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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.

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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).

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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.

3.7.2**vertical ladder**

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

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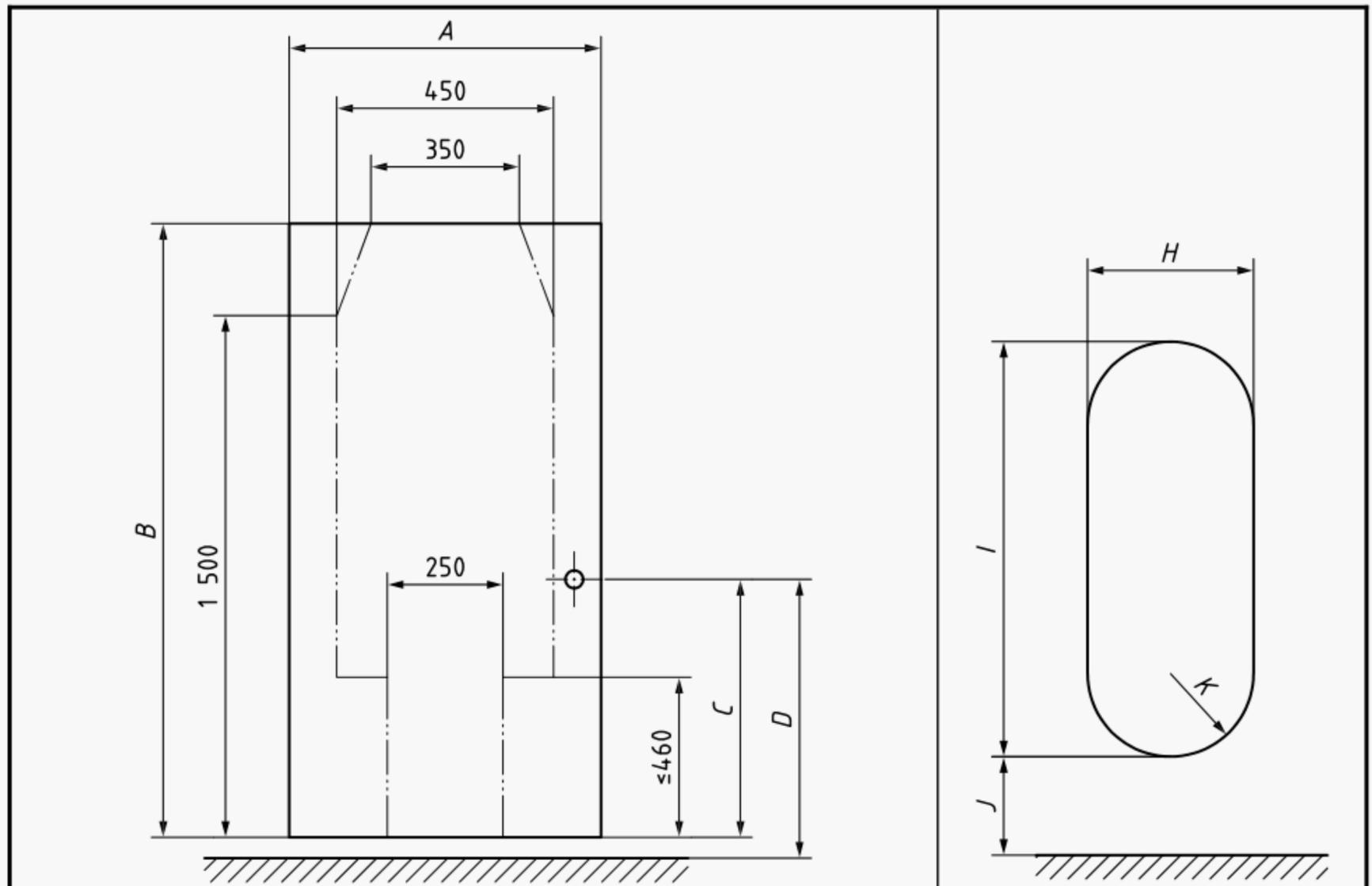
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- the potential for damage to the access system, and masking of visibility around the machine, machine equipment or attachments shall be evaluated.

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 *H* is less than 680 mm and *J* is greater than 250 mm, then *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.

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

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.

