



**International
Standard**

ISO 8103-1

**Escalators and moving walks —
Part 1:
Safety requirements**

*Escaliers mécaniques et trottoirs roulants —
Partie 1: Exigences de sécurité*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by the European Committee for Standardization (CEN) (as EN 115-1:2017) and was adopted, without modification other than those given below by Technical Committee ISO/TC 178, *Lifts, escalators and moving walks*

- change "this European Standard" or "this standard" to "this document";
- change any "EN ISO xxxx" references to "ISO xxxx" references.

A list of all parts in the ISO 8103 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 General

The content of this document was already published in EN 115-1:2017. This document contains only editorial changes and update of references.

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

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e. g. trade unions, organizations for people with special needs);
- service providers, e. g. for maintenance (small, medium and large enterprises);
- consumers (in the case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

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 type-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.

0.2 General remarks

The contents of this document are based on the assumption that persons using escalators and moving walks are able to do so unaided. However, physical and sensory abilities in a population can vary over a wide range, escalators and moving walks are also likely to be used by persons with a range of other disabilities.

Some individuals, in particular older people, might have more than one impairment. Some individuals are not able to use an escalator or moving walk independently and rely on assistance/support being provided by a companion. Furthermore, some individuals can be encumbered by objects or be responsible for other persons, which can affect their mobility. The extent to which an individual is incapacitated by impairments and encumbrances often depends on the usability of products, facilities and the environment.

The use of wheelchairs on escalators and moving walks can lead to dangerous situations which cannot be mitigated by machine designs and therefore should not be permitted.

The use of lifts is the preferred method of vertical travel for most people with disabilities and in particular wheelchair users and persons with guide dogs.

Additional signs should be provided to indicate the location of other facilities, these facilities should be in close proximity to the escalators and moving walks and easy to find.

The risks arising from the configuration of escalators and moving walks within a building (e.g. obstructions or voids adjacent to escalators) should be risk assessed according to methodology of the ISO 14798 by the building designer/owner at the building design stage and measures identified to eliminate hazards or reduce risk to an acceptable level.

It is assumed that negotiations have been made for each contract between the customer and the supplier/installer (see also [Annex A](#)) about:

- a) intended use of the escalator or moving walk;
- b) environmental conditions;
- c) civil engineering problems;
- d) other aspects related to the place of installation.

Planning of traffic flows and evacuation/rescue purposes are under the responsibility of the building designer/owner.

If escalators or moving walks are intended to be operated under special conditions, such as directly exposed to the weather or explosive atmosphere, or in exceptional cases serve as emergency exits, appropriate design criteria, components, materials and instructions for use should be used that satisfy the particular conditions.

An Interpretation Committee has been established to clarify, if necessary, the spirit in which the clauses of the standard have been drafted and to specify the requirements appropriate to particular cases. Interpretation Requests can be sent to the National Standard Bodies which will contact the responsible Technical Committee ISO/TC 178. The formats of an interpretation request and the interpretation are given in the Information Note – System of ISO/TC 178 series of standards, Interpretations and Frequently Asked Questions (FAQ) procedures.

Escalators and moving walks —

Part 1: Safety requirements

1 Scope

This document is applicable for new escalators and moving walks (pallet or belt type) as defined in [Clause 3](#).

This document deals with all significant hazards, hazardous situations, and events relevant to escalators and moving walks when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see [Clause 4](#)).

This document is not applicable to escalators and moving walks which were manufactured before the date of its publication. It is, however, recommended that existing installations be adapted to this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 1929-2:2004, *Basket trolleys — Part 2: Requirements, tests and inspection for basket trolleys with or without a child carrying facility, intended to be used on passenger conveyors*

EN 1929-4:2005, *Basket trolleys — Part 4: Requirements and tests for basket trolleys with additional goods carrying facility(ies), with or without a child carrying facility, intended to be used on passenger conveyors*

EN 1990:2002¹⁾, *Eurocode — Basis of structural design*

EN 1993-1-1:2005, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

EN 1998-1:2004, *Eurocode 8: Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*

EN 10025-1:2004, *Hot rolled products of structural steels — Part 1: General technical delivery conditions*

EN 10025-2:2004, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3:2004, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-4:2004, *Hot rolled products of structural steels — Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

EN 10025-5:2004, *Hot rolled products of structural steels — Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*

EN 10025-6:2004+AMD1:2009, *Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition — Amendment 1*

EN 10083-1:2006, *Steels for quenching and tempering — Part 1: General technical delivery conditions*

1) This standard is currently impacted by the amendment EN 1990:2002/A1:2005.

