
**Earth-moving machinery — Access
systems**

Engins de terrassement — Moyens d'accès





COPYRIGHT PROTECTED DOCUMENT

© ISO 2011

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Requirements for access systems	5
5 Requirements for enclosure openings.....	8
6 Requirements for guardrails, foot barriers, platforms, passageways, walkways and other surfaces used for walking, crawling, climbing, stepping or standing	10
7 Requirements and recommendations for handrails and handholds	13
8 Requirements for stairways and steps	15
9 Requirements for ladders	17
Annex A (informative) Examples of surfaces considered to be slip-resistant	20
Annex B (normative) Additional requirements for powered retractable access system that transports a person.....	21
Bibliography.....	22

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2867 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

This seventh edition cancels and replaces the sixth edition (ISO 2867:2006), which has been technically revised.

Introduction

The structure of safety standards in the field of machinery is as follows.

- a) Type-A standards (basic standards) give basic concepts, principles for design and general aspects that can be applied to machinery.
- b) Type-B standards (generic safety standards) deal with one safety aspect or one type of safeguard that can be used across a wide range of machinery:
 - type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);
 - type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure-sensitive devices, guards).
- c) Type-C standards (machinery safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This document is a type-C standard as stated in ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

NOTE ISO 14122 is a series of type-B standards that provides general requirements for access to stationary and mobile machines and that can be used as a general reference for the design of access systems for earth-moving machines.

Earth-moving machinery — Access systems

1 Scope

This International Standard specifies criteria for systems that provide access to the operator station and to routine maintenance points on earth-moving machinery as defined in ISO 6165. It is applicable to the access systems (e.g. enclosure openings, platforms, guardrails, handrails and handholds, stairways and steps, ladders) on such machines parked in accordance with the manufacturer's instructions. Its criteria are based on the 5th to 95th percentile operator dimensions as defined in ISO 3411. It deals with the following significant hazards, hazardous situations and events: slip, trip and fall of persons, unhealthy postures and excessive effort.

The general principles set out in this International Standard can be used for the selection of fixed and/or portable access systems for repairs, assembly, disassembly and longer interval maintenance.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3411, *Earth-moving machinery — Physical dimensions of operators and minimum operator space envelope*

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 12508, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*

ISO 14122-1:2001, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means of access between two levels*

ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 14567, *Personal protective equipment for protection against falls from a height — Single-point anchor devices*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General terms and definitions

3.1.1

target dimension

dimensional value that takes into account ergonomics criteria based on comfort

NOTE Acceptable values are within the specified range (from minimum to maximum).

3.1.2

machine repairs

work on a machine that is done as a result of a machine failure

3.1.3

routine maintenance points

locations on a machine that are specified in the periodic maintenance schedule of the operator's manual for performing scheduled daily/weekly/monthly maintenance on the machine

3.1.4

two-point support

feature of an access system that enables a person to use, simultaneously, both feet, or one hand and one foot, while ascending, descending or moving about on the machine

3.1.5

three-point support

feature of an access system that enables a person to use, simultaneously, both hands and one foot, or both feet and one hand, while ascending, descending or moving about on the machine

3.1.6

operator station

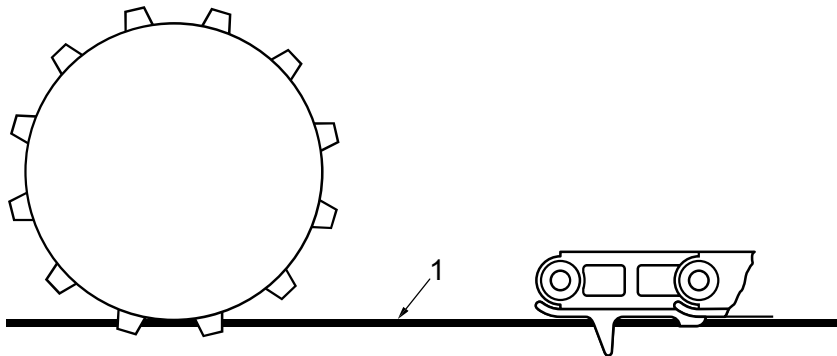
area from which an operator controls the travel and work functions of the machine

3.1.7

ground

surface on which a machine is positioned, taking into account full penetration of pad feet or track grousers

See Figure 1.



Key

1 ground reference plane (GRP)

Figure 1 — Ground location for machines with pad feet or track grousers

3.2 Access systems

3.2.1

access system

system provided on a machine for ascending from the ground or descending to the ground or for moving from one area on the machine to another area

3.2.1.1

primary access system

access system used for ascending from the ground to the operator station or descending to the ground from the operator station

3.2.1.2

retractable access system

access system that has a portion that retracts (e.g. rotates, translates, telescopes, articulates), with or without a power source, from a stored position before being used

3.2.1.3

powered retractable access system

access system that is retracted by a power source on the machine

3.2.2

alternative exit path

route from the operator station to the ground used during situations in which the primary access system cannot be used

3.2.3

secondary access system

access system used for ascending from the ground to the operator station or descending from the operator station to the ground during situations in which the primary access system cannot be used

3.3 Enclosure openings

3.3.1

enclosure opening

opening leading to or from an access system, intended for a person to pass through

3.3.1.1

primary opening

enclosure opening used for normal ingress to and egress from the operator station

3.3.1.2

alternative opening

enclosure opening intended for use during situations when the primary opening is not usable

3.3.1.3

maintenance opening

enclosure opening for use during routine maintenance

3.4 Walking and standing areas

3.4.1

walkway

part of an access system that permits walking or moving from one area on the machine to another area

3.4.1.1

boom walkway

walkway used mainly on long booms

3.4.1.2

passageway

walkway with confining barriers on both sides

3.4.2

platform

horizontal surface intended for the support of persons engaged in operation or routine maintenance

3.4.2.1

rest platform

platform used between parts of an access system on which a person may rest

3.4.3

ramp

plane inclined at an angle of 20° or less from the horizontal

3.5 Guardrails, handrails and handholds

3.5.1

guardrail

device installed along the open sides of walkways or platforms providing protection from falling

3.5.2

handrail

device for hand placement that aids body support and balance and permits hand movement on the device while moving on an access system

3.5.3

handhold

device for single hand placement that aids body support and balance

3.6 Stairways and steps

3.6.1

stairway

access system, or part of an access system, inclined from the horizontal at an angle greater than 20° but not more than 50°, consisting of three or more steps

3.6.2

step

device for placement of one or both feet, either as part of a ladder or stairway, or installed (placed) as an individual step or a series of steps