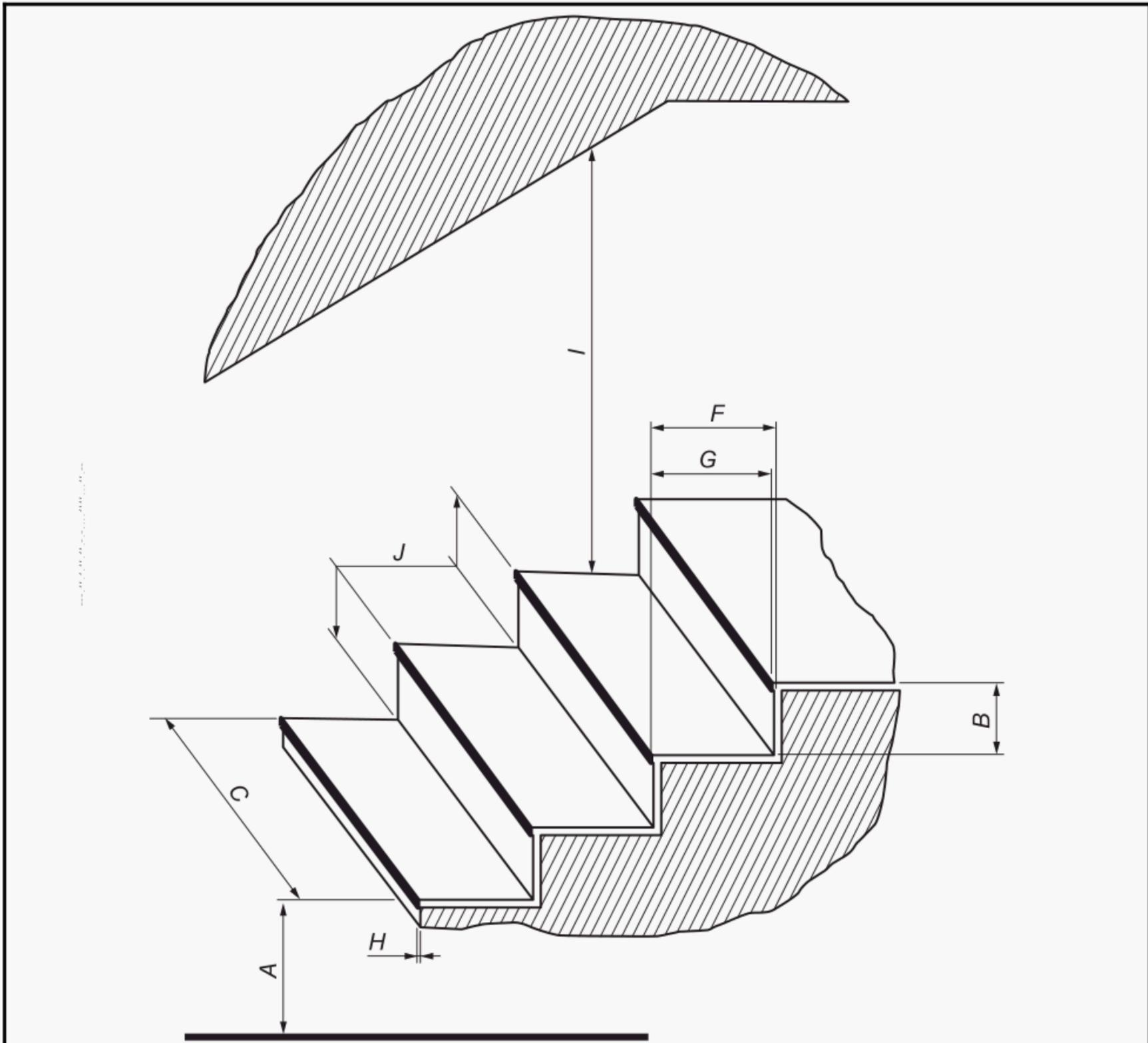
8.2.8 For a track frame/retracted step system (with a maximum of two steps), the top step can be recessed, as specified in Table 5 in respect of dimension *Q*. In such cases, due to the limited view during egress, the step width shall be at least as wide as the target width for two feet (see Table 6).