- EN 10083-2:2006, *Steels for quenching and tempering — Part 2: Technical delivery conditions for non alloy steels*
- EN 10083-3:2006, *Steels for quenching and tempering — Part 3: Technical delivery conditions for alloy steels*
- EN 12015:2014, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Emission*
- EN 12016:2013, *Electromagnetic compatibility — Product family standard for lifts, escalators and moving walks — Immunity*
- EN 13501-1:2007+AMD1:2009, *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests — Amendment 1*
- EN 60068-2-6:2008, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:2007)*
- EN 60068-2-14:2009, *Environmental testing — Part 2-14: Tests — Test N: Change of temperature (IEC 60068-2-14:2009)*
- EN 60068-2-27:2009, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock (IEC 60068-2-27:2008)*
- EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2006, modified)*
- EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*
- EN 60664-1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests (IEC 60664-1:2007)*
- EN 60947-4-1:2010²⁾, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1:2009)*
- EN 60947-5-1:2004³⁾, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices (IEC 60947-5-1:2004)*
- EN 61249 (all parts), *Materials for printed boards and other interconnecting structures (IEC 61249, all parts)*
- EN 62061:2005⁴⁾, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)*
- EN 62326-1:2002, *Printed boards — Part 1: Generic specification (IEC 62326-1:2002)*
- ISO 868:2003, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*
- ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design*
- ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*
- ISO 3864-1:2011, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*
- ISO 3864-3:2012, *Graphical symbols — Safety colours and safety signs — Part 3: Design principles for graphical symbols for use in safety signs*

2) This standard is currently impacted by the amendment EN 60947-4-1:2010/A1:2012.

3) This standard is currently impacted by the amendment EN 60947-5-1:2004/A1:2009.

4) This standard is currently impacted by the amendment EN 62061:2005/A1:2013.

HD 60364-4-41:2007, *Low-voltage electrical installations — Part 4-41: Protection for safety — Protection against electric shock*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

angle of inclination

maximum angle to the horizontal in which the steps, the pallets or the belt move

3.1.2

authorized person

suitably trained person with authorization to access restricted areas of escalators and moving walks (e.g. machinery spaces, separate machine rooms) and to work there for the purpose of inspection, testing and maintenance

Note 1 to entry: Authorized persons should be competent for the tasks they have been authorized for (see also [3.1.8](#)).

3.1.3

balustrade

part of the escalator/moving walk which ensures the user's safety by providing stability, protecting from moving parts and supporting the handrail

3.1.4

balustrade decking

transverse member of the balustrade which meets the handrail guidance profile and which forms the top cover of the balustrade

3.1.5

brake load

load on the step/pallet/belt which the brake system is designed to stop the escalator/moving walk

3.1.6

comb

pronged section at each landing that meshes with the grooves

3.1.7

comb plate

platform at each landing to which the combs are attached

3.1.8

competent person

person who is in possession of the necessary technical knowledge, skills, qualification and experience to perform a work or task

Note 1 to entry: National Regulation may require certification of competence.

3.1.9

escalator

power-driven, inclined, continuous moving stairway used for raising or lowering persons in which the user carrying surface (e.g. steps) remains horizontal

Note 1 to entry: Escalators are machines - even when they are out of operation - and cannot be considered as fixed staircases.

3.1.10

exterior panel

part of the exterior side of the enclosure of an escalator or moving walk

3.1.11

failsafe circuit

safety related electrical and/or electronic system with defined failure mode behaviour

3.1.12

handrail

power-driven moving rail for persons to grip while using the escalator or moving walk

3.1.13

interior panel

panel located between the skirting or lower inner decking and the handrail guidance profile or balustrade decking

3.1.14

lower inner decking

profile that connects the skirting with the interior panel when they do not meet at a common point

3.1.15

lower outer decking

profile that connects the exterior panels with the interior panel

3.1.16

machinery

escalator or moving walk machine(s) mechanisms and associated equipment

3.1.17

machinery spaces

space(s) inside or outside of the truss where the machinery as a whole or in parts is placed

3.1.18

maximum capacity

maximum flow of persons that can be achieved under operational conditions

3.1.19

moving walk

power-driven installation for the conveyance of persons in which the user carrying surface remains parallel to its direction of motion and is uninterrupted (e.g. pallets, belt)

Note 1 to entry: Moving walks are machines - even when they are out of operation - and should not be used as a fixed access.

3.1.20

newel

end of balustrade

3.1.21

nominal speed

speed in the direction of the moving steps, pallets or the belt stated by the manufacturer for which the escalator or moving walk has been designed, without load on the steps/pallets/belt at nominal frequency and nominal voltage

3.1.22

rise

vertical distance between the upper and lower finished floor levels

3.1.23

safety circuit

part of the electric safety system consisting of electrical safety devices

3.1.24

safety devices

part of a safety circuit consisting of safety switches and/or failsafe circuits and/or E/E/PE, used to carry out safety functions

3.1.25

safety integrity level

SIL

discrete level for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE

Note 1 to entry: In this document, SIL 1 is representing the lowest level and SIL 3 the highest, even when it does not make use of SIL 3.

3.1.26

safety related electrical, electronic and programmable electronic devices (E/E/PE)

system for control, protection or monitoring based on one or more electrical, electronic or programmable electronic devices, including all elements of the system such as power supplies, sensors and other input devices, data highways and other communication paths, and actuators and other output devices, used in safety related applications as listed in [Table 8](#) and [Table 9](#)

3.1.27

safety system

safety related part of the electrical control system as an arrangement of safety circuits and monitoring devices

3.1.28

skirting

vertical part of the balustrade interfacing with the steps, pallets or belt

3.1.29

skirt deflector

device to minimize the risk of trapping between the step and the skirting

3.1.30

structural rated load

load which the structure is designed for

3.2 Symbols and abbreviations

The following symbols and corresponding units of measurement of the following [Table 1](#) are used in this document.