3.6.3

flexible step

step mounted with a material which moves when it contacts an obstacle and returns to the original location

3.6.4

riser height

height between two consecutive steps, measured from the tread surface of one step to the tread surface of the next step

3.6.5

tread depth

distance from the leading edge to the back of the step

3.6.6

stride distance

horizontal distance from the leading edge of one step to the leading edge of the next step

3.6.7

track frame step

step that is an integral part or added component of the track frame

3.7 Ladders

3.7.1

inclined ladder

ladder with an angle of inclination from the horizontal greater than 75° but not more than 80°

3.7.2

vertical ladder

ladder with angle of inclination from the horizontal greater than 80° but not more than 90°

3.7.3

step ladder

ladder with angle of inclination from the horizontal greater than 50° but not more than 75°

3.7.4

flight

uninterrupted sequence of steps

3.8 Slip and fall

3.8.1

personal fall arrest system

PFAS

system designed to stop the fall of a person before collision with the ground or other obstruction

3.8.2

personal fall restraint system

PFRS

system that restrains or hinders a person from reaching a fall point

3.8.3

slip-resistant surface

access system surface having qualities that improve the grip of footwear or other contact combination (e.g. as when crawling)

3.8.4

foot barrier

device intended to hinder a person's foot from slipping off the edge of a platform, step or walkway

3.8.5

ladder fall limiting device

device that minimizes the risk of falling from a ladder system

4 Requirements for access systems

4.1 General

4.1.1 The selection of the type of access system between two levels shall be in accordance with ISO 14122-1:2001, Clauses 4 and 5, and the following.

4.1.2 In the design of an access system:

- use inclined ladders whenever possible, instead of vertical or step ladders with an angle of 60° to 75°;
- the surface of wheels and tyres are not acceptable as part of the access system;
- track surfaces are acceptable as part of the access system if three-point support is provided, but whenever practical, use a type of access system other than the track surface as a walkway;
- the potential for damage to the access system, and masking of visibility around the machine, machine equipment or attachments shall be evaluated.

4.1.3 Correct use of the access system for hand and foot placement shall be self-evident without special training. Instructions for retractable access systems shall be included in the operator's manual. Instructions shall be provided regarding the need for inspection for wear or damage, including to slip-resistant surfaces, of the access system. The instructions shall state when the manufacturer recommends other access system aids.

Retractable access systems shall include instructions for use in the machine operations manual and on an information label near the access system, as appropriate.

4.1.4 Protrusions into the access system that could create a hazard for tripping or for catching or holding body appendages shall be minimized.

4.1.5 The access system shall be designed to minimize the potential for the user to come into contact with hazards such as surfaces having extreme temperatures (heat or cold), or areas with electrical hazards, moving parts or sharp corners.

4.1.6 All surfaces of the access system designed for walking, climbing, stepping or crawling shall be slip-resistant (including any device or structural component designed as part of an access system). This is not relevant for the track surfaces referred to in 4.1.2. See Annex A for examples of slip-resistant surfaces.

4.1.7 Proper placement of components of the access system shall permit and encourage a person to maintain three-point support while using an access system that is more than 1 m above the ground. Two-point support above 1 m is acceptable for stairways, ramps, walkways and platforms.

4.1.8 If the operator or a maintenance person needs to carry items to the operator station or to a routine maintenance point, a system such as one of the following shall be provided (together with corresponding instructions in the operator's manual if this is not obvious):

- a stairway or ramp to provide access where two-point support is adequate and one hand can be available for carrying items;
- additional platforms or surfaces, with minimum dimensions of 300 mm by 400 mm every 1,7 m of height on a continuous climbing access system, where items can be temporarily placed so that three-point support can be maintained when moving on the access system;
- a procedure or system (e.g. rope pulley system) for transferring items to the operator station or routine maintenance point so that three-point support can be used on the access system at all times.

NOTE Routine maintenance points serviced from the ground meet these requirements.

4.1.9 Illumination shall be provided for the primary access system to the operator station if the platform of the operator station is at a height of more than 3 m. Activation of lights shall be possible from the ground and the operator station.

4.1.10 Access systems shall be fitted for the use and daily maintenance of attachments or options (e.g. mirrors) provided by the machine manufacturer.

4.1.11 For routine maintenance intervals that exceed one month, other access system aids, such as personal fall arrest systems (PFASs), personal fall restraint systems (PFRSs), or an external access system (e.g. portable working platform, stairway) can be used. The operator's manual shall provide guidance for the use of other access system aids. Anchorage points, if provided, shall be in accordance with ISO 14567.

4.1.12 Access for machine repairs shall be covered in the manufacturer's available instructions (e.g. machine repair manual, dealer repair manual, service manual). Access systems for machine repairs can be provided on the machine or manufacturer's instructions can provide recommendations for use of external access systems (e.g. portable working platform, or stairway).

4.1.13 Parts of access systems that are likely to be damaged by contact with objects or the ground shall be designed for easy replacement.

4.1.14 Handling, assembly, disassembly, storage and transport of removable parts of the access system shall be described in the operator's manual (e.g. for transportation).

4.1.15 For machines that have operating positions on jacks or stabilizers, or that have track width adjustment, the access system shall be designed to ensure adequate access on the work site in these operating positions.

4.2 Retractable access systems

4.2.1 General

4.2.1.1 In addition to the following requirements, specific to retractable access systems, such systems shall meet all other relevant requirements given in this International Standard.

4.2.1.2 A portion of an access system may be retractable for convenient storage on the machine. It shall stay in the intended position when in use and in the stored position, e.g. by gravity, spring force or attachment mechanism.

4.2.1.3 Retractable access systems shall be designed to reduce the risk of entrapment.

4.2.1.4 If the operator station is higher than 2 m above the ground, the operation of the manual or powered retractable access system shall be possible from the ground or a secondary access system shall be provided that meets the requirements of this International Standard.

4.2.2 Manually retractable access systems

A means shall be provided to alert the operator whenever a manually retractable access system is not in the retracted (stored) position if there is risk of damage in the position of use.

4.2.3 Powered retractable access systems

4.2.3.1 Movement shall stop when the control is released.

4.2.3.2 The powered retractable access system shall be visible from the control location or shall have additional devices [e.g. mirrors, closed-circuit television (CCTV)] for adequate visibility.

4.2.3.3 An interlock shall be provided for the powered retractable access system to prevent machine movement that could cause damage to the access system through contact with the machine itself (e.g. the swing of an excavator) when not in the retracted (stored) position. For other machine movement, an operator warning is sufficient. For a powered retractable access system that transports a person, the additional requirements given in Annex B apply.

