven fibrous fabric, or equivalent material, may be provided for added weathering resistance. It may consist of glass of Type A, B or E, or be a polyester staple fibre. Alternative materials or other techniques that provide at least an equivalent weathering resistance may be employed. In any event, the outermost layer shall consist of polyester.

The reinforcement design shall provide bidirectional strength in the composite.

2.3.3 Resin, filler and additives The resin shall be chosen after consideration of its structural, electrical, thermal, and outdoor weather-resistant characteristics. Except where the specific resin system provides equivalent ultraviolet resistance, an ultraviolet screen or absorber shall be employed.

Fillers, lubricants, catalysts, and other additives shall be selected after consideration of their effect on the electrical, thermal, outdoor weather resistance, water absorption and structural properties of the composite.

2.3.4 Pigment The particular ingredients in the pigmentation employed shall be light stable and have no detrimental effect on the weathering, thermal, electrical, or structural properties of the composite. The interaction of pigments, fillers and catalysts and their overall effect on the resin system shall be considered during the selection process.

2.3.5 Special requirements Composites may be modified for specific situations. Adverse environments involving conditions such as corrosion, high humidity, sunlight, cold, heat, or erosion may require a special resin, a unique enveloping material, an exterior finish, or a combination thereof. The resulting product shall comply with the requirements in Section 9.

NOTE: The specification of criteria for nonflammability may result in impairment of other properties.

2.3.6 Product cure The composite shall be cured sufficiently to attain a minimum Barcol hardness of 50 in accordance with ASTM D 2583.

2.3.7 Fabrication properties The material shall be capable of being bored, punched, drilled and riveted without splitting or delaminating when these operations are performed, in accordance with accepted tooling practice for glass-reinforced plastics.

NOTE: A drift pin test, with the pin tapered to 1.04 times the hole diameter, has been found to provide a means of determining satisfaction of this requirement.

2.3.8 Physical and mechanical properties Typical physical and mechanical properties of reinforced plastic stiles are given in Appendix A.

2.3.9 Accelerated weathering test procedures As a means of determining the weathering characteristics of newly manufactured fibreglass-reinforced plastic ladders; both outdoor and artificial weathering tests may be employed. The different types of accelerated exposure devices used may include, but are not limited to, the following:

- (a) Fluorescent ultraviolet (UV) and condensation apparatus, as outlined in ANSI/ASTM G 53, to simulate the deterioration caused by sunlight and water as rain or dew. This test is preferred, particularly if a cycle of 6 h of ultraviolet exposure at 54°C followed by 6 h of condensation at 38°C is used.
- (b) Carbon-arc devices as outlined in ANSI/ASTM G 23, using distilled or deionized water in the water spray cycle. The requirements of ANSI/ASTM D 1499 should also be met.
- (c) Xenon-arc type devices as outlined in ANSI/ASTM D 2565, and ANSI/ASTM G 26, using distilled or deionized water in the water spray cycle.

In either of the methods given in Items (b) and (c), the cycle should consist of the following: 102 min light only, black-panel temperature $63 \pm 5^\circ\text{C}$ during light-only cycle; 18 min light and spray, relative humidity 50 ± 5 percent, black-panel temperature $38 \pm 5^\circ\text{C}$ during light and spray; and ozone, 5 parts per hundred million (optional).

- (d) An accelerated weathering device, utilizing an equatorial mount with mirrors for acceleration and water spray, may be used after correlation with one of the artificial weathering devices.

2.3.10 Evaluation of surface appearance The degradation of surface appearance after exposure to the weathering cycle is subjective. The characteristics given in Clauses 2.3.11 to 2.3.14 should be considered.

2.3.11 Change in surface fibre appearance An increase in the prominence of fibres on the surface of the material. This may be called 'fibre blooming', and can be a result of resin erosion. The change should be given a rating of 8 times the degree of change given in Table 2.1.

2.3.12 Change in colour Colour changes which are noticeable to the eye should be given a rating of 5 times the degree of change given in Table 2.1.

2.3.13 Loss of gloss The loss of glossiness in the material, i.e. reduction of light reflected from the surface, should be given a rating equal to the degree of change given in Table 2.1.

TABLE 2.1
RATING VALUES FOR SURFACE
APPEARANCE CHANGES

Degrees of change	Rating
None	0
Trace	1
Slight	2
Medium	3
Heavy	4
Severe	5

2.3.14 Classification of weather resistance The weather resistance of a reinforced plastic material should be classified by comparing the sum of the ratings given in Clauses 2.3.10 to 2.3.13, with those given in Table 2.2.

TABLE 2.2
CLASSIFICATIONS
OF WEATHER RESISTANCE

Rating ranges	Classification
≤35	Weather resistant
>35 ≤49	General purpose
>50 ≤70	Interior application

2.4 ELECTRICAL PROPERTIES

2.4.1 General The electrical properties of the materials used in stiles for reinforced plastic ladders, shall be determined at the time of manufacture.