Table 1 — Symbols and corresponding units of measurement used in this document

Symbol	Designation	Unit	Figures
a_{gR}	Peak ground acceleration (reference peak ground acceleration on type A ground)	m/s ²	—
b_1	Distance between the handrail centre lines	m	Figure 6
b_2	Width of the handrail	mm	Figure 6
b_3	Horizontal distance between skirting and interior panel	mm	Figure 6
b_4	Width of the horizontal part of the lower inner decking that directly joins the interior panel	mm	Figure 6
b_5	Horizontal distance between the inner edge of the handrail and the top edge of the interior panel	mm	Figure 6
b_6', b_6''	Horizontal distance between the handrail profile and guide or cover profiles	mm	Figure 6
b_7	Width of the grooves	mm	Figure 5
b_8	Web width	mm	Figure 5
b_9	Horizontal distance between the outer edge of the handrail and a non-continuous obstruction, e.g. roof intersection, column	mm	Figure A.1
b_{10}	Horizontal distance between the outer edge of the handrail and a continuous obstruction, e.g. wall	mm	Clause 5, Figure A.1
b_{11}	Horizontal distance between the handrails of adjacent escalators/moving walks	mm	Figure A.1
b_{12}	Perpendicular distance between the lower edge of the handrail and the balustrade decking	mm	Figure 6
b_{13}	Width of the lower outer decking	mm	Figure 7
b_{14}	Horizontal distance between the outer edges of interior panels on adjacent escalators or moving walks	mm	Figure 7
b_{15}	Horizontal distance between the building structure (wall) and the centreline of the handrail	mm	Figure 7
b_{16}	Horizontal distance between the centrelines of the handrails of adjacent escalators/moving walks	mm	Figure 7
b_{17}	Horizontal distance of the anti-slide device to the outer edge of the handrail	mm	Figure 7
b_{18}	Perpendicular distance between the lower edge of the handrail and the point where the handrail stand is connected to the balustrade	mm	Figure 6
h_1	Vertical distance between the top of the handrail and step nose or pallet surface or belt surface	m	Figures 5, 6
h_2	Perpendicular distance between top edge of skirting or bottom edge of cover joints and the line of the step nose or the tread surface of the pallets or belt	mm	Figure 6
h_3	Distance between the entry of handrail into the newel and the floor	m	Figures 5, 6
h_4	Free height above any point of step surfaces, pallets or belt over the area between both outer edges of the handrails including the area to the end of the newel and the unrestricted area at all points	m	Figures 5, A.1
h_5	Height of the deflector	m	Figures 5, 7
h_6	Clearance between the upper edge of the tread surface and the root of the comb teeth	mm	Figure 5
h_7	Depth of the grooves	mm	Figure 5
h_8	Mesh depth of the comb into the grooves of the tread	mm	Figure 5
h_9	Vertical distance between floor and lower end of the anti-climbing device	mm	Figure 7
h_{10}	Vertical distance between lower edge of the handrail and upper end of the access restriction device	mm	Figure 7

Table 1 (continued)

Symbol	Designation	Unit	Figures
h_{11}	Height of the anti-slide device	mm	Figure 7
h_{12}	Height of the upper edge of the free space outside the handrail	mm	Figure A.1
h_{13}	Vertical distance between the upper and lower finished floor levels	m	Figure 5
L_1	Root of the comb teeth	—	Figure 5
l_1	Horizontal distance between supports	m	Figure 5
L_2	Comb intersection line	—	Figure 5
l_2	Distance between the furthest point reached by the handrail and the comb intersection line measured parallel to the tread surface	m	Figure 5
l_3	Length of the straight portion of the handrail in the direction of landing measured from the comb intersection line	m	Figure 5
l_4	Distance between the furthest point reached by the handrail and the point of entry into the newel measured parallel to the tread surface	m	Figure 5
l_5	Length of anti-climbing device on the lower outer decking	mm	Figure 7
Q_{SE}	Seismic step load	kg/step	—
v	Nominal speed	m/s	—
x_1	Step height	m	Figure 8
y_1	Step depth	m	Figure 8
z_1	Nominal width for the load carrying area (step, pallet or belt)	m	Figures 6, 8
z_2	Horizontal distance between skirting	m	Figure 6
z_3	Transverse distance between the supporting rollers	mm	Figure 11
α	Angle of inclination of the escalator or moving walk	°(degree)	Figure 5
β	Design angle of the teeth of the comb	°(degree)	Figure 5
γ	Cross-sectional angle of inclination of the lower inner decking	°(degree)	Figure 6
μ	Friction coefficient	—	—
ψ	Load factor (seismic)	—	—

4 List of significant hazards

4.1 General

This clause contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this document, identified by risk assessment as significant for escalators and moving walks and which require action to eliminate or reduce the risk. These significant hazards are based upon ISO 12100:2010.