4.2.3.4 In the case of a power failure, it shall be possible to lower the retractable access system or a secondary access system shall be provided.

4.3 Alternative exit path and opening

4.3.1 An alternative opening from the operator station shall be provided on a surface other than that of the primary opening. Its dimensions shall be in accordance with Table 1. An alternative exit path shall be provided at a different location on the machine than that of the primary access system.

4.3.2 The alternative opening shall be clearly marked. If the alternative exit path is not obvious, it shall be identified.

4.3.3 Vertical ladders are acceptable for the alternative exit path and the distance from the lower step to the ground shall be a maximum of 700 mm.

4.3.4 The alternative exit path is intended for situations where the primary access system is not available due to hazards or obstructions. Therefore, it does not need to meet the general requirements given in 4.1, except when used as part of the secondary access system, in which case it shall meet those requirements.

4.4 Requirements for specific tracked machines with a rotating upper structure

For pipelayers capable of 360° continuous rotation of their upper structure, and for excavators equipped for piling and drilling, an additional access system is required in the case where access to, and egress from, the operator's cab is required on a regular basis when the upper structure is rotated to a position other than the normal parked position as defined by the manufacturer. This additional access system shall meet all requirements of this International Standard.

5 Requirements for enclosure openings

5.1 Enclosure openings shall be in accordance with Table 1, except for the machines specified in 5.3, whose openings may alternatively be in accordance with 5.3.1 and 5.3.2.

5.2 For primary openings that are modified rectangles, the minimum opening area may be reduced to the minimum opening dimensions indicated by dashed lines in the drawing in Table 1. Alternatively, the vertical distance from the floor of the lower (narrower) area of the minimum opening may be increased from 460 mm to 770 mm maximum, in conjunction with an increase in the minimum width from 250 mm to 300 mm. The shape of openings does not need to be symmetrical.

5.3 For compact excavators, minimal swing radius excavators and compact machines that by design require front entrance or step-down into the operator enclosure (e.g. skid steer loaders), the dimensions given in 5.3.1 and 5.3.2 may be used instead of those given in Table 1.

5.3.1 The width, *A*, of the primary opening shall be greater than 550 mm and the height, *B*, of the opening above the sill shall be greater than 875 mm.

5.3.2 The dimensions of an alternative opening shall permit the passage of a rectangle 380 mm × 550 mm with a radius in accordance with Table 1.

5.4 The primary opening door(s) of the enclosure, if so equipped, shall permit opening and closing without interfering with the user, while maintaining three-point support. Contact with the door, or parts attached to the door, shall not be considered one of the points of support while opening or closing the door.

5.5 The force needed to open or close a hinged primary enclosure door shall not exceed 135 N. The force needed to open or close all other hinged access doors or covers shall not exceed 245 N. This applies to the opening and closing of the door, not to the activation of the latch.

5.6 An enclosure door shall be designed with a means to secure it in the closed position. An enclosure door that is designed to be left open during machine operation shall be provided with a means to secure it in the open position and shall be able to withstand a closing force of 300 N without failure of the securing device.

5.7 Doors shall be designed to prevent hazardous door movements due to inertial force caused by machine operations.

5.8 Hinged doors shall normally open outward.

5.9 A minimum of 40 mm hand clearance shall be provided

- a) between the outer edge of a hinged door and any fixed object other than its door frame, and
- b) from any fixed part that might come into contact with the hand when removing or opening other types of enclosures, doors or covers that are within the scope of this International Standard.

5.10 Removable enclosure opening covers held in place by gravity, including roof windows, shall be designed to prevent the possibility of their falling through the opening.

5.11 The mass of a hand-removable enclosure opening cover shall not exceed 25 kg.

Table 1 — Dimensions of enclosure openings

Dimensions in millimetres

Primary opening		Maintenance opening		
Symbol	Description	Dimension		
		Min.	Max.	Target
Primary opening^a				
<i>A</i>	Width	450	—	680
<i>B</i>	Height — Sit-down cab	1 300	—	>1 300
	Height — Stand-up cab	1 800	—	>1 800
<i>C</i>	Height of internal door handle from floor — Operator sitting position	350	850	>350
	Height of internal door handle from floor — Operator standing position	800	1 200	>800
<i>D</i>	Height of external door handle above standing surface	500	1 700	900
Alternative opening^a (preferably same size as primary opening)				
	Round (diameter)	650	—	>650
	Square	600 × 600	—	>600 × 600
	Rectangular	450 × 650	—	>450 × 650
Maintenance opening				
<i>H</i>	Width	450	—	680
<i>I</i>	Height ^b	760	—	1 100
<i>J</i>	Bottom edge to floor	—	500	250
<i>K</i>	Corner radius	—	0,5 <i>H</i>	150
^a The corner radius of primary and alternative openings shall be <190 mm.				
^b If <i>H</i> is less than 680 mm and <i>J</i> is greater than 250 mm, then <i>I</i> shall be >1 100 mm.				

6 Requirements for guardrails, foot barriers, platforms, passageways, walkways and other surfaces used for walking, crawling, climbing, stepping or standing

6.1 Surfaces

6.1.1 Any surface, including steps, used for walking, crawling, climbing, stepping or standing shall be able to withstand the forces given below without permanent deformation. These forces shall be applied separately, not simultaneously:

- a) 2 000 N applied at the most unfavourable position through a 125 mm diameter solid disc;
- b) a uniformly distributed force of 4 500 N per square metre of surface area with a proportional load is permitted to be used if the surface area is less than 1 m².

Enclosure roofs, such as cab and canopy roofs, that are used for the support of persons during inspection need only meet the requirement of a) above.

Verification by calculation is acceptable.

6.1.2 Walkway, passageway and platform surfaces shall meet the following criteria:

- prevent the passage of a spherical object of diameter 20 mm or larger where persons are normally intended to walk, stand or work under the walkway or platform;
- prevent the passage of a spherical object of diameter 40 mm or larger where persons will not normally be walking, standing or working under the walkway or platform.

Surfaces without openings shall be used when necessary on walkway passageways and platforms to prevent the passage of material that could result in personal injury to a person above or below.

6.2 Platforms, passageways, walkways, guardrails and foot barriers

6.2.1 The dimensions of platforms, passageways, walkways, guardrails and foot barriers shall be in accordance with Table 2.

6.2.2 Guardrails shall have a rail placed midway between the top rail of a guardrail and the walkway or platform. Alternatively, vertical posts may be used if the space between these posts is no more than 180 mm.

