



Amusement rides and devices

Part 4.1: Specific requirements— Land-borne inflatable devices



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 - Australian Amusement Leisure and Recreation Association
 - Consumers Federation of Australia
 - Engineers Australia
 - Kidsafe
 - Office of Industrial Relations, Qld
 - Safety Institute of Australia
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-

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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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Australian Standard®

Amusement rides and devices

Part 4.1: Specific requirements— Land-borne inflatable devices

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PREFACE

This Standard was prepared by the Standards Australia Committee, ME-051, Amusement Rides and Devices, to complement the general requirements for amusement rides and devices given in AS 3533.1 and AS 3533.2. This Standard will supersede AS 3533.4.1—2005.

The objective of this Standard is to provide designers, manufacturers, proprietors and operating staff with requirements and guidance specific to the design, construction, operation and maintenance of inflatable devices that will protect the health and safety of both operating staff and patrons.

Since the original publication there have been many changes in the industry. In particular these changes have included the introduction of very large inflatable devices that were not envisaged in 2005.

Major changes to the previous edition are as follows:

- (a) Revision of flammability requirements.
- (b) Revision of structural integrity requirements.
- (c) Addition of device setup requirements.
- (d) Addition of wall height measurement.

It should be noted that conformance with this Standard alone does not necessarily ensure that all legal obligations are being fulfilled.

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.

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STANDARDS AUSTRALIA

Australian Standard

Amusement rides and devices

Part 4.1: Specific requirements—Land-borne inflatable devices

1 SCOPE

This Standard sets out requirements and guidance for the design, manufacture, operation and maintenance of land-borne inflatable amusement devices that are static when in use. It also specifies information to be supplied with the equipment.

NOTE: This Standard is not applicable to inflatable toys, water-borne inflatable devices, air-supported buildings to which the National Construction Code would apply, inflatable devices used for protection rather than play or inflatable devices acting as artificial climbing structures involving belay systems.

2 APPLICATION

This Standard is intended to be used in conjunction with AS 3533.1 and AS 3533.2, which provide requirements and recommendations on matters common to all amusement rides and devices. Specific requirements in this Standard take precedence over corresponding requirements in AS 3533.1 and AS 3533.2. If the requirements of any part of this Standard conflict with any national, state or territory regulations, the appropriate statutory regulations shall apply.

This Standard does not prevent the use of materials, methods of assembly, procedures and the like that do not conform with the specific requirements of this Standard, or are not mentioned in it, provided the minimum dimensional and performance requirements specified herein are met.

3 REFERENCED DOCUMENTS

The following Standards are referred to in this Standard:

AS

3533	Amusement rides and devices
3533.1	Part 1: Design and construction
3533.2	Part 2: Operation and maintenance
3533.3	Part 3: In-service inspection
4442	Playground surfacing—Specifications, requirements and test method
4685	Playground equipment and surfacing
4685.1	Part 1: General safety requirements and test methods (EN 1176-1:2008 MOD)
4878	Methods of test for coated fabrics
4878.6	Method 6: Determination of tensile strength and elongation at break

AS/NZS

2512	Methods of testing protective helmets
2512.1	Part 1: Definitions and headforms

ISO	
2231	Rubber- or plastics-coated fabrics—Standard atmospheres for conditioning and testing
4674	Rubber- or plastics-coated fabrics—Determination of tear resistance
4674-1	Part 1: Constant rate of tear methods
6487	Road vehicles—Measurement techniques in impact tests—Instrumentation
15025	Protective clothing—Protection against flame—Method of test for limited flame spread
BS	
3408	Specification for tarpaulins
ABCB	
National Construction Code	

4 DEFINITIONS

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

4.1 Acceleration pulse

A non-oscillatory acceleration of a short duration.

4.2 Accelerometer

A transducer (sensor) that has an electrical output proportional to acceleration for a specified axis and frequency range.

NOTE: Piezoelectric crystals are most commonly used to produce the output.

4.3 Blower

A powered fan used to inflate the device.

4.4 Blow tube

The part of the inflatable device to which the blower is connected for the purpose of inflation.

4.5 Competent person

A person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required.

4.6 Critical fall height

The upper limit of all free heights of fall, for which the surface provides adequate levels of impact attenuation.