2.4.2 a.c. dielectrical strength When tested in accordance with the short-time test method given in ASTM D 149 and ASTM D 229, using the parallel plane to plane method in oil, as modified below, the a.c. dielectric strength of a 25 mm long full section specimen shall be not less than 25 000 V.

The full section specimen having parallel ends is placed edgewise between circular disc flat electrodes having a nominal outside diameter of 125 mm and a nominal thickness of approximately 25 mm. The edges are rounded to a 6 mm radius.

The electrodes should extend a minimum of 12 mm beyond the specimen. Ten specimens shall be tested and the arithmetic mean value for dielectric strength is determined.

2.4.3 d.c. current leakage When tested using the method given below, the d.c. current leakage between two electrodes spaced 250 mm apart shall not exceed 90 mA when a voltage of 90 kV is applied to the electrodes.

The sample of ladder stile shall be conditioned at $23 \pm 3^{\circ}\text{C}$ and 60 percent relative humidity for 72 h before testing.

Two continuous lengths of metallic conductive tape are affixed completely around the periphery of the sample at a separation of 250 mm. After connecting the tape to a suitable power supply, the voltage applied to the tapes is progressively raised to 90 kV, and the leakage current is measured. Should flashover occur at less than 90 kV, the voltage and flashover current is reported.

2.5 QUALITY OF MANUFACTURE AND FINISH The composite may be made by a continuous open-end moulding process, such as the pultrusion method of manufacture. The product of any process which meets the performance requirements in Section 9 of this Standard may be employed.

The material shall be smooth, clean, uniform in colour, and reasonably free from conducting particles, foreign materials, pits, cracks, voids, chips, sink marks, delaminations, blisters, and scratches. The distribution of filler, additives, or glass fibre shall be in accordance with an acceptable commercial standard. The material shall be free of resin-rich and resin-starved areas, and there shall be no evidence of significant reinforcement shifting, wrinkles, bunching up, or density variation within a length, all in accordance with an acceptable commercial standard.

2.6 STILES

2.6.1 Design Because of the wide variety of types of ladders and the varied conditions of use, ladders may be designed with parallel stiles, with stiles varying uniformly in separation along the length (i.e. tapered), or with stiles flaring at the base.

2.6.2 Manufacture Stiles shall be manufactured in accordance with the following requirements:

- (a) The stiles shall be manufactured from a suitable cross-sectional shape and shall provide secure support for the treads, rungs, or cross-bearers.
- (b) Where stiles are manufactured from hollow section material, means shall be provided to prevent the retention of water within the stile.

2.6.3 Feet Feet shall be fitted to the bottom of each stile in the bottom section of the ladder and may be fixed or hung. Feet shall comply with the following requirements:

- (a) The feet shall be manufactured from or faced with a material which will resist deformation and slipping, and which will comply with the requirements of Clause 9.2.10 or Clause 9.3.10, as appropriate.
- (b) The feet or surfacing material shall be securely fixed to the stiles but may be removable for renewal.

The projected area of ladder feet shall be not less than the area enclosed by the external dimensions of the stile or back leg, as appropriate, after taking account of the angle at which the bottom of the stiles and back leg are cut (see Figure 2.1).

2.7 TREADS AND RUNGS

2.7.1 Size and shape Treads and rungs shall comply with the following requirements for size and shape:

- (a) They shall present a working surface that will minimize the possibility of slipping. Working surfaces of rungs, steps, and platforms for use in ascending, descending, working or standing shall be corrugated, serrated, knurled, dimpled, or coated with a skid-resistant material.

- (b) They shall be of a suitable size and cross-sectional shape adequate to comply with Section 9.

NOTE: The size and shape of the working surface will affect the comfort and therefore the safety of persons working from ladders for extended periods. Accordingly, the maximum practicable working surface is desirable.

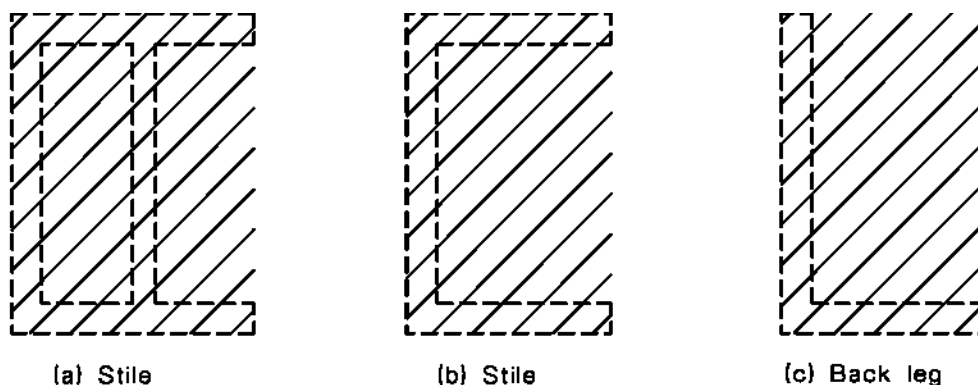


FIGURE 2.1 EXAMPLES OF MINIMUM AREA OF FEET (HATCHED) FOR DIFFERENT SECTION OF STILE OR LEG

2.7.2 Spacing The spacing of treads and rungs shall comply with the following requirements:

- Treads and rungs shall be parallel with each other within ± 2 degrees
- Treads and rungs shall be uniformly spaced at a distance between centres within the range 248 ± 2 to 306 ± 2 mm. Measurements may be made at any position.
- The distance from the bottom ends of the stile including feet where fitted to the top of the first tread or rung shall be equal to the nominal tread or rung spacing.
- For stepladders other than platform stepladders, treads shall be spaced so that the distances from the upper surface of the top cap to the top of the nearest tread or rung shall be equal (± 8 mm) to the spacing of the treads or rungs (all measurements along the stiles).