6.2.3 Guardrails shall be provided along an open side of platforms and walkways if the height above the ground, platform, walkway or passageway is greater than 3 m.

For platforms and walkways of between 2 m and 3 m height above the ground, platform, walkway or passageway, and where a border of the standing or walking area of the platform or walkway is less than 1,5 m from an open side of the machine, the following applies:

- guardrails shall be provided on the open side of platforms or walkways where routine maintenance with both hands is required in the standing position;
- a guardrail or handrail (see Clause 7) shall be provided on the open side of a platform or walkway, or handrails or handholds shall be provided on the inside for three-point support as shown in Table 2 (illustration of dimension *G*).

Fixed guardrails may be replaced by retractable guardrails or handrails and handholds in order to ensure easy transportation from jobsite to jobsite.

6.2.4 The horizontal opening between the two vertical ends of guardrails shall not be less than 75 mm and not greater than 120 mm. The maximum radius of the corners of the handrails shall be 250 mm. For larger openings, a barrier shall be provided. These requirements do not apply to openings between guardrails/handrails (see Table 3, dimension *G*) that lead to other parts of the access system (e.g. platform, walkway, stairway, ladder). The barrier shall be in accordance with 6.2.5.

6.2.5 Guardrails shall be capable of withstanding a minimum force of 1 000 N, applied at any point distributed over 50 mm from any direction, without visible permanent deformation. Flexible guardrails or barriers (chains or cables) shall not deflect, with a minimum force of 1 000 N, more than 80 mm from their normal undeflected position.

6.2.6 Wherever a foot could slip from the edge of a walkway or platform, creating a hazard to the foot or leg, a foot barrier shall be provided unless it would create a tripping hazard. Foot barriers are recommended when there is a risk of material (e.g. tools) falling from the edge of a platform onto a person.

6.2.7 The minimum length of a platform shall be 400 mm.

6.2.8 Provisions shall be made to permit the removal or storage of guardrails, handrails or handholds which create hazards during the transport of machines.

6.3 Maintenance

6.3.1 Platforms for routine maintenance points at a height of less than 2 m above the ground or another suitable surface may have a minimum width of 300 mm if handholds or handrails are provided (see Table 2, dimension *G*). Walkways or platforms for motor graders over the rear tandem wheels may have a minimum width of 200 mm if three-point support is provided. Where maintenance activities are performed in a bending or squatting position, the platform shall have a minimum width or length of 600 mm.

6.3.2 Handholds/handrails shall be located so that they are not within the walkway or platform width (see 6.3.1 and Table 2).

6.4 Boom walkways

Where routine maintenance points are present along a boom (e.g. diaphragm walling machine cable and rope changing) the walkway/platform shall be the full width and length of the boom (see 6.2.3).

The operating manual shall describe the working procedure and, if relevant, the use of PFASs or PFRSs.

The maximum slope of the walkway shall not exceed 20° in the maintenance position.

Table 2 — Dimensions of platforms, passageways, walkways, guardrails, and foot barriers

Dimensions in millimetres

Symbol	Description	Dimension		
		Min.	Max.	Target
A	Platform width	300 ^{a e}	—	600
	Walkway width	300 ^{a b}	—	600
	Passageway width — Forward-facing passage of user ^c	550	—	650
	Passageway width — Sideways passage of user	330	—	450
	Passageway width — Users passing from opposite directions	900	—	1 300
B	Head clearance — Standing	2 000	—	—
	Head clearance — Kneeling ^d	1 500	—	—
	Head clearance — Crawling ^d	1 000	—	—
C	Guardrail height	1 000	1 100	1 100
D	Foot barrier height	50	—	100
E	Foot barrier to floor clearance	0	10	0
G	Platform width — Less than 2 m height	300 ^e	—	—

^a Minimum width *A* is dependent on head clearance, *B*, as defined in the graph at right.

^b See 6.3.1.

^c Use target dimension as minimum for crawling.

^d For routine maintenance points only.

^e See 6.3.1 and 6.3.2.

7 Requirements and recommendations for handrails and handholds

7.1 The dimensions of handrails and handholds shall be in accordance with Table 3.

7.2 Handrails and handholds shall be appropriately placed along an access system to provide intuitive and continuous support to a person moving along the access system, and to enable the user to maintain three-point or two-point support, as applicable.

7.3 Continuous handrails are preferred over handholds. The maximum spacing between adjacent handrails shall be 400 mm; 120 mm is preferred. A single handrail may be used for both hands for three-point support as an exception for one or two steps if the length of the handrail (see Table 3, dimension *B*) is at least 250 mm.

7.4 The recommended cross-section of a handrail and handhold is circular. A square or rectangular cross-section with rounded corners in accordance with ISO 12508 is permissible.

7.5 Any handrail or handhold on which the hand grasp surface extends beyond the support shall have a change of shape at the end of the hand grasp surface to provide some protection from the hand slipping off the end.

7.6 Handrails are recommended on each side of a ladder system instead of handholds. Handrails or handholds may be an integral part of, or separate from, the ladder.

7.7 Handrails and handholds shall be designed and positioned such that the risk of damage to the handrails and handholds are minimized.