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

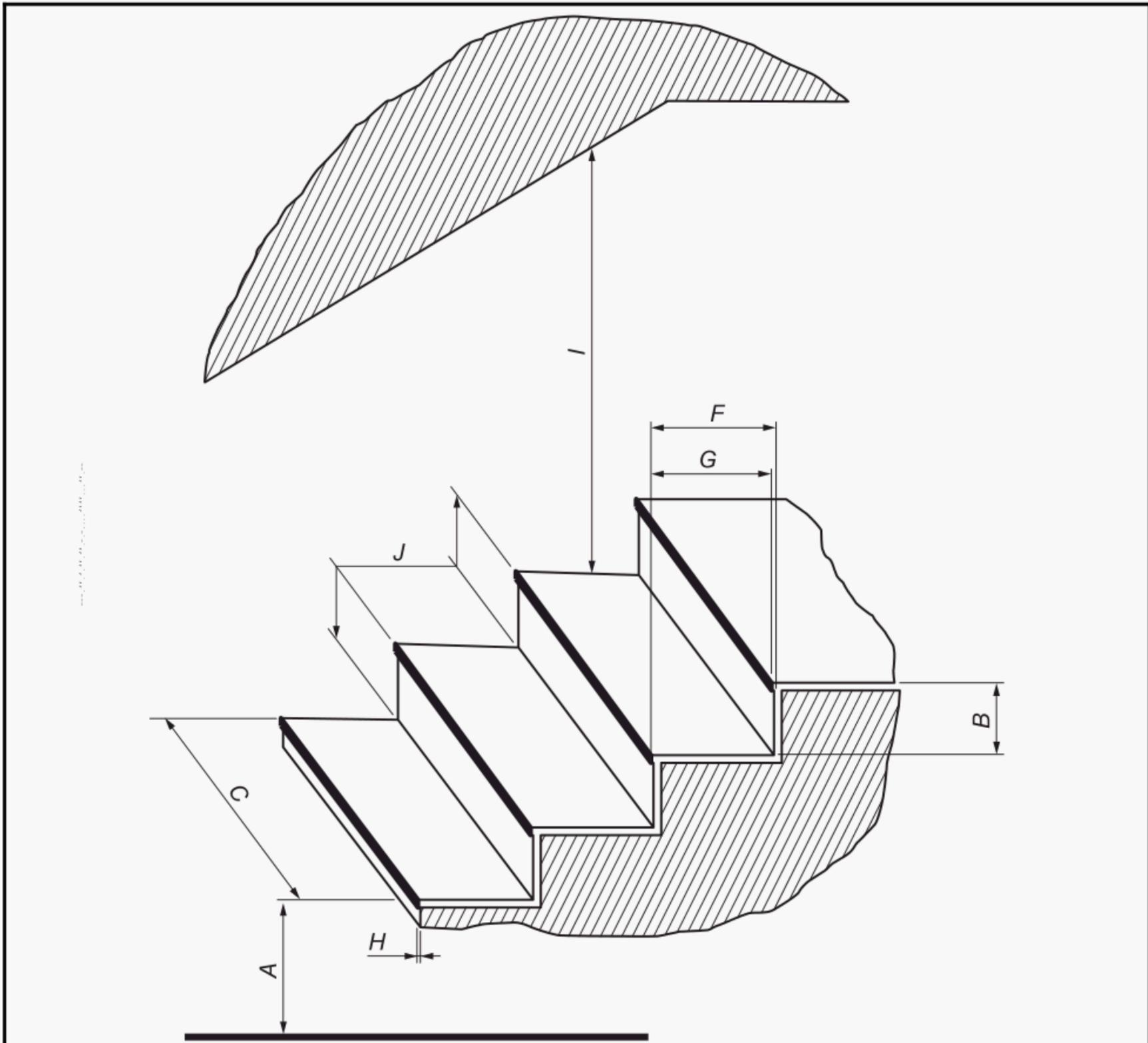
Dimensions in millimetres



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 4 — Dimensions of stairways