2.8 MARKING All ladders shall have the following information permanently marked in a prominent position:

- The name of the Australian manufacturer or importer (whether the ladder has been made for sale or otherwise).
- In the largest lettering practicable, the duty rating (i.e. 'INDUSTRIAL' or 'DOMESTIC', as appropriate), the words: 'This ladder is intended to carry a maximum load of' and the load rating in kilograms.
- The working length of the ladder (the closed and maximum working lengths for extension type ladders).
- On double-sided stepladders, the words 'TO BE USED IN THE FULLY OPEN POSITION ONLY'.
- A warning against standing on those treads or rungs which would represent an unsafe working position. Such marking shall warn against standing any higher than—
 - the second top tread or on a stepladder not being a platform stepladder; or

- (ii) the third top tread on a single or extension ladder.

Labels used to illustrate such marking shall comply with the requirements of Clause 9.6 and Appendix B and shall be located to guard against wear, abrasion and disfiguring. Labels shall be attached by a method which does not affect the strength of the members to which they are attached.

NOTES:

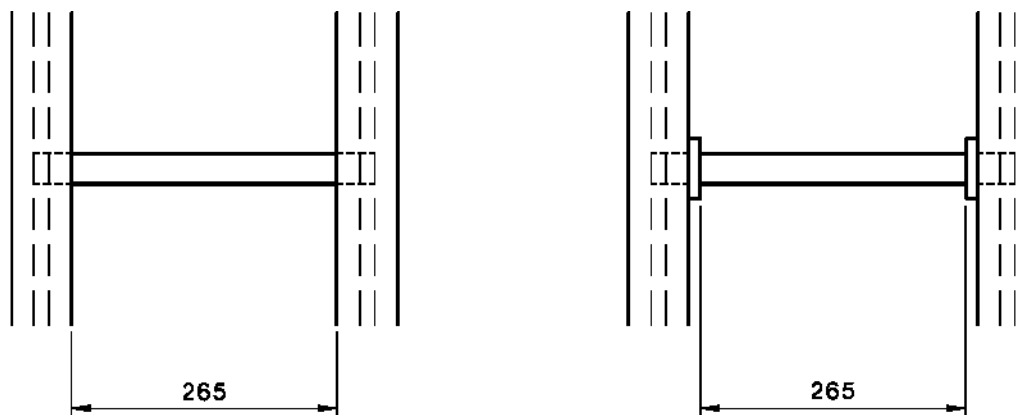
- 1 Labels are not considered satisfactory unless appropriately located or protected.
- 2 Examples of labels used to illustrate additional safety warnings are given in Appendix C (Figures C1, C2 and C3).
- 3 Manufacturers making a statement of compliance with this Australian Standard on a product, packaging, or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

SECTION 3 PARTICULAR REQUIREMENTS FOR SINGLE LADDERS

3.1 LENGTH The length of a single ladder, measured along the stiles and including any feet and end caps, shall not exceed—

- (a) 9 m, for industrial ladders; or
- (b) 5 m, for domestic ladders.

3.2 DISTANCE BETWEEN STILES The clear distance between the inside faces of the stiles shall be not less than 265 mm (see Figure 3.1). If the stiles are flared (see Clause 2.6), this dimension shall apply to the portion of the ladder above the flare.



NOTE: The 265 mm distance is the minimum clear distance between the stiles, not the length of the rung.

DIMENSIONS IN MILLIMETRES

FIGURE 3.1 DISTANCE BETWEEN STILES

3.3 PERFORMANCE Single ladders shall comply with the relevant requirements of Clause 9.2.

SECTION 4 PARTICULAR REQUIREMENTS FOR EXTENSION LADDERS

4.1 LENGTH The maximum working length of an extension ladder, including feet, shall not exceed—

- (a) 15 m, for industrial ladders; or
- (b) 7 m for domestic ladders.

4.2 EXTENSION OF STILE ABOVE TOP RUNG Except for those ladders fitted with a pole chain, hoop, or similar device, the space between the centre of the working surface on the top rung and the top of the ladder, when measured axially along the centre line of the ladder, shall not exceed 308 mm.

4.3 DISTANCE BETWEEN STILES The clear distance between the inside faces of the stile, or the width of the working surface of rungs in the narrowest section of the ladder shall be not less than 265 mm (see Figure 3.1).