4.7 Free height of fall

The greatest distance from the clearly intended body support, when measured in the unloaded but inflated state, to the impact area below, minus 5%.

NOTE: This 5% takes into account the lowering of the body support under load.

4.8 g

The acceleration due to the earth's gravity at sea level surface.

NOTES:

- 1 It varies with the latitude and elevation of the observer.
- 2 By international agreement, the value 9.80665 m/s^2 is the nominal international standard acceleration due to gravity.

4.9 $g_{\max}$

The maximum acceleration experienced during the impact test.

4.10 Head injury criteria (HIC)

A measure of impact severity that considers the duration over which the most critical section of the acceleration pulse persists as well as the peak level of that acceleration.

4.11 Inflatable structure or device (continuously blown)

A structure or device relying on a continuous supply of air pressure to maintain its shape, on or in which patrons may play.

4.12 Inflatable structure or device (sealed)

A structure or device that is inflated by means of air supply and, having achieved the design pressure, is sealed with a bung or stopper and does not require continuous inflation, on or in which patrons may play.

4.13 Open side

Any external side of an inflatable with no containment wall.

4.14 Platform

Any surface on which a patron may stand or traverse.

4.15 Playing area

Any part or area of the device that is used by patrons solely for the purpose of taking part in the activity for which the device is designed.

4.16 Ramp

An inclined section aiding the access and egress of patrons into and out of the playing area of the inflatable, making the transition between the height of the playing area and the ground.

4.17 Step

A section of intermediate height aiding the access and egress of patrons into and out of the playing area of the inflatable, making the transition between the height of the playing area and the ground.

4.18 Tri-axial accelerometer

An accelerometer used to measure the components of acceleration relative to three orthogonal spatial axes.

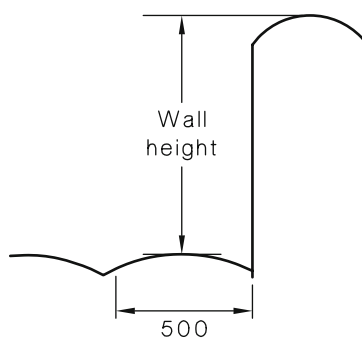
4.19 Toy

A play item that, when attached to the playing area, forms part of the inflatable device.

4.20 Wall height

The height measured, without load, from the highest point on the adjacent platform within a 500 mm distance perpendicular to the wall to the highest point on the wall.

NOTE: See Figure 1.



DIMENSIONS IN MILLIMETRES

FIGURE 1 MEASUREMENT OF WALL HEIGHT

5 METHODS OF CONSTRUCTION AND MATERIALS

5.1 Methods of construction

There shall be no hard or sharp angles or edges in any part of the inflatable device that is accessible to patrons, e.g. outside seams with a raw edge, square inflated corners and sharp pointed cones.

Patrons shall not be able to come into contact with any hard object placed inside or adjacent to the inflatable when in use or during unintended deflation.

Any hard object positioned over the playing area and supported by air pressure should have an additional support system independent of air pressure.

Joints and seams in those parts of the device that are subject to force and stress applied by patrons or are part of the load path of anchorage systems shall be made so they achieve no less than the minimum tensile strength of the fabric used in those parts. These joints and seams shall be capable of inspection during the life of the device to check their integrity.

5.2 Fabrics

5.2.1 Strength

Fabrics shall be of adequate tear and tensile strength for the weight of the intended patrons. Fabrics shall have sufficient air retention abilities to enable the inflatable, when pressurized to the levels specified in the operation manual, to resume its intended shape after distortion under load. Fabrics used in those parts of the inflatable that are subject to force or stress, as applied by the patrons or the anchorage system, shall have the following minimum strengths after conditioning in accordance with Atmosphere C of ISO 2231:

- (a) The fabric shall have a minimum tear strength of 400 N warp and 350 N weft when tested in accordance with Method A of ISO 4674-1.
- (b) The fabric shall have a minimum tensile strength of 2250 N warp and 1850 N weft when tested in accordance with AS 4878.6.

Lower strength fabrics may be used in decorative parts that do not come into contact with patrons. Such fabrics shall be of adequate tear and tensile strength to withstand the design operating pressure.