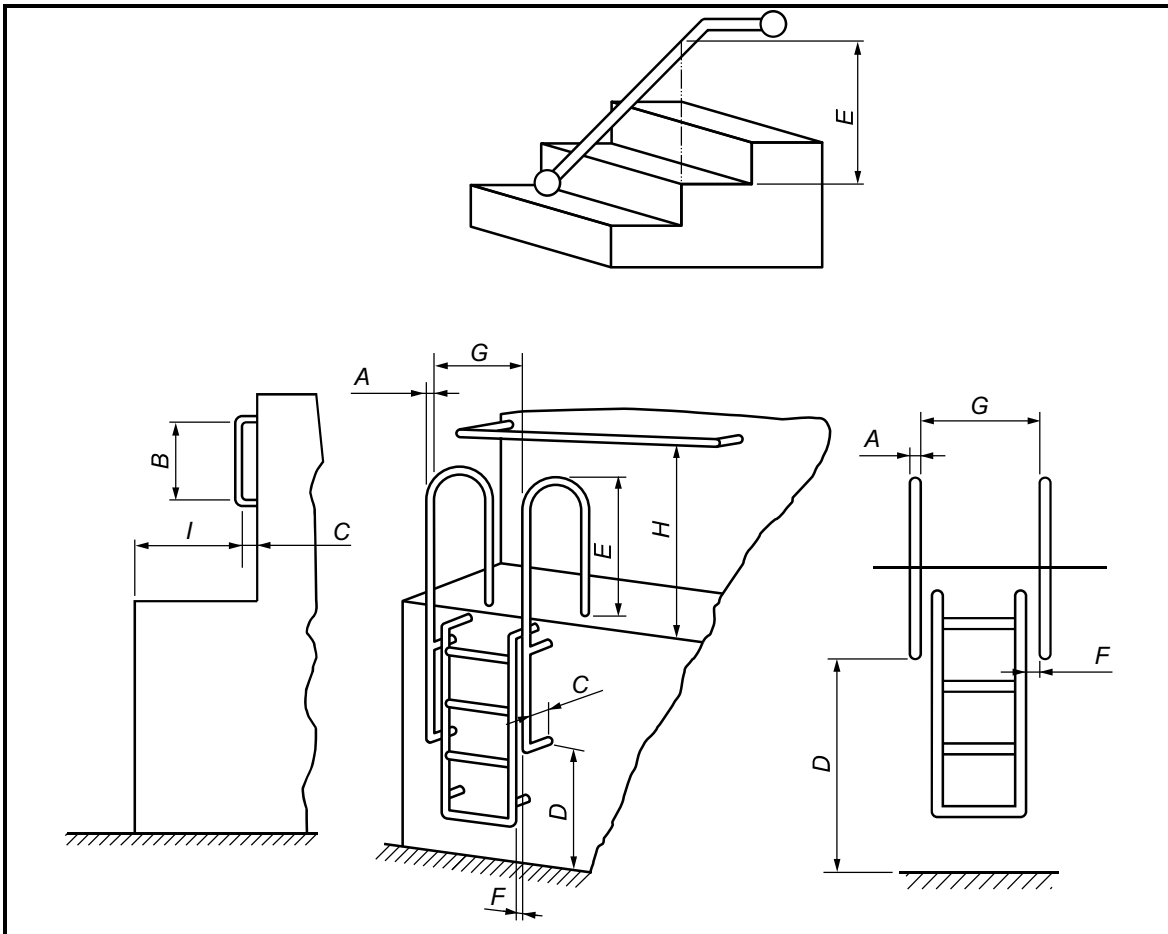
7.8 Handrail and handhold surfaces shall be free of roughness, sharp corners (see ISO 12508) or protrusions that could cause injury to the hand.

7.9 Handrails and handholds can be installed on a cover or a movable part (e.g. door, cover, guard), only if the movable part can be locked in position when the force is applied to the handrails and handholds or the force is applied in a direction that does not lead to unexpected movement of the movable part.

7.10 Handrails and handholds shall be capable of withstanding a minimum force of 1 000 N, applied at any point from any direction, without visible permanent deformation. Flexible handrails and handholds shall not deflect, with a minimum force of 1 000 N, more than 80 mm from their normal undeflected position.

Table 3 — Dimensions of handrails and handholds

Dimensions in millimetres



Symbol	Description	Dimension		
		Min.	Max.	Target
A	Ladder or step — Handrail diameter (or width across flats)	15 ^a	38	25
	Stairway, walkway, platform or ramp — Handrail diameter (or width across flats)	15	80	50
B	Length between bend radii for support legs of handholds	150	—	250
C	Hand clearance to mounting surface	50	—	75
D	Distance above standing surface or ground	—	1 700	900
E	Vertical distance of handrail continuation above step, platform, stairway or ramp	850	1 100 ^c	900
F	Offset distance of handrail or handhold from edge of ladder/steps (if ladder/steps and handrail are separate parts)	50	200	150
G	Ladder — Width between parallel handrails	300 ^d	950 ^b	600
	Stairway and ramp — Width between parallel handrails	460	—	700
H	Distance above walkway, passageway, step or stairway step	850	1 400 ^c	900
I	Forward reach to handhold from the ground, step, platform or walkway	—	765	500

^a 19 mm if orientation is vertical and the standing position for the handrail or handhold is greater than 3 m above the ground.

^b Up to 1 100 mm maximum when the handrails/handholds are an integral part of a door opening.

^c May be increased to 1 700 mm for handrails and handholds located above the cab door.

^d 300 mm up to a maximum height of 450 mm (see E); over 460 mm height, a width of 460 mm is required.

8 Requirements for stairways and steps

8.1 Stairways

8.1.1 Stairway steps shall be in accordance with 8.2 and Table 4.

8.1.2 Step tread depth on stairways shall be greater than or equal to the riser height. Successive riser heights and successive step tread depths shall be uniform.

8.1.3 Stairways shall be provided with at least one handrail.

8.1.4 Stairways with a vertical distance greater than 3 m above the ground or other suitable surface shall be provided with guardrails, with a foot barrier in accordance with 6.2.6 and a handrail in accordance with 6.2.2, on the open side or sides.

8.1.5 Handrails or guardrails shall be provided along the open side of stairways with a vertical distance of between 2 m and 3 m above the ground or other suitable surface (platform or walkway). See Table 3, dimension *G*.

8.2 Steps

8.2.1 Step design shall provide the user with natural foot placement, or the steps shall be clearly visible to the user. Step dimensions shall be in accordance with Table 5 or 6, as applicable. Steps shall be wide enough for two feet, except where a one-foot-wide step is necessary to accommodate machine constraints (e.g. to accommodate machine size, the use of alternating single steps, or risk of damage to the step).

8.2.2 Where lateral body movement is necessary for passing to the next stepping surface — from the top step of a ladder or stairway to a platform, or from one platform to another — the distance between the step and the nearest edge of the stepping surface shall be in accordance with Table 7.

8.2.3 If a foot could protrude through the step and come into contact with a moving part, a shield shall be provided between the step and the moving part.

8.2.4 Steps shall be designed to minimize the risk of the foot slipping laterally off the step. If foot barriers are used, its minimum height shall be 20 mm.

8.2.5 The step tread surface shall not be designed for use as a handhold.

8.2.6 Step design shall minimize accumulation of debris and aid in the cleaning of mud and debris.

8.2.7 Flexibly mounted steps (or series of steps) shall be avoided unless the step is susceptible to damage during machine operation. A single step or the lowest step in a series of flexibly mounted steps shall not deflect more than 80 mm inward (away from the person) when a horizontal force of 250 N is applied, centred on the outer edge of the lowest flexible step and pushing inward.