4.2 Mechanical hazards

Mechanical hazards on escalators and moving walks and in their immediate vicinity can occur because of the design of the machine or access to it.

These include:

- contact with moving machinery parts (e.g. driving unit, handrail drive) normally not accessible to the public (see [5.2.1.1](#), [5.2.1.2](#), [5.2.1.3](#), [5.2.1.5](#), [5.2.1.6](#), [5.2.3](#), [5.2.4](#), [5.8.1](#), [5.12.2.7.17](#), [5.12.3.13](#), [A.3.2](#), [A.3.3](#));
- crushing and shearing of fingers between handrail and balustrade and between balustrades (see [5.5.2.5](#), [5.6.2](#));
- cutting hazard caused by adjacent cover profile parts (see [5.5.2.4](#));
- impact on bodies caused by collision with building structures (wall, roof, criss-cross arrangement), or with persons on adjacent escalators/moving walks (see [A.2.1](#), [A.2.2](#), [A.2.3](#), [A.2.4](#));

- drawing-in at handrail entry into the balustrade (see [5.6.4.3](#), [5.6.5](#));
- trapping between skirting and steps, between comb and step/pallet (see [5.3.4](#), [5.3.5](#), [5.5.3](#), [5.5.5](#), [5.7.2.5](#), [5.7.3](#), [Fig. G.1](#));
- trapping between the floor/fixed devices and the handrail (see [5.6.4.1](#), [5.6.4.2](#), [A.5](#));
- trapping between step and step or pallet and pallet (see [5.3.2](#)).

4.3 Electric hazards

Electric hazardous situations can occur due to:

- contact of persons with live parts (see [5.8.3.3](#), [5.11.1.3](#));
- indirect contact (see [5.11.1.4](#), [A.6](#));
- inadequate emergency stops (see [5.12.3.8](#));
- wrong assembly of electric components (see [5.11.4.4](#));
- electrostatic phenomena (see [5.12.1.5](#));
- external influences on electric equipment (see [5.12.2.4](#), [5.12.2.6.1.3](#)).

4.4 Radiation hazards

4.4.1 Electromagnetic radiation generated by the machine

Electromagnetic radiation can be emitted by the escalator or moving walk during normal operation (see [5.11.1.2.3](#), [5.12.2.4](#)).

4.4.2 Electromagnetic radiation received from outside

Electromagnetic radiation, like low frequency radiation, radio frequency radiation and microwaves, can be received by the escalator or moving walk during normal operation (see [5.11.1.2.3](#), [5.12.2.4](#)).

4.5 Fire hazard

Fire hazards can be generated by accumulation of combustible material inside the truss, by the insulation material for cables and overloading of drives (see [5.2.1.4](#), [5.9](#)).

4.6 Hazards generated by neglecting ergonomic principles in machinery design

Hazardous situation can occur because of:

- neglecting ergonomic dimensions for the users (e.g. height of balustrade, width of handrail) (see [5.5.2.1](#), [5.6.2](#), [5.6.3](#));
- inadequate lighting in the working places and access to them (see [5.8.3.1](#), [5.8.3.2](#), [A.3.3](#), [A.3.4](#));
- insufficient space in working places (see [5.8.2.1](#), [5.8.2.2](#), [5.8.2.3](#), [A.3.5](#), [A.3.6](#), [A.3.7](#));
- missing lifting equipment for heavy loads (see [5.8.2.2](#), [5.10](#)).

4.7 Hazard generated by failure of control circuit

Hazardous situation can occur because of:

- no stopping in case of dangerous situations (see [5.11.2](#), [5.12.1.2](#));

- short circuit of electric wiring (see [5.11.1.4](#), [5.11.1.6](#), [5.11.4](#));
- overload of electric wiring (see [5.12.1.3](#), [5.11.4](#), [5.12.1.2](#), [5.12.3](#));
- unexpected start of machine after an interruption (see [5.12.3](#), [5.12.3.5.1](#));
- unexpected reversal of drive (see [5.4.2.3](#), [5.12.1.2](#));
- excessive speed (see [5.4.2.3](#), [5.12.1.2](#));
- excessive deceleration during stopping (see [5.12.1.2](#)).

4.8 Hazards generated by break-up during operation

Even if the design of an escalator or moving walks follows the requirements of EN 115-1, there are specific hazards which can occur due to

- greater than specified user and structural loads on the truss (see [5.2.5](#));
- loads greater than specified onto the balustrade (see [5.5.2.3](#), [5.5.2.4](#));
- loads greater than specified on the steps/pallets by unforeseeable misuse (see [5.3.3](#));
- loads greater than specified on the drive unit (see [5.4.1.3](#), [5.4.3](#), [5.4.4](#)).

4.9 Slipping, tripping and falling hazards

Most of the dangerous situations on escalators and moving walks are caused by the slipping and falling of persons.