NOTE: Cold flex cracking and surface coating adhesion are both measurable parameters that should be considered by the designer as they affect performance of the fabric.

5.2.2 Flammability

Fabrics, including netting or mesh with openings smaller than 5 mm, that are used in or attached to an inflatable device shall be tested in accordance with the surface ignition test (Procedure A) in ISO 15025 and shall conform with either (or both) of the pass criteria for flammability performance in accordance with BS 3408.

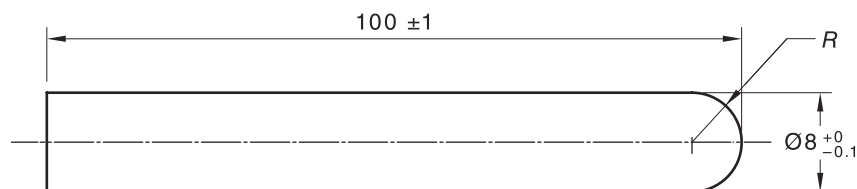
Netting or mesh with openings larger than 5 mm used in or attached to an inflatable device shall be tested in accordance with the bottom edge ignition test (Procedure B) in ISO 15025 and shall conform with either (or both) of the pass criteria for flammability performance as specified in BS 3408.

5.3 Thread

Thread used in joints and seams shall be of non-rotting yarn such as polyester or nylon and be a minimum of 88 N tensile strength.

5.4 Netting or mesh

Where used to contain patrons, netting or mesh shall be in accordance with the strength requirements of Clause 5.2. The mesh size shall be small enough to prevent the 8 mm finger rod from passing through (see Figure 2) when applied in accordance with Clause 11.3.



DIMENSIONS IN MILLIMETRES

FIGURE 2 8 mm FINGER ROD

5.5 Rope clamber nets

Rope clamber nets shall be securely attached to the inflatable to prevent lifting by the patrons. The rope from which it is made shall be a minimum of 16 mm diameter and securely knotted at intersections. Clamber nets shall conform to AS 4685.1.

5.6 Climbing ropes

Climbing ropes shall be fixed at both ends. The maximum possible displacement either side of the climbing rope's centre line shall not exceed 10% of the distance between the points of fixing.

5.7 Zips

Zips shall withstand the air pressure generated within the device. When used as emergency exits, they shall be accessible to use from both sides. Zips used for deflation purposes shall have the puller hidden from view, e.g. by a flap or pocket.

5.8 Paint or other decorative substances

Paint or other decorative substances shall be non-toxic and non-flammable.

6 ANCHORAGE

6.1 Number of anchorage points

Sufficient anchorage points shall be provided around the entire perimeter and located such as to enable stability and restraint to be maintained under the designer's stated operating conditions.

NOTE: The perimeter includes the front, the rear and all sides.

Inflatable devices shall be designed with a wind speed of not less than 11.1 m/s (40 km/h).

NOTE: See Appendix A for the Beaufort Scale.

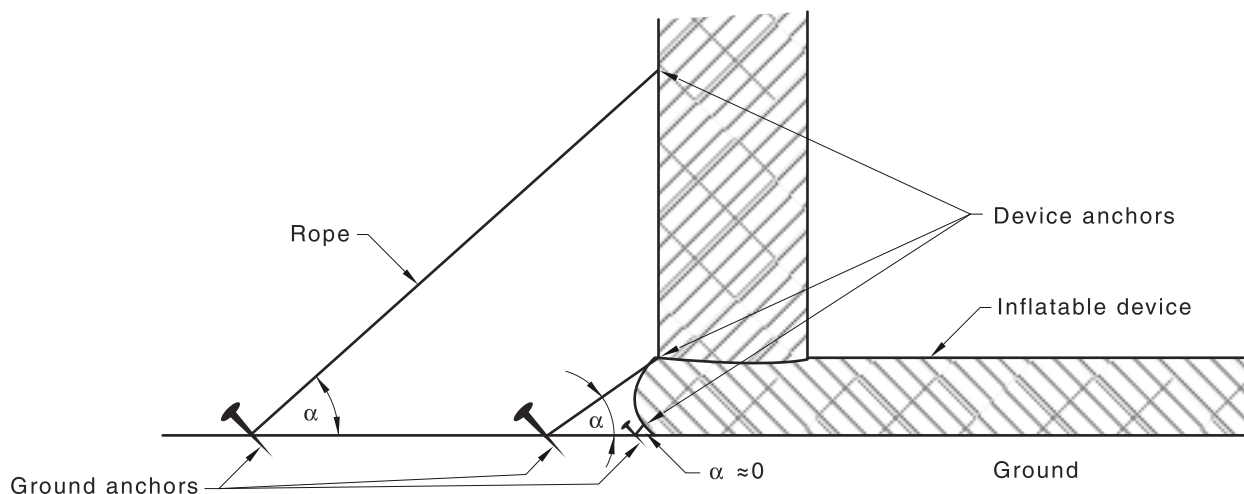
The number of anchorage points to address wind loads from any direction shall be calculated in accordance with Appendix B.