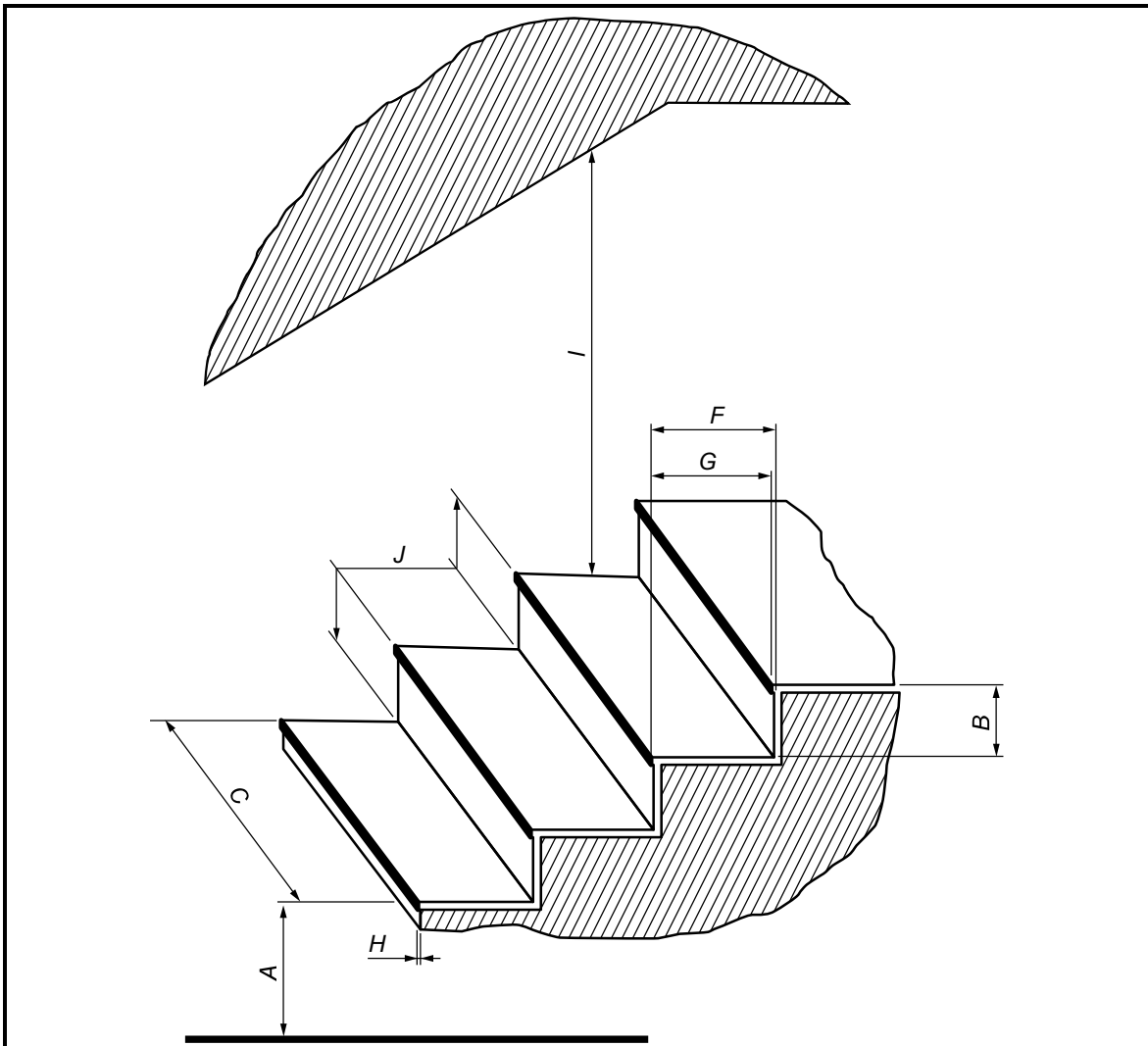
8.2.8 For a track frame/retracted step system (with a maximum of two steps), the top step can be recessed, as specified in Table 5 in respect of dimension *Q*. In such cases, due to the limited view during egress, the step width shall be at least as wide as the target width for two feet (see Table 6).

8.2.9 The top step or vertical steps may be recessed up to 30 mm from the edge of the platform or walkway.

8.2.10 Steps may be used as a standing surface for routine maintenance points, or as a rest platform for heights of less than 2 m above the ground or other suitable surface, if the steps meet the step width requirements for both feet according to Table 6.

Table 4 — Dimensions of stairways

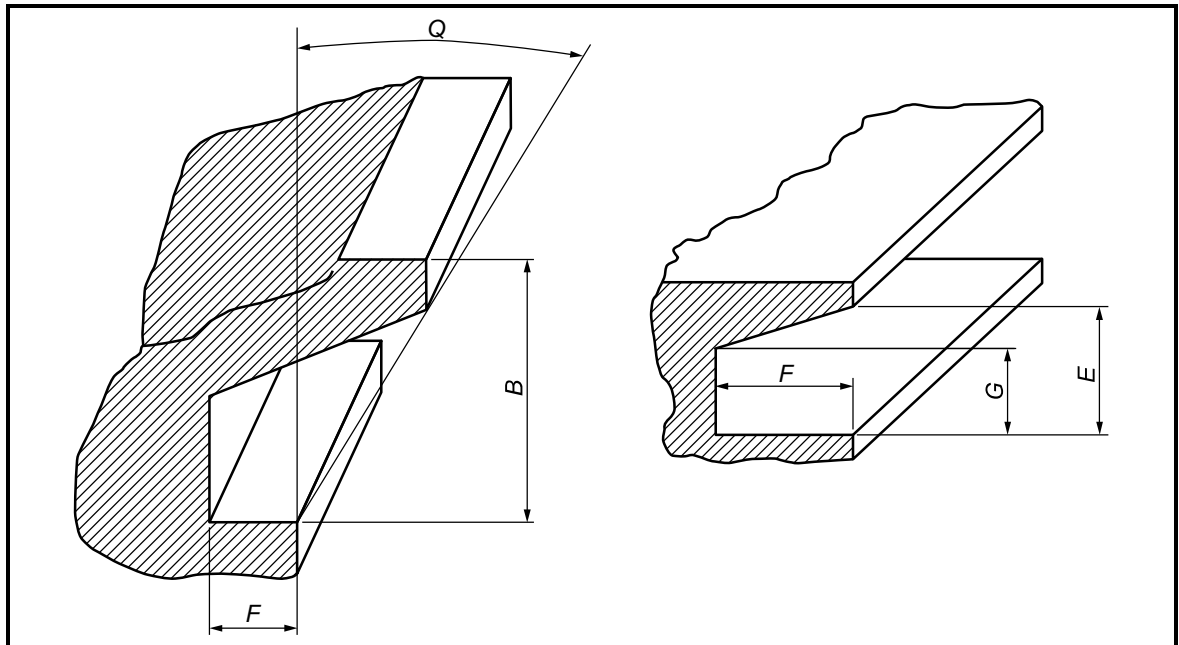
Dimensions in millimetres



Symbol	Description	Dimension		
		Min.	Max.	Target
<i>A</i>	Height of first step above ground, platform, walkway or passageway	—	600	400
<i>B</i>	Riser height	—	250	180
<i>C</i>	Step width	320	—	400
<i>F</i>	Tread depth	240	400	300
<i>G</i>	Stride distance	215	—	—
<i>H</i>	Tread projection from riser	—	25	0
<i>I</i>	Head clearance above step leading to walkway	2 000	—	> 2 000
<i>J</i>	Step proportion where $J = G + 2B$	—	800	600