These include:

- slipping on steps/pallets/belt, on the comb plate and floor plate (see [5.3.1](#), [5.5.4](#), [5.7.1](#));
- falling caused by handrail speed deviation (incl. standstill) (see [5.6.1](#), [Figure G.2](#));
- falling caused by change of the direction of movement (see [5.4.2.3](#));
- falling caused by increased acceleration/deceleration (see [5.2.2](#), [5.4.1.1](#), [5.4.1.2](#), [5.4.2.1](#), [5.4.2.2](#), [5.7.2.1](#), [5.7.2.2](#), [5.7.2.3](#), [5.7.2.4](#));
- falling caused by unexpected start/stopping or excessive speed of the machine (see [5.12.3.5.1](#));
- falling caused by inadequate lighting at the landings (see [A.2.8](#), [A.2.9](#)).

4.10 Hazards specific for this type of machine

Many hazards are specific for that type of machine. These include:

- missing steps or pallets (see [5.3.6](#));
- trapping by hand winding device (see [5.4.1.4](#));
- misuse by transporting other items than persons (e.g. shopping or luggage trolleys, push chairs) (see [7.4.1 d](#)), [A.4](#), [Annex I](#));
- climbing on the outside of the balustrade (see [5.5.2.2](#));
- sliding between balustrades (see [5.5.2.2](#));
- climbing over the balustrade (see [5.5.2.6](#));
- surfing on the handrail (see [5.5.2.2](#));

- storage of merchandise adjacent to the balustrade (see [7.4.1 d](#));
- creation of traffic jam at blocked landings or intermediate exits of consecutive escalators or moving walks (see [A.2.5](#), [A.2.6](#));
- disturbance of the person flow in connected escalators/moving walks (see [A.2.5](#), [A.2.6](#));
- lifting by the handrail at the newel ends and falling over adjacent fixed barrier or the balustrade of the escalator/moving walk (see [A.2.7](#)).

NOTE For the actual type of machinery, noise is not considered as a significant nor relevant hazard.

4.11 Significant hazards due to seismic events

- Damage to equipment (see [M.2](#), [M.3](#), [M.5](#));
- Crushing by displacement of equipment (see [M.4](#)).

5 Safety requirements and/or protective measures

5.1 General

Escalators and moving walks shall comply with the safety requirements and/or protective/risk reduction measures of this clause.

In addition, escalators and moving walks shall be designed according to the principles of ISO 12100:2010, 6.2, for relevant but not significant hazards, which are not dealt with by this document.

Certain escalators and moving walks are subject to special operational and environmental conditions. For these cases some additional recommendations are defined (see [H.2](#) and [Annex M](#)).

5.2 Supporting structure (truss) and enclosure

5.2.1 General

5.2.1.1 All mechanically moving parts of the escalator or moving walk shall be completely enclosed within imperforate panels or walls. Exempt from this are the accessible steps, the accessible pallets, the accessible belt and that part of the handrail available for the user. Apertures for ventilation are permitted (see also [5.2.1.5](#)).

5.2.1.2 Any gaps or openings are restricted to 4 mm where there is a risk of contact with moving parts. The exterior panels shall withstand a force of 250 N at any point at right angles on a round or square area of 2 500 mm² without breakage. The fixing shall be designed in that way to carry at least twice the dead load of the enclosure.

5.2.1.3 It is permissible to omit an enclosure of the mechanically moved parts if other measures (such as rooms with locked doors accessible to authorized personnel only) make a hazard to the public impossible.

5.2.1.4 Accumulation of materials (e.g. grease, oil, dust, paper) represents a fire risk. Therefore it shall be possible to clean the inner part of the escalator/moving walk.

5.2.1.5 Ventilation apertures shall be built or arranged in such a way to comply with ISO 13857:2019, Table 5. However, it shall not be possible to pass a straight rigid rod 10 mm in diameter through the enclosure and to touch any moving part through a ventilation aperture.

5.2.1.6 Any exterior panels which are designed to be opened (e.g. for cleaning purposes) shall be provided with a safety device according to [5.12.2.7.14](#).

5.2.2 Angle of inclination

The angle of inclination α of the escalator shall not exceed 30°, but for rises h_{13} not exceeding 6 m and a nominal speed not exceeding 0,50 m/s the angle of inclination is permitted to be increased up to 35° (see α in [Figure 5](#)).

The angle of inclination of moving walks shall not exceed 12°.

5.2.3 Access to the interior

Machinery spaces inside the truss shall only be accessible to authorized persons (e.g. by key, access control).

5.2.4 Inspection covers

Inspection covers shall be provided with a safety device according to [5.12.2.7.14](#).

It shall only be possible to open inspection covers by a key or a tool suited for that purpose. Parts of the balustrade (e.g. deckings, panels) which are required to be removed for maintenance purposes shall not be considered to be inspection covers.

If the inspection cover consists of more than one part, one safety device shall be provided on the one to be opened first. For the consecutive ones either removal shall be prevented, e.g. by mechanical interlocking, overlapping or each single part shall be provided with a safety device.

If rooms behind inspection covers can be entered, it shall be possible to open them from the inside without a key or a tool even when locked.

Inspection covers shall be imperforate. Inspection covers shall conform to the same conditions as required for the location (e.g. the balustrade, the cladding, the floor plate) where they are installed.