6.2 Anchorage systems

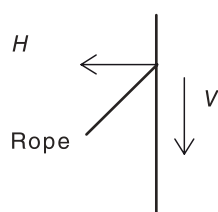
The following requirements apply to anchorage systems:

- (a) Where the inflatable device is not secured with ground anchor stakes, such as on hard or paved areas, the total anchorage system shall be designed and detailed to withstand the same forces as though it was secured with ground anchor stakes.
- (b) Where the inflatable device is secured to the ground with ground stakes, each anchorage point on the inflatable and its stake or stakes shall withstand a minimum horizontal force of 1.6 kN (160 kgf).
- (c) Anchor points on the inflatable device shall be designed to accommodate horizontal and vertical loads on the inflatable device, acting simultaneously, according to the specified angle to which the tie strap or rope is to be installed. The minimum design loads shall be as specified in Table 1 for the arrangements shown in Figure 3.
- (d) Where the location of device anchor points or the design layout for ground anchor points result in a taut rope connection of greater than 60° above ground or a lateral displacement between the device and ground anchor points, the design loads shall be verified by a competent person.
- (e) Ground stakes shall be fit for purpose and designed by the manufacturer or a competent person to achieve a reasonable specified life when repeatedly installed and extracted. Simple driven stakes shall be not less than 16 mm diameter if made from steel rod or deformed bar and 30 mm in leg length if in steel star picket form or steel angle.

NOTE: A reasonable life, unless special circumstances apply, should not be less than 12 months.
- (f) Each anchorage rope or strap and associated fittings shall have a minimum breaking load in accordance with the value in Figure 4 relevant to the rope angle.
- (g) An anchorage system incorporating stakes shall be designed so that operators or patrons cannot be injured by tripping or falling on the stakes or patrons shall be prevented from access to such stakes.
- (h) The anchorage system shall be designed so that the anchor ropes or straps are secured in a manner that prevents the device lifting off the ground.
- (i) Anchorage systems shall be consistent and incorporate reproducible attachment methods that follow recognized rigging practice.



(a) Inflatable device anchor point locations



(b) Device anchor forces

LEGEND:

 H = Horizontal component of force on anchor V = Vertical component of force on anchor

FIGURE 3 INFLATABLE DEVICE ANCHORAGE POINT LOCATIONS

TABLE 1
MINIMUM DESIGN LOADS FOR DEVICE
ANCHOR POINTS

Angle of taut rope (α)	Horizontal component of design force on anchor (H)	Vertical component of design force on anchor (V)
Degrees	kN	kN
0–30	1.6	0.5
30–50	1.6	1.6
50–60	1.6	3.0