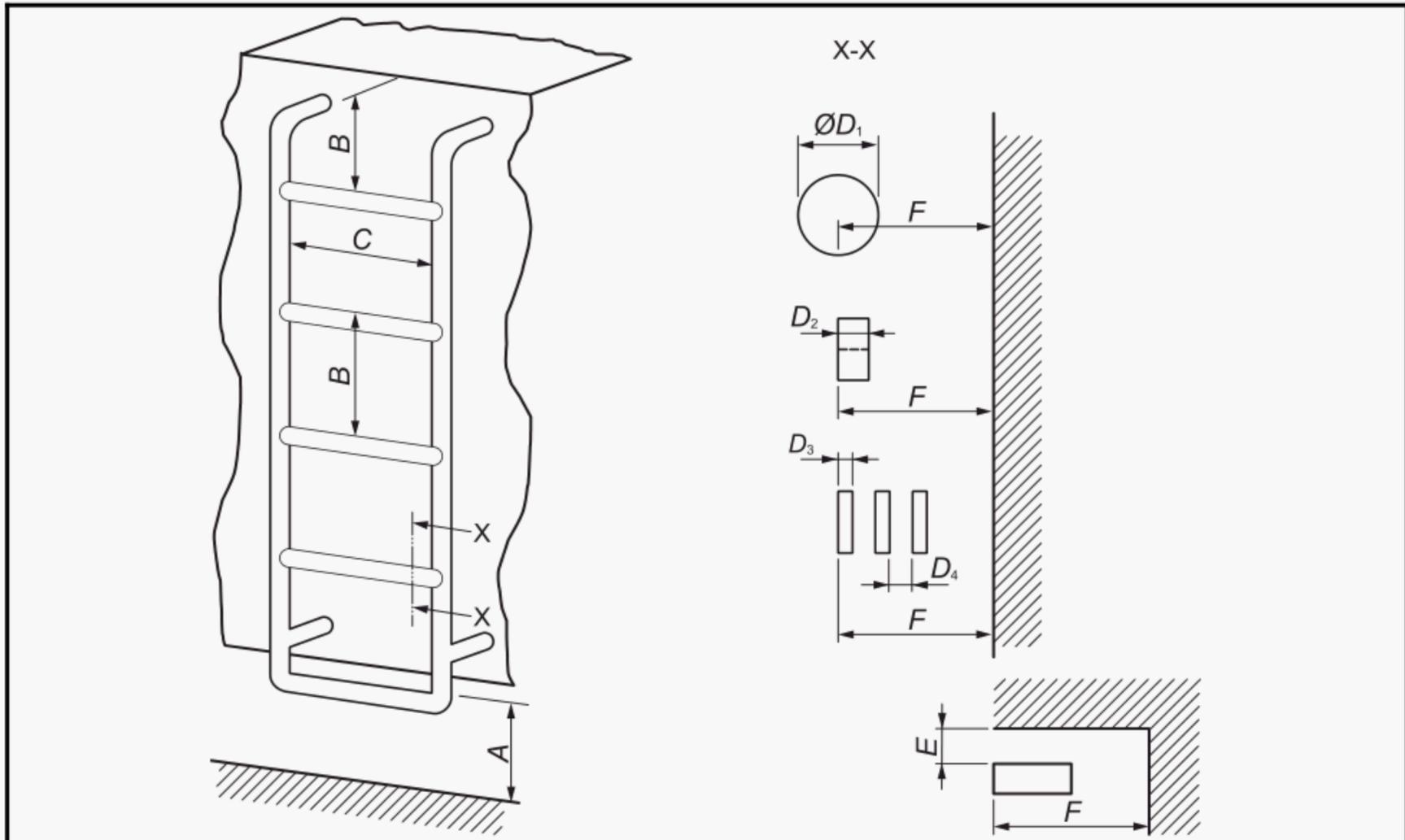
Dimensions in millimetres



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<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 6 — Dimensions of ladders and single or multiple steps