4.4 OVERLAP Care shall be taken to ensure that the rungs on overlapping sections coincide.

4.5 STOPS The ladder shall be designed so that it cannot be overextended.

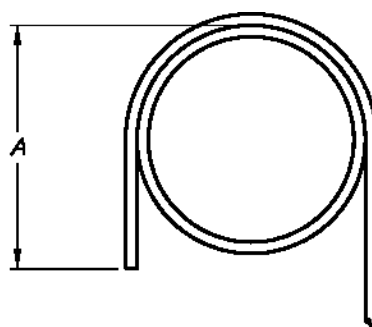
4.6 FITTINGS

4.6.1 General Fittings shall comply with the requirements of Clause 9.2.13.

4.6.2 Finish Fittings shall have no sharp edges liable to cause indentation to stiles or rungs.

4.6.3 Fixed hooks Fixed hooks shall—

- (a) have an effective length over the rungs of not less than the depth of the rung (see Figure 4.1); and
- (b) bear equally on the rungs for a width of not less than 12 mm.



A — effective length of
hook over the rung

FIGURE 4.1 FIXED HOOK

4.6.4 Latching devices Ladders in which the upper section(s) are raised or lowered by rope shall be fitted with latching devices which shall—

- (a) operate to engage automatically should the rope break or be released; and
- (b) comply with the requirements of Clause 9.2.12.

Latching devices, where fitted, shall—

- (i) not be dependent for their operation on a spring;
- (ii) bear equally on the rungs for a width of not less than 12 mm;
- (iii) operate dynamically with the ladder at an angle of not less than 70 degrees and statically at an angle of 90 degrees above the horizontal; and
- (iv) be designed so as to maintain the top and bottom sections of the ladder in a relative position, so that the working surface of rungs at the overlap form double treads at every intended stage of extension.

4.6.5 Guide brackets Guide brackets where used, shall be attached securely and positioned so as to prevent the upper section from tipping or disengaging while being raised, lowered, or while the ladder is being used.

4.7 LIFTING DEVICES

4.7.1 General Where the maximum working length of an extension ladder is greater than 5 m, the ladder shall be equipped with a hauling rope and pulley or suitable device to enable an operator at ground level to raise the top section or intermediate section.

4.7.2 Load The fittings and rope shall be capable of withstanding a load equal to 10 times the mass of the movable section(s) of the ladder.

4.7.3 Rope The hauling rope used with the pulley shall be non-conductive, of natural or synthetic fibre complying with the strength requirements of AS 4142.2, and shall—

- (a) have a circumference of not less than 25 mm (8 mm diameter);
- (b) when composed of natural fibre, be treated to resist rotting; and
- (c) when composed of synthetic fibre, be a fibrolated filament polypropylene with ultraviolet light protection, or other fibre having equivalent performance.

4.7.4 Hauling system Pulleys shall—

- (a) be designed to avoid excessive wear of either the pulley or the hauling rope;
- (b) be of a size and design in accordance with the relevant requirements of AS 2089; and
- (c) be attached in a manner that does not weaken the stiles or rungs, to the extent that such components fail to comply with the relevant requirements of this Standard.

4.8 PERFORMANCE Extension ladders shall comply with the relevant requirements of Section 9.

SECTION 5 PARTICULAR REQUIREMENTS FOR STEPLADDERS

5.1 LENGTH The length of a stepladder measured along the front edge of the stile including any feet, shall not exceed—

- (a) 6.1 m, for industrial ladders; or
- (b) 2.4 m, for domestic ladders.

5.2 DISTANCE BETWEEN STILES The front section of single-sided stepladders and both sections of double-sided stepladders shall be designed so that the clear distance between the stiles available to support the user at the tread immediately below the top cap is not less than 290 mm, and either—

- (a) the distance between the stiles varies uniformly along the length (i.e. tapered stepladder); or
- (b) the stiles flare out at the bottom to increase stability.

For tapered ladders described in Item (a) above, the distance between stiles shall increase by not less than 125 mm per metre length of stile.

For flared ladders described in Item (b) above, the distance between the bottom of the stiles shall be equivalent to that for a tapered ladder of the same length and the flare shall be incorporated in a manner that does not weaken the stiles.

5.3 BACK LEGS The back legs shall comply with the following:

- (a) Be constructed and braced so that the stepladder is stable when in the fully open locked position.
- (b) For single-sided stepladders, be braced in a manner that does not encourage the bracing to be used for ascending or descending.
- (c) Be hinged by a means that is at least equivalent in strength (single shear), wear and cross-section to low carbon steel pivot pins of 8 mm diameter. Neither the back legs nor the stiles shall bear on any threaded portions of pivot pins. Nuts, if used, shall be effectively locked. Tubular or hollow-section rivets shall not be used as pivot pins.
- (d) Be fitted with means of preventing abrasion to pivot pins.
- (e) Except for double-sided stepladders, they be of such length that when the ladder is laid against a wall in the fully closed position with the working surfaces horizontal, it is supported fully on the front stiles or feet.
- (f) When folded, they not cause damage to the stiles, treads, or spreader bars.