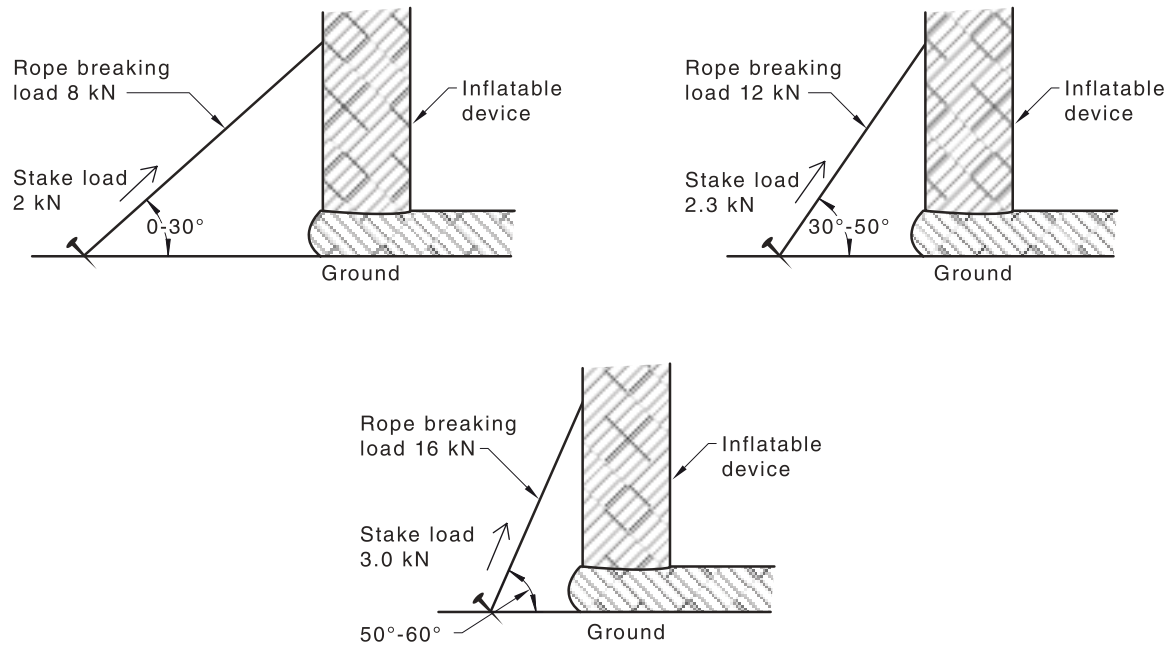


FIGURE 4 LOADS FOR GROUND ANCHOR POINTS ASSOCIATED WITH ABOVE-GROUND DEVICE ANCHOR POINTS

7 STRUCTURAL INTEGRITY

7.1 General

A risk assessment plan shall be developed for the safe evacuation of the maximum number of patrons and staff, and the controlled deflation of inflatable devices in emergency situations.

7.2 Air pressure

The minimum air pressure inside the inflatable device shall in all cases be sufficient to give a firm and reliable footing and adequately support the entire inflatable device.

Playing areas, platforms, steps and ramps shall support the weight of the largest (heaviest) patron for whom the inflatable is designed without allowing patrons to impact the surface beneath the inflatable device. When tested in accordance with the method in Appendix C, the appropriate weight shall remain supported by the inflatable at each test point.

Containing walls and towers shall be strong enough to contain the largest patron for whom the inflatable is designed.

The inflatable device shall support itself and any attachments included in the design under all operational load conditions.

Any structure which supports a playing area or containment walls above 3.0 m shall be continuously blown. For inflatable devices with a platform height of 3.0 m and above, redundant power supplies should be considered.

For inflatable devices with a platform height of 3.0 m and above, audible alarms shall be provided for electrical or blower failure.

7.3 Support

The design of an inflatable device shall ensure that, upon loss of air pressure, the device remains supported with sufficient clearances and for adequate time—

- (a) to enable all patrons to evacuate, and for the operator to ensure that the device is clear; or

- (b) for action to be taken to restore inflation before there is a danger of entrapment of any patron.

NOTE: An independent support system may be used.

To minimize the risk of injury or entrapment in an unintended collapse of the inflatable device through failure of a blower, power supply or disconnection of a blow tube, the air supply system shall include the following:

- (a) A non-return flap at the device end of every blow tube to prevent backflow of inflation air.

and

- (b) Any other means necessary to maintain sufficient air within the device to prevent sudden deflation and allow safe evacuation in accordance with the risk assessment plan in Clause 7.1.

Inflatable devices shall be designed to ensure accessibility in order to assist patrons during emergency evacuation.

Specifications shall be provided for the level of inflation and the time the device's design allows for emergency evacuation, along with the methods for testing evacuation provisions and the frequency of such tests.