Dimensions in millimetres



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

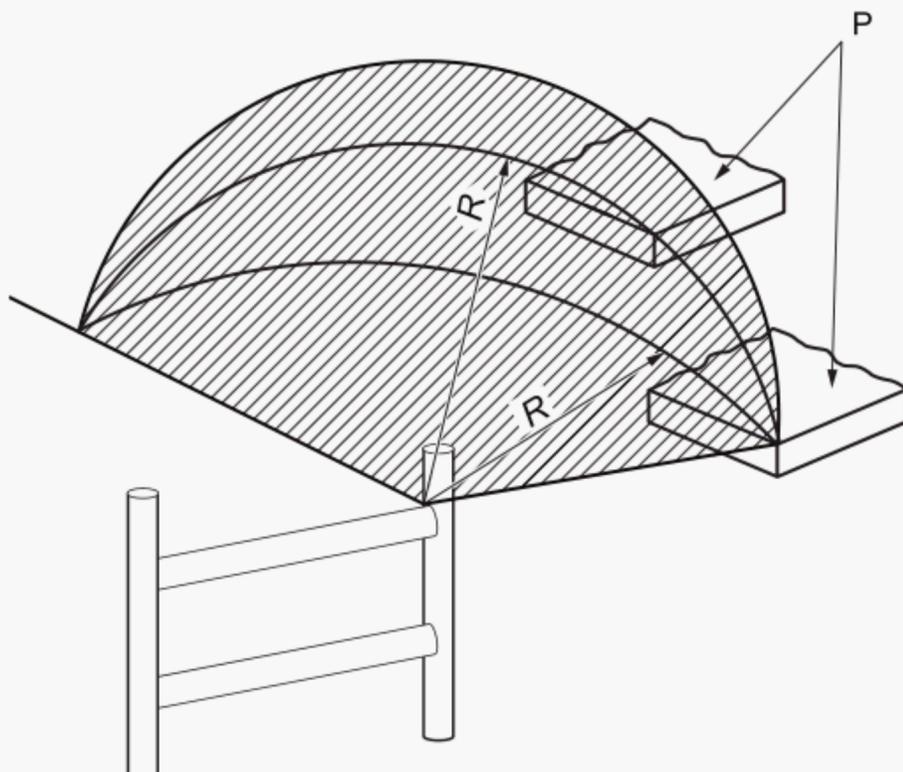
^c If track systems are used as steps, the riser height may be increased to 500 mm from the track to the platform. This also applies to wheeled excavators or other machines with a rotating upper structure for the step from the lower structure.

^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.

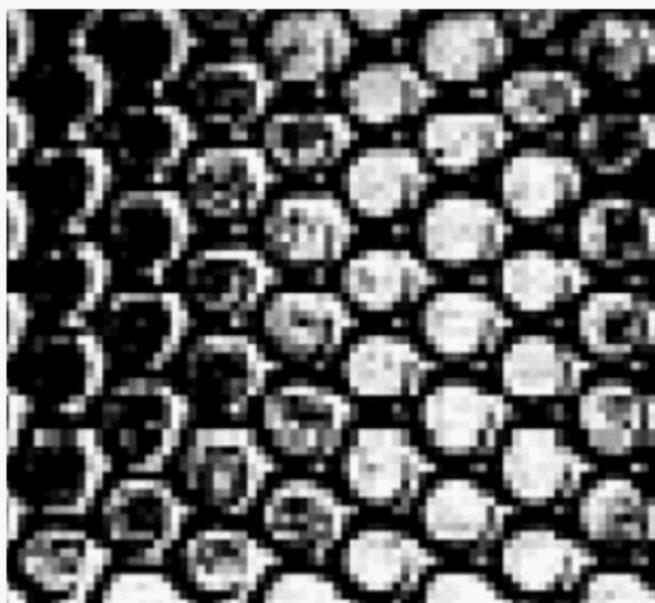


Figure A.1 — Raised grip surface

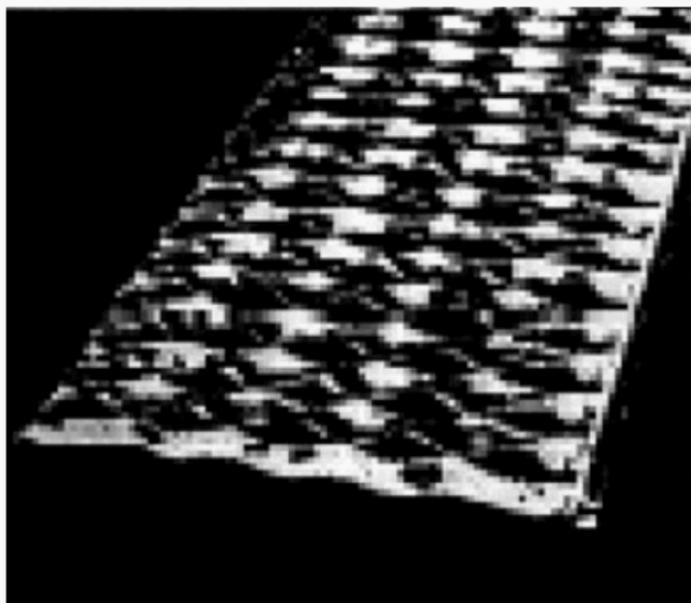


Figure A.2 — Open grip surface

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.

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