5.4 SPREAD BETWEEN STILES AND BACK LEGS With the ladder in the fully open position, the clear distance between the rear edge of the stiles and the front edge of the back legs shall be not less than 500 mm and not greater than 660 mm per metre length of stile.

5.5 BEARING AREA OF FEET The bearing area of feet fitted to stiles or back legs shall be not less than that specified in Clause 2.6.3.

The four feet of the stepladder shall fully bear on a flat horizontal surface when the ladder is in the open locked position, and shall remain so when subject to the compression test in Clause 9.3.1.

5.6 TREADS Treads shall have a working surface width not less than 75 mm. They shall be fitted to the stiles so that when the stepladder is fully open on a horizontal surface, the working surfaces of the treads are horizontal to within ± 2 degrees, measured from front to back of the working surface.

5.7 SPREADER The spreader shall be designed so that when correctly engaged, it will—

- (a) improve the rigidity of the ladder;
- (b) prevent the ladder from opening beyond its design spread;
- (c) prevent the ladder from being used at less than the design spread; and
- (d) prevent the legs accidentally closing when the legs are fully open.

When the ladder is in the closed position, the spreader shall not cause structural damage to the ladder, or to itself.

5.8 TOP CAP The top cap fitted to the stepladder shall be not less than 75 mm wide from front to back. The top may overhang at the front, back or sides, but any overhang to the front shall be not greater than 12 mm.

5.9 PERFORMANCE Stepladders shall comply with the relevant requirements of Section 9.

SECTION 6 PARTICULAR REQUIREMENTS FOR TRESTLE LADDERS

6.1 LENGTH A trestle ladder shall not exceed 5 m in length.

6.2 SPACING OF CROSS-BEARERS Cross-bearers on both pairs of stiles shall be evenly spaced and be not less than 300 mm nor more than 610 mm apart. The top cross-bearer on one pair of stile shall be located not less than 150 mm from the top of the stile. The three alternative means of spacing the cross bearers are shown in Figure 6.1.

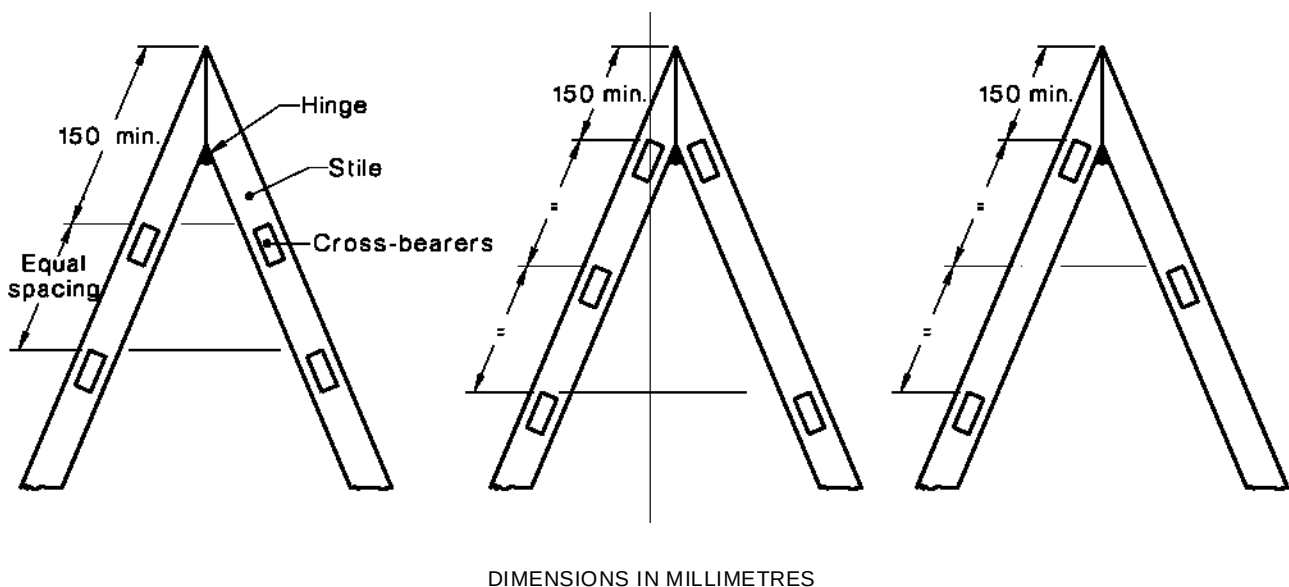


FIGURE 6.1 POSITION OF CROSS-BEARERS ON TRESTLE STILES

6.3 DISTANCE BETWEEN STILES When measured at the top cross-bearer, the distance between the inside face of the stiles shall be as follows:

- (a) For trestles up to and including 2.5 m in length, not less than 380 mm nor greater than 530 mm.
- (b) For trestles over 2.5 m in length, not less than 500 mm nor greater than 530 mm.

The distance between the stiles shall increase toward the bottom at a uniform rate of not less than 125 mm per metre length of stile.