8 OPEN SIDES, ACCESS AND EGRESS

On any open side, the free height of fall shall be not greater than 700 mm.

NOTE: This corresponds to approximately 735 mm in the unloaded condition (see Clause 4.7).

On any open side of the inflatable device, the design shall specify the type and extent of the impact-attenuating system to be placed at that side. The impact-attenuating system shall extend a distance of at least 1.2 m on the ground (see Figure 5). The surface in the impact area shall not produce any impact that results in a $g_{\max}$ measurement greater than 200g, a head injury criteria (HIC) value greater than 1000 or an unacceptable impact profile when tested in accordance with Appendix D or an equivalent impact test. Four locations shall be tested on each specimen. Each impact test shall comprise four consecutive drops onto the same location on the specimen from a free height of fall of 700 mm using a concrete substrate.

The manufacturer should supply the specified impact-attenuating material.

NOTE: Designers should consider provision of attachment points for ensuring the impact-attenuating material can be retained in the impact area.

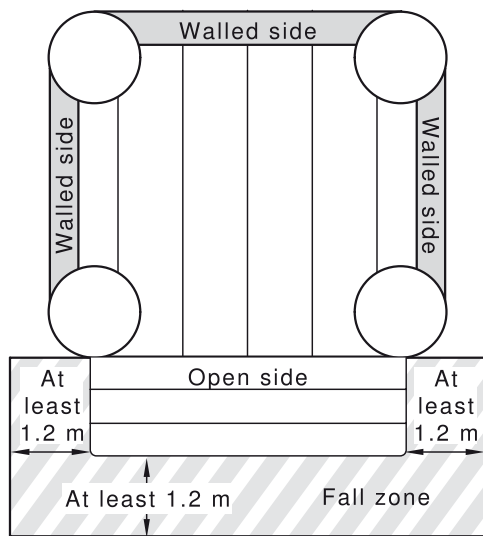
Anchorage points in the impact area shall be avoided if possible. Where anchorage points are necessary, they shall be connected to the bottom perimeter seam of the inflatable device and extend a minimal distance so they do not cause a danger to patrons, or additional specifically-configured, impact-attenuating material shall be included to prevent anchor points from being contacted by patrons.

Access staircases shall not exceed an inclination of 45°.

For access stairways that exceed 18 continuous steps (risers), or equivalent, control procedures shall be provided to reduce the risk of potential falls of patrons onto other patrons or a hard surface. The control procedures shall be documented.

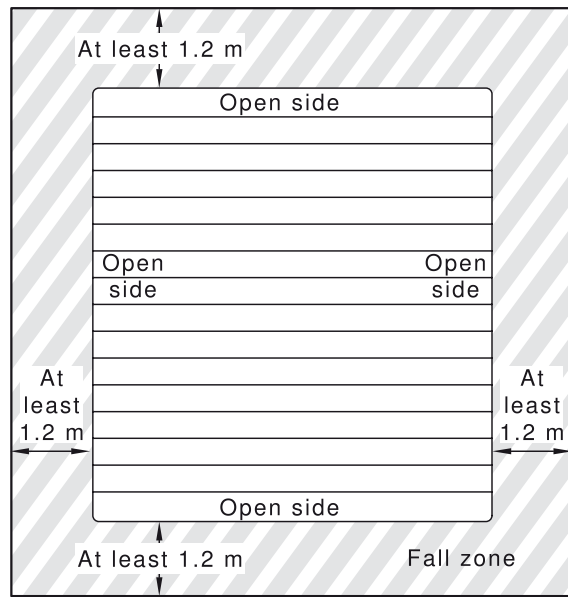
A step or ramp shall be wide enough to cover the whole of the access/egress aperture with overlap as shown in Figure 5. In its inflated form, a step or ramp shall have a tread length of at least 1.5 times the height of the playing area to which it is attached (see Figure 6).

Bump stops and walls placed on any step, ramp or slide exit shall be in accordance with the requirements of Clauses 7 and 9.