NOTE Floor plates can have the functionality of an inspection cover. In this case the same conditions for inspection covers apply.

5.2.5 Structural design

The supporting structure shall be designed in a way that it can support the dead weight of the escalator or moving walk plus a structural rated load of 5 000 N/m². It shall be calculated in accordance with EN 1993-1-1:2005.

NOTE Load carrying area = (nominal width z_1 (see [Figure 6](#)) of the escalator or moving walk) x (distance l_1 between the supports) (see [Figure 5](#)).

Based on the structural rated load, the maximum calculated or measured deflection shall not exceed 1/750 of the distance l_1 between the supports.

Based on the structural rated load for the comb plate and floor plate the maximum deflection shall not exceed 4 mm and the meshing of the combs shall be ensured.

5.3 Steps, pallets, belt

5.3.1 General

In the user carrying area of the escalator, the step treads shall be horizontal with a tolerance of $\pm 1^\circ$ in the direction of travel.

NOTE 1 The maximum permissible height between two consecutive steps at the landings is defined in [5.3.4](#) and [5.7.2.1](#).

Tread surfaces for escalators and moving walks shall provide a secure foothold.

NOTE 2 For definition of materials and test methods, see [Annex J](#).

5.3.2 Dimensions

5.3.2.1 General

For escalators and moving walks the nominal width z_1 shall be not less than 0,58 m and not exceed 1,10 m. For moving walks with an angle of inclination up to 6° widths up to 1,65 m are permitted.

5.3.2.2 Step treads and pallets (see [Figure 5](#), detail X and [Figure 8](#))

5.3.2.2.1 The step height x_1 shall not exceed 0,24 m.

5.3.2.2.2 The step depth y_1 shall be not less than 0,38 m.

5.3.2.2.3 The surface of the step treads and pallets shall have grooves in the direction of movement with which the teeth of the combs mesh.

5.3.2.2.4 The step risers shall be cleated, and the surface of the cleat shall be smooth. The ends of the step tread shall mesh with the cleating of the next step riser.

5.3.2.2.5 The width b_7 of the grooves shall be at least 5 mm and not exceed 7 mm.

5.3.2.2.6 The depth h_7 of the grooves shall be not less than 10 mm.

5.3.2.2.7 The web width b_8 shall be at least 2,5 mm and not exceed 5 mm.

5.3.2.2.8 The step treads and step risers or pallets shall not finish with a groove at their side edges.

5.3.2.2.9 The edge between the surface of the step tread and the riser shall have any sharpness relieved.

5.3.2.3 Belts (see [Figure 5](#), detail X)

5.3.2.3.1 The belts shall have grooves in the direction of travel with which the teeth of the comb mesh.

5.3.2.3.2 The width b_7 of the grooves shall be at least 4,5 mm and not exceed 7 mm and shall be measured at the tread surface of the belt.

5.3.2.3.3 The depth h_7 of the grooves shall be not less than 5 mm.

5.3.2.3.4 The web width b_8 shall be at least 4,5 mm and not exceed 8 mm and shall be measured at the tread surface of the belt.

5.3.2.3.5 The belt shall not finish with a groove at the side edge of the belt.

Splicing of the treadway belt shall be such as to provide a continuous unbroken treadway surface.

5.3.3 Structural design

5.3.3.1 General

The materials shall retain their strength characteristics during their specified life cycle taking into account the environmental conditions, e.g. temperature, ultraviolet radiation, humidity, corrosion.

The steps, pallets and the belt shall be designed to withstand all possible loading and distortion effects, which may be imposed by the tracking, guiding and driving system during normal operation and shall be designed to support an equally distributed load corresponding to 6 000 N/m².

NOTE 6 000 N/ m² is derived from a structural rated load of 5 000 N/m² (see [5.2.5](#)) plus an impact factor of 1,2.

To establish the dimensions of the belt and its supporting system, an area of effective width x 1,0 m length shall be taken as a basis for this corresponding load (in addition the requirements of [5.3.3.2.4](#) shall be complied with).

Assembled steps and pallets shall be designed such that all component parts e.g. inserts are securely attached and do not become loose during their life cycle. The inserts and fixings shall withstand the reaction force of operating the comb/comb plate safety device ([5.12.2.7.7](#)).

5.3.3.2 Static test

5.3.3.2.1 Steps

The step shall be tested for deflection with a single force of 3 000 N (including weight of the plate) applied perpendicular to the tread surface on a steel plate 0,20 m x 0,30 m in size and at least 25 mm thick, in the centre of the tread surface. The edge of the plate being 0,20 m long shall be arranged parallel to the front edge of the step, the edge of the plate being 0,30 m long at right angles to the front edge of the step.

During this test, the deflection measured at the tread surface shall be not more than 4 mm. There shall be no permanent deformation (initial setting tolerances are permitted).