6.4 SPREAD BETWEEN PAIRS OF STILES With the ladder in the fully open position, the clear distance between the rear edge of the stiles and the front edge of the back legs, shall be not less than 500 mm and not greater than 660 mm per metre length of stile.

6.5 SPREADER Trestle ladders shall incorporate a device which—

- (a) prevents the trestle from opening beyond the designed limit; and
- (b) is designed to prevent the stiles from accidentally closing when the stiles are fully open.

6.6 HINGES Stiles shall be hinged by means at least equivalent in strength (single shear), wear and cross-section to low carbon steel pivot pins of 8 mm diameter. Neither the back legs nor the stiles shall bear on any threaded portions of pivot pins. Nuts, if used, shall be effectively locked. Tubular or hollow-section rivets shall not be used as pivot pins.

6.7 CHECK BLOCKS Check blocks shall be fitted to the stiles to relieve the hinges of side strain when the trestles are being moved in the closed position. They shall be attached between the first and second cross-bearers from the bottom of one pair of stiles.

6.8 PERFORMANCE Trestle ladders shall comply with the requirements of Clause 9.3.

SECTION 7 PARTICULAR REQUIREMENTS FOR MULTIPURPOSE LADDERS

7.1 LENGTH

7.1.1 Where used as a single ladder The length measured along the front edge of the stile, including feet, shall not exceed—

- (a) 9.0 m, for industrial ladders; or
- (b) 5.0 m, for domestic ladders.

7.1.2 Where used as a stepladder The length measured along the front edge of the stile, including feet to the centre of the hinge pivot-pin, shall not exceed—

- (a) 6.1 m, for industrial ladders; or
- (b) 2.4 m, for domestic ladders.

7.2 DISTANCE BETWEEN STILES The clear distance between the stiles shall be not less than 280 mm and with either—

- (a) the distance between the stiles increasing uniformly from the centre articulated joint towards both ends; or
- (b) the stiles parallel from the centre articulation towards both ends, and flaring at the ends for added stability.

For tapered stiles described in Item (a) above, the distance between the stiles increases by not less than 75 mm per metre-length of stile.

For flared stiles described in Item (b) above, the distance between the bottom of the stiles shall be equivalent to that for a tapered ladder of the same length, but not less than 340 mm and the flare shall be incorporated in a manner that does not weaken the stiles.

7.3 ANGLE BETWEEN STILES

7.3.1 Where used as a stepladder Where used as a stepladder, the spread between the front and rear stiles shall be not less than 65 degrees and not greater than 80 degrees above the horizontal.

7.3.2 Where used as a work platform Where used as a work platform, the slope of the front and rear stiles shall be not less than 65 degrees, and not greater than 80 degrees above the horizontal.

7.4 ARTICULATION Joints shall be attached to the stiles such that under the foreseeable conditions of use in each of the ways in which the ladder may be configured, the joint will not unintentionally separate from the stile.

Joints shall have locking positions to permit configuration of the ladder in the positions intended by the ladder manufacturer. All sharp edges or pinch points shall be avoided or eliminated. Each joint shall clearly indicate whether it is locked or unlocked and shall incorporate a means of preventing accidental release.

7.5 PERFORMANCE Multipurpose ladders shall comply with the relevant requirements of Section 9.

SECTION 8 PARTICULAR REQUIREMENTS FOR OTHER LADDERS

8.1 SCOPE OF SECTION The requirements of this Section apply to ladders which are not specifically described in other Sections.

8.2 REQUIREMENTS Ladders which are manufactured for special use by adapting or modifying standard type ladders shall comply, as far as practicable, with the requirements of the relevant Section(s) as follows:

NOTE: It is not possible to list all ladders which are designed for special use. Other ladders designed for special use should comply with those requirements of Section 9 which are applicable to the ladder which they most closely resemble and with the requirements of the relevant regulatory authorities. Ladders designed for special use may require additional working or operating instructions.

- (a) **Combination stepladder (or dual-purpose stepladder)** When used as a single ladder, Section 3. When used as a stepladder, Section 5.
- (b) **Extension stepladder** When used as an extension ladder, Section 4. When used as a stepladder, Section 5.
- (c) **Fruit-picker's stepladder** Section 5, except that a single back leg may be fitted.
- (d) **Platform stepladder** Section 5 and in addition, the platform shall comply with the tread bending test in Clause 9.3.3.
- (e) **Bucket/tray stepladder** Section 5 and in addition, the tray shall support a distributed mass of 45 kg without visible signs of distortion or failure. The tray shall be clearly marked with the words 'NOT A STEP'.
- (f) **Access hole ladders** Section 3, except that the distance between the stiles may be less than 265 mm.
- (g) **Order-picking stepladders** When order-picking stepladders are designed especially for order picking in aiseways between shelved racking, the following shall apply:
 - (i) Except as varied hereunder, the relevant requirements of Section 5 shall apply.
 - (ii) Stiles may be parallel provided that the distance between stiles is the widest practicable for the intended aiseway.
 - (iii) Handrails and kickplates shall be provided, but any foldable handrail system shall not form a nip-point to trap hands and shall have stanchions that lock into the vertical position.
 - (iv) Spring castoring wheels may be fitted to one or both sets of stiles and shall be adjusted to prevent ladder movement when one foot is placed upon a ladder tread. The force applied to a tread to prevent movement of the ladder shall not exceed 150 N (15 kg).
 - (v) The ladders shall be designed to ensure stability and rigidity for use in stockpicking (e.g. be of diagonal bracing or be constructed of rigid frames).