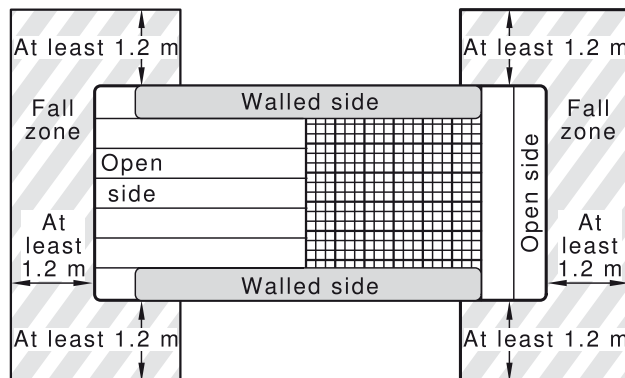
PLAN VIEW

(a) Castle type



PLAN VIEW

(b) Flat-bed



PLAN VIEW

(c) Up and over slide

FIGURE 5 IMPACT AREA

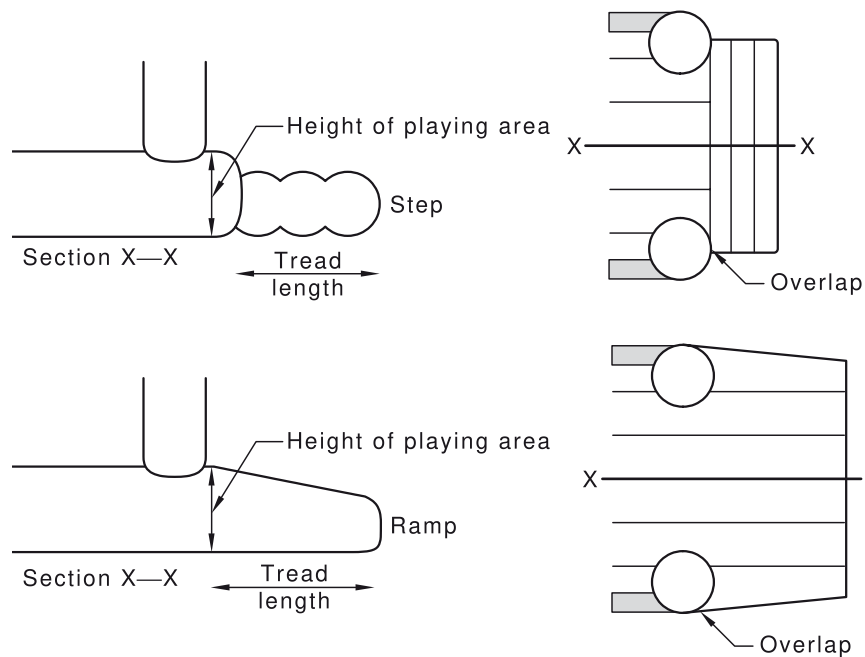


FIGURE 6 STEP OR RAMP DETAIL

9 CONTAINMENT

9.1 Platforms of height greater than 700 mm

NOTE: This corresponds to 735 mm in the unloaded condition (see Clause 4.6).

A means to contain patrons shall be provided where the level platform height is greater than 700 mm.

On inflatable devices with a level platform height of greater than 700 mm up to and including 3 m, containment shall be provided by either—

- (a) walls of a height at least equal to the height of patrons for which it is designed when they are standing on the platform, up to a patron height of 1.8 m, after which no increase in wall height is required; or
- (b) walls roofed in a manner that contains patrons.

NOTE: These roofed walls may be of a lesser height than specified in Item (a).

For inflatable devices with a level platform height of greater than 3.0 m (see Figure 7), containment shall be provided by either—

- (i) walls to a height at least 1.25 times the height of the patrons for which it was designed with the walls designed so that patrons cannot climb unaided over the walls; or
- (ii) walls roofed in a manner that contains patrons.

NOTE: These roofed walls may be of a lesser height than specified in Item (i).

Where a roof is fitted to contain patrons, the minimum clear height measured from the platform surface shall be 750 mm plus 75 mm for each square metre of platform area over 5 m² to a height of 1.25 times the height of the patrons for which it was designed after which no increase in roof height is required.

Inflatable devices shall not have walls that naturally fall outwards on deflation.

Inflatable devices with a level platform height over 2.0 m shall be designed so that, on unintended collapse, the containing walls around the platform naturally fall inwards to contain the patrons.