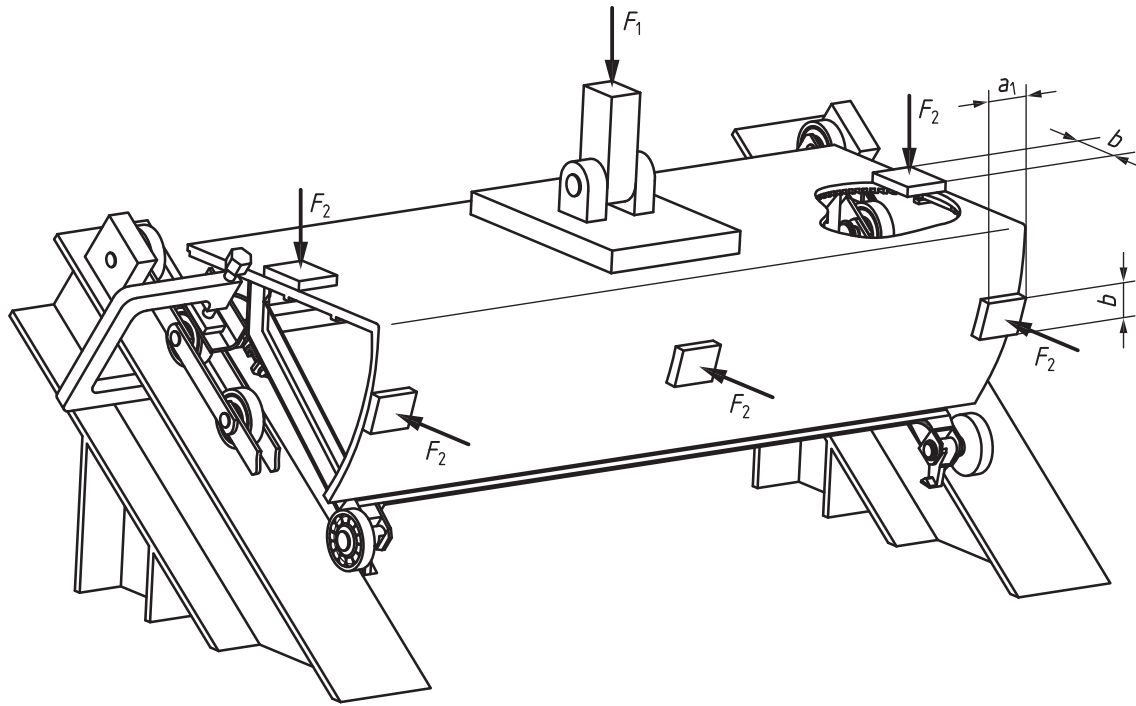
The step shall be tested as a whole together with rollers (not rotating), axles or stub shafts (if existing) in a horizontal position (horizontal support) and at the maximum inclination (inclined support) for which the step shall be applied.

For all inclinations smaller than the maximum inclination permitted, a new test is not required. A test of the installed step, i.e. together with the guide rails and the supporting structure of the escalator, is also not necessary.

The tread surface on the side of the skirting shall not deflect in any position by more than 4 mm, when subjected to a single load of 1 500 N applied perpendicular to the tread surface at the beginning, on an area of 2 500 mm², using a square steel plate, minimum thickness 25 mm. See [Figure 1](#). In case of inserts/fixings on the tread surface the load shall be applied only on the insert/fixings itself, when assembled to the step. The area of the load shall be 50 mm by the width of the insert/fixings. See [Figure 2](#). The applied force should be fixed vertically. The direction of the applied force shall not change during the test. There shall be no permanent deformation.

5.3.3.2.2 Step riser

The riser shall not deflect by more than 4 mm, when subjected to a single load of 1 500 N applied perpendicular to the surface at the beginning, on an area of 2 500 mm², using a square or round steel plate, minimum thickness 25 mm, shaped to fit the risers curvature. This load shall be applied in the middle of the full height of the step riser in three positions across its width in the middle and at both ends of a fully assembled step. The applied force should be fixed and the direction of the applied force shall not change during the test. The step shall be tested in a fixed position with axles or stub shafts (if existing). There shall be no permanent deformation (initial setting tolerances are permitted).