Table 5 — Dimensions of steps on a track frame/retracted step

Dimensions in millimetres



Symbol	Description	Dimension		
		Min.	Max.	Target
<i>B</i>	Riser height	230	400 ^a	300
<i>E</i>	Vertical instep clearance	150	—	190
<i>F</i>	Toe clearance (free space behind front edge of step or centreline of circular step)	150	—	200
<i>G</i>	Vertical toe clearance	100	—	—
<i>Q</i>	Maximum inclination of a step on a track frame/retracted step	—	15°	—

^a If track systems are used as steps, the riser height may be increased to 500 mm from the track to the platform or from the step to the top of the track. This also applies to wheeled excavators for the step from the lower structure to the rotating upper structure.

9 Requirements for ladders

9.1 Ladder steps shall be in accordance with 8.2 (requirements for steps in general) and Table 6.

9.2 Vertical ladder flights that extend more than 3 m in vertical distance from the ground or platform shall be equipped with a ladder fall-limiting device, preferably of the passive type (e.g. ladder cage), in accordance with ISO 14122-4. Such a device shall not require continual manipulation at each step for the user to ascend or descend the ladder.

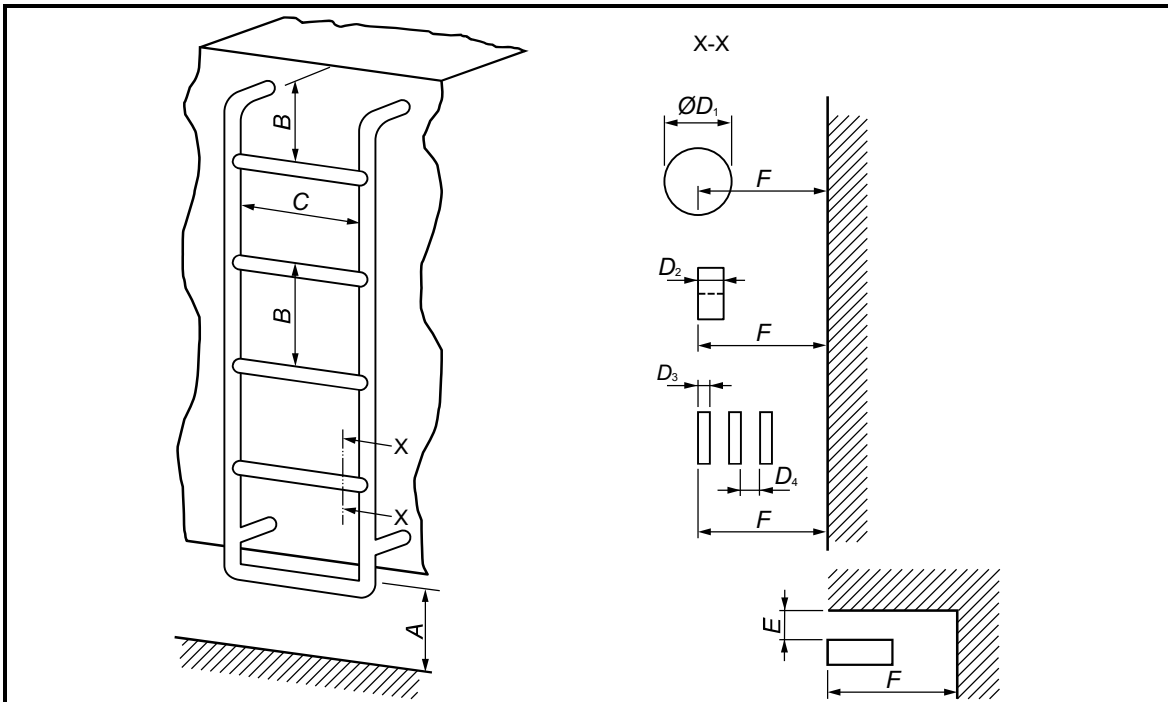
The internal surface of a ladder cage shall not extend more than 700 mm from the steps, nor shall its internal width be more than 700 mm.

9.3 A rest platform shall be provided at every 6 m maximum, except in the case of a single-section ladder, where the falling height shall not exceed 10 m.

9.4 Ladder riser heights shall be uniform on a specific ladder.

Table 6 — Dimensions of ladders and single or multiple steps

Dimensions in millimetres



Symbol	Description	Dimension		
		Min.	Max.	Target
<i>A</i>	Height of first step above ground, platform, walkway, or passageway	—	600 ^a	400
<i>B</i>	Riser height	230 ^b	400 ^c	300
<i>C</i>	Step width — For one foot	160	—	200
	Step width — For both feet	320	—	400
<i>D</i> ₁	Tread depth — Circular ^d	19	—	60
<i>D</i> ₂	Tread depth — Square or rectangular	12	—	50
<i>D</i> ₃	Tread element depth — Multiple element step	3	—	—
<i>D</i> ₄	Tread element spacing — Multiple element step	—	50	50
<i>E</i>	Vertical instep clearance	100 ^e	—	150
<i>F</i>	Toe clearance (free space behind outer edge of step or centreline of circular step)	150	—	200

^a The first step height for skid steer loaders with large buckets or attachments may be up to 700 mm. This also applies to compact excavators, tractor-dozers, landfill compactors and derivative machines with steel wheels and pad feet.

Dimension *A* may be increased up to 700 mm for steps used for routine maintenance points where there is a risk of damage.

^b 150 mm from top step of ladder to platform.