SECTION 9 PERFORMANCE REQUIREMENTS

9.1 GENERAL Ladders specified in Sections 3 to 7 inclusive, shall comply with the relevant requirements specified in this Section. Other ladders (see Section 8), shall comply with the tests applicable to the ladder which they most closely emulate.

9.2 PERFORMANCE REQUIREMENTS FOR SINGLE AND EXTENSION LADDERS

9.2.1 Stile deflection test When tested in accordance with Appendix D, the stile deflection shall not exceed the limit (D), when determined from the following equation:

$$D = 15L \quad \dots (9.2.1)$$

where

D = permissible deflection, in millimetres

L = effective span of ladder while under load, in metres

9.2.2 Angular deflection test When tested in accordance with Appendix E, the angular deflection of the stiles shall not exceed the limit (T), when determined from the following equation:

$$T = 0.92L^{0.83} \quad \dots (9.2.2)$$

where

T = permissible angular deflection, in degrees

L = effective span of ladder under test, in metres

9.2.3 Proof bend test When tested in accordance with Appendix F, there shall be no structural failure of an extension ladder from the proof test.

9.2.4 Rung torque test When tested in accordance with Appendix G, there shall be no visible relative motion between the rung and stiles.

9.2.5 Rung strength test When tested in accordance with Appendix H, the permanent set in the rung shall not exceed 1 percent of the rung length between the faces of the stiles and the ladder shall suffer no structural failure.

9.2.6 Rung shear test When tested in accordance with Appendix I, the ladder shall suffer no structural failure.

9.2.7 Side sway test When tested in accordance with Appendix J, the deflection of the bottom stile while loaded with a 260 N force shall not exceed 1 percent of the distance between the supports, and the ladder shall suffer no structural failure.

9.2.8 Stile cantilever test When tested in accordance with Appendix K, the stile shall suffer no structural failure.

9.2.9 Foot friction test When tested in accordance with Appendix L, the coefficient of static friction between the foot and the test surface shall be not less than 0.5.

9.2.10 Dynamic drop test When tested in accordance with Appendix M, the permanent deformation of any part of the stile at the point of contact with the ground shall not exceed 6 mm and there shall be no structural failure.

9.2.11 Ladder section twist test When tested in accordance with Appendix N, the total angular deflection between two consecutive torque applications shall not exceed—

- (a) 18 degrees per metre, for industrial rated ladders; or
- (b) 22 degrees per metre, for domestic rated ladders.

9.2.12 Latching device test When tested in accordance with Appendix O, the latching device of an extension ladder shall re-engage before the upper section of the ladder falls 450 mm and there shall be no structural failure or malfunction of the ladder.

9.2.13 Extension ladder fittings test When tested in accordance with Appendix P, the fittings shall show no visible permanent deformation and the distortion of the foot shall not exceed 6 mm in any direction.

9.3 PERFORMANCE REQUIREMENTS FOR STEPLADDERS AND TRESTLE LADDERS

9.3.1 Compression and foot distortion test When tested in accordance with Appendix Q, the ladder shall suffer no visible structural failure, the permanent set shall not exceed 0.3 percent, and the distortion of the foot shall not exceed 6 mm in any direction.

9.3.2 Stile bending test When tested in accordance with Appendix R, the ladder shall suffer no structural failure, and the permanent set shall not exceed 0.2 percent.

9.3.3 Tread bending test When tested in accordance with Appendix S, the ladder shall suffer no structural failure and the permanent set of the tread shall not exceed 1.0 percent of the length of tread measured between the inside surfaces of each stile.

9.3.4 Tread-to-stile shear test When tested in accordance with Appendix T, the ladder shall suffer no structural failure.

9.3.5 Tread torque test When tested in accordance with Appendix U, the alternating torque shall not cause any relative movement between tread and stile during application or removal of the forces.

The tread torsional stiffness shall be not less than 2.0 N.m²/degree, when determined from the following equation:

$$S_t = \frac{0.25L_t T}{\alpha} \quad \dots (9.3.5)$$

where

S_t = tread torsional stiffness, in N.m²/degree

L_t = tread length between attachment to stiles, in metres

T = torque, in newton metres

α = angle of rotation from unloaded to loaded condition, in degrees

$$= \sin^{-1} \frac{(H_1 - H_2 - H_3 + H_4)}{2L}$$

H = vertical height above datum plane

9.3.6 Stability test When tested in accordance with Appendix V, the bottom surface of the stiles and back legs shall remain in contact with the level surface during application of the forces.