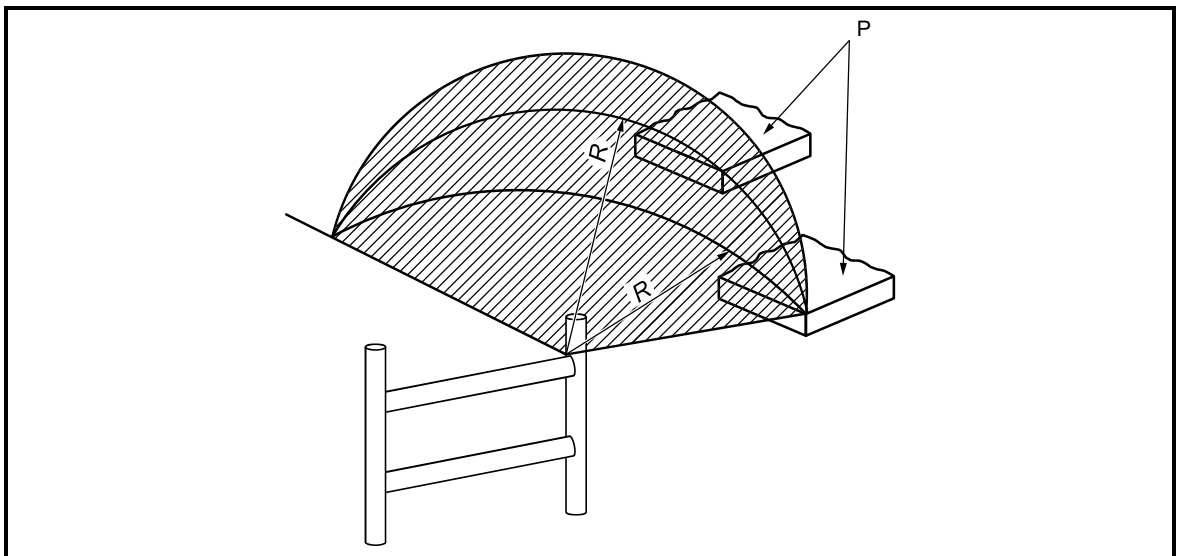
^c If track systems are used as steps, the riser height may be increased to 500 mm from the track to the platform. This also applies to wheeled excavators or other machines with a rotating upper structure for the step from the lower structure.

^d Circular steps to have slip-resistant surfaces.

^e The minimum vertical instep clearance for compact excavators for stepping on the track shall be 70 mm if the step height is less than 600 mm.

Table 7 — Dimensions from ladder to platform

Dimensions in millimetres



Symbol	Description	Dimension		
		Min.	Max.	Target
<i>R</i>	Spherical radius from ladder or platform to next step placement ^a	—	500	400
<i>P</i>	Platform			

^a See 8.2.2.

Annex A (informative)

Examples of surfaces considered to be slip-resistant

The following are examples of surfaces that are considered to be slip-resistant:

- a) **raised grip**: grating with raised, perforated buttons (see Figure A.1);
- b) **open grip**: grating with diamond pattern having serrated surface edges (see Figure A.2);
- c) **sand coat**: surface coated with sand containing paint, or paint to which sand has been applied before drying;
- d) **flex tread**: high-friction textured sheet material, consisting of a plastic film coated with silicon carbide abrasive particles on one side and with a pressure-sensitive adhesive on the other.

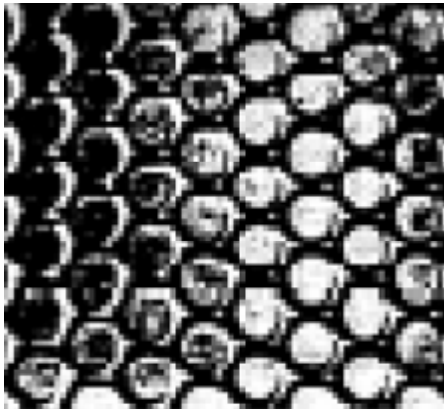


Figure A.1 — Raised grip surface

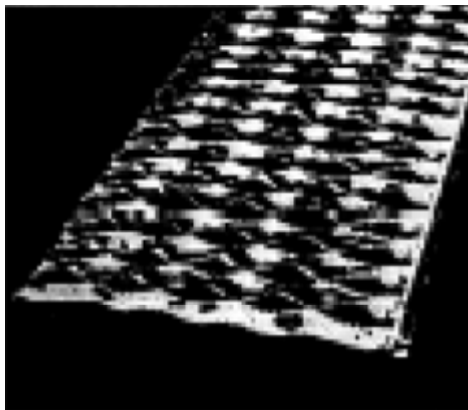


Figure A.2 — Open grip surface

Annex B (normative)

Additional requirements for powered retractable access system that transports a person

B.1 General

When a powered retractable access system that transports a person is in the lowest position, the first step height shall be less than 600 mm. Such a system's lift and descent speed shall not exceed 0,6 m/s under normal operating conditions. If service or maintenance work has to be done with an access system of this type in a raised position, a mechanical support device shall be provided. This device shall withstand a force of twice the mass of the access system.

The design load factor shall be at least four times the anticipated working load.

Uncontrolled falling shall be prevented if a fluid line or energy source failure occurs.

Devices which operate more than 2 m above the ground shall be equipped with guardrails or side enclosures.

A capacity plate indicating the maximum working load and number of persons shall be provided which is readily visible at the device controls.

Device deployment movements shall be controlled to prevent rapid motions that could result in personal injury or damage to the device.

Access onto a device shall be possible only after it has been fully deployed.

B.2 Powered access system control

The powered access system control shall be clearly marked and protected against unintentional activation. Movement of the powered access system shall stop when the control is released or returned to the neutral position.

B.3 Emergency descent

In case of failure of the energy source, an engine stop or a hydraulic system failure, it shall be possible for the operator to lower the powered retractable access system that transports a person to the lowest position, irrespective of the actual position.

B.4 Visibility for lowering

If the operator does not have a direct view of the area between the powered retractable access system that transports a person and the frame, visibility aids (e.g. exterior mirror or mirrors) shall be installed to allow the operator to observe the area between the powered retractable access system and the frame when lowering the access system.

B.5 Operation manual

The operator's manual shall contain safety instructions for powered retractable access systems that transport a person.

Bibliography

- [1] ISO 2860, *Earth-moving machinery — Minimum access dimensions*
- [2] ISO 3457, *Earth-moving machinery — Guards — Definitions and requirements*
- [3] ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- [4] ISO 10333-4, *Personal fall-arrest systems — Part 4: Vertical rails and vertical lifelines incorporating a sliding-type fall arrester*
- [5] ISO 14122-2, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*
- [6] ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*
- [7] ISO 16024, *Personal protective equipment for protection against falls from a height — Flexible horizontal lifeline systems*