9.3.7 Walking test When tested in accordance with Appendix W, the spreaders shall remain locked and the average distance through which both front feet have moved shall not exceed the permissible walking distance (W) when determined from the following equation:

$$W = 20L^{1.65} \quad \dots (9.3.7)$$

where

W = permissible walking distance, in millimetres

L = effective length of the ladder under test, in metres

9.3.8 Stile and back leg cantilever test When tested in accordance with Appendix X—

- (a) the stiles and back legs shall not exhibit any sign of tearing; and
- (b) the permanent set of the front stile or stiles shall not exceed 2 mm.

NOTE: Stiles and back legs may be distorted without evidence of tearing during this test. Distortion alone is permissible.

9.3.9 Dynamic drop test When tested in accordance with Appendix Y, the permanent set at the point of contact with the ground shall not exceed 6 mm, and there shall be no—

- (a) visible deformation of the bracing;
- (b) stretching of rivets; and
- (c) visible signs of damage to other components.

9.3.10 Foot friction test When tested in accordance with Appendix L, the coefficient of static friction between the foot and the test surface shall be not less than 0.5.

9.4 PERFORMANCE REQUIREMENTS FOR MULTIPURPOSE LADDERS

9.4.1 Stile deflection test When tested in accordance with Appendix D, the stile deflection shall not exceed the limit (D), when determined from the following equation:

$$D = 15L \quad \dots (9.2.1)$$

where

D = permissible deflection, in millimetres

L = effective span of ladder while under load, in metres

9.4.2 Angular deflection test When tested in accordance with Appendix E, the angular deflection of the stiles shall not exceed the limit (T), when determined from the following equation:

$$T = 0.92L^{0.83} \quad \dots (9.2.2)$$

where

T = permissible angular deflection, in degrees

L = effective span of ladder under test, in metres

9.4.3 Permanent set test When tested in accordance with Appendix F, the ladder shall suffer no structural failure.

9.4.4 Side sway test When tested in accordance with Appendix J, the deflection of the bottom stile while loaded with a 260 N force shall not exceed 1 percent of the distance between the supports, and there shall be no structural failure.

9.4.5 Foot friction test When tested in accordance with Appendix L, the coefficient of static friction between the foot and the test surface shall be not less than 0.5.

9.4.6 Dynamic drop test When tested in accordance with Appendix M, the permanent deformation of any part of the stile at the point of contact with the ground shall not exceed 6 mm, and there shall be no—

- (a) visible deformation of the bracing;
- (b) stretching of rivets; and
- (c) signs of structural failure to other components.

9.4.7 Compression test When tested in accordance with Appendix Q, the ladder shall suffer no structural failure, the permanent set shall not exceed 0.3 percent and the distortion of the foot shall not exceed 6 mm in any direction.

9.4.8 Stile bending test When tested in accordance with Appendix R, the ladder shall suffer no structural failure and the permanent set shall not exceed 0.2 percent.

9.4.9 Tread bending test When tested in accordance with Appendix R, the ladder shall suffer no structural failure, and the permanent set shall not exceed 0.2 percent.

9.4.10 Tread-to-stile shear test When tested in accordance with Appendix T, the ladder shall show no visible sign of damage.

9.4.11 Tread torque test When tested in accordance with Appendix U, the alternating torque shall not cause any relative movement between tread and stile during application or removal of the forces.

The tread torsional stiffness shall be not less than 2.0 N.m²/degree, when determined from the following equation:

$$S_t = \frac{0.25L_t T}{\alpha} \quad \dots (9.3.5)$$

where

S_t = tread torsional stiffness, in N.m²/degree

L_t = tread length between attachment to stiles, in metres

T = torque, in newton metres

α = angle of rotation from unloaded to loaded condition, in degrees

$$= \sin^{-1} \frac{(H_1 - H_2 - H_3 + H_4)}{2L}$$

H = vertical height above datum plane

9.4.12 Stability test When tested in accordance with Appendix V, the bottom surface of the stiles and back legs shall remain in contact with the level surface during application of the forces.

9.4.13 Walking test When tested in accordance with Appendix W, the spreaders shall not have unlocked and the average distance through which both front feet have moved shall not exceed the permissible walking distance (W), when determined from the following equation.

$$W = 20L^{1.65} \quad \dots (9.3.7)$$

where

W = permissible walking distance, in millimetres

L = effective length of the ladder under test, in metres

9.4.14 Stile and back leg cantilever test When tested in accordance with Appendix X—

- (a) the stiles and back legs shall not exhibit any sign of tearing; and
- (b) the permanent set of the front stile or stiles shall not exceed 2 mm.

NOTE: Stiles and back legs may be distorted without evidence of tearing during this test. Distortion alone is permissible.

9.4.15 Work platform bending test When tested in accordance with Appendix Z, the ladder shall suffer no structural failure.

9.5 DESIGN VERIFICATION TESTS

9.5.1 Cyclic horizontal bending test When tested in accordance with Appendix AA, there shall be no ultimate failure of either stile.