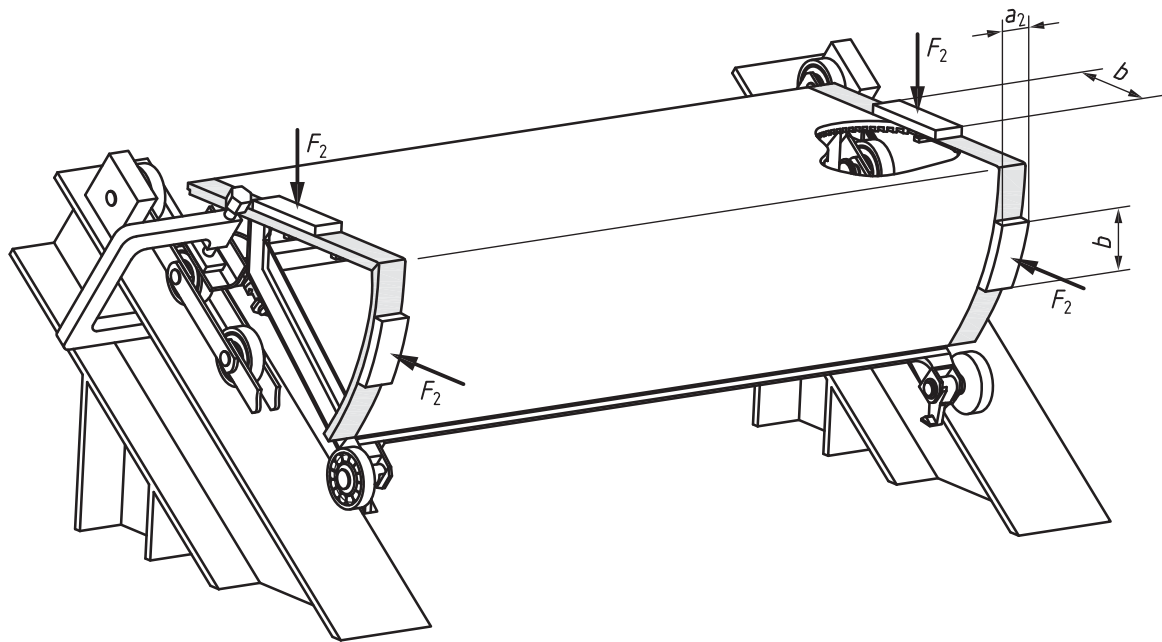


Key

F_1	3 000 N
F_2	1 500 N
a_1	50 mm
b	50 mm

Figure 1 — Step test

In case of inserts/fixings on a step riser an additional test shall be undertaken on a fully assembled step with a load applied on the riser insert/fixings, in the middle of the full height of the step riser, to an area of 50 mm by the width of the insert/fixings.

**Key** F_1 3 000 N F_2 1 500 N a_2 width of the inserts/fixings b 50 mm**Figure 2 — Step test with inserts/fixings****5.3.3.2.3 Pallets**

The pallet shall be tested for deflection with a single force which, for a pallet area of 1 m², shall be 7 500 N (including weight of the plate). The force shall be applied perpendicular to the tread surface on a steel plate 0,30 m x 0,45 m in size and at least 25 mm thick, in the centre of the tread surface, and the edge of the plate being 0,45 m long shall be arranged parallel to the lateral edge of the pallet.

For pallets with smaller or larger areas, the force and the loading area shall be changed proportionally, whereby for the loading area the ratio of edge length shall be 1:1,5; however, the force shall not be below 3 000 N (including weight of the plate), the size of the plate not smaller than 0,20 m x 0,30 m and its thickness not less than 25 mm.

For pallets with a depth smaller than 0,30 m the plate width shall be 0,20 m and the length of the plate shall be the depth of the pallet.

During this test the deflection measured at the tread surface shall be not more than 4 mm. There shall be no permanent deformation (initial setting tolerances are permitted).

The pallet shall be tested as a whole together with rollers (not rotating), axles or stub shafts (if existing) in a horizontal position. A test of the installed pallet, i.e. together with the guide rails and the supporting structure of the moving walk, is not required.

5.3.3.2.4 Belts

With the belt tensioned to suit operational conditions, a single force of 750 N (including weight of the plate) shall be applied on a steel plate 0,15 m x 0,25 m x 0,025 m in size. The plate shall be placed centrally between the edge supporting rollers in such a way that its longitudinal axis is parallel to the longitudinal axis of the belt. The deflection at the centre shall not exceed 0,01 z_3 where z_3 is the transverse distance between the supporting rollers (see z_3 in [Figure 11](#)).

5.3.3.3 Dynamic tests

5.3.3.3.1 Steps

5.3.3.3.1.1 Load test

The step shall be tested at the maximum inclination (inclined support) for which it shall be applied, together with rollers (not rotating), axles or stub shafts (if existing). It shall be subjected to a load pulsating between 500 N and 3 000 N at one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved. The load shall be applied perpendicular to the tread surface on a steel plate 0,20 m x 0,30 m in size and at least 25 mm thick, arranged as specified in [5.3.3.2.1](#), in the centre of the tread surface.

After the test the step shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Steps or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

If rollers are damaged during the test, it is permissible to replace them.

5.3.3.3.1.2 Torsional test

The step design shall be such that the structure can accommodate torsional loading equivalent to a ± 2 mm displacement of the trailer wheel centre, moving in an arc whose centre is the chain wheel centre. The ± 2 mm displacement is a relative to a trailer wheel to chain wheel centre distance of 400 mm. This ratio shall be maintained, when the 400 mm dimension is varied (see [Annex F](#) for test examples).

The dynamic test shall be adjustable to ensure that the specified deflections above are achieved throughout the test. It shall be applied with one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved.

After the test the step shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Steps or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

5.3.3.3.2 Pallets

5.3.3.3.2.1 Load test

The pallet, irrespective of its size, shall be tested in a horizontal position together with rollers (not rotating), axles or stub shafts (if existing). It shall be subjected to a load pulsating between 500 N and 3 000 N at one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved. It shall be applied perpendicular to the tread surface on a steel plate 0,20 m x 0,30 m in size and at least 25 mm thick, in the centre of the tread surface.

For pallets with a smaller length than 0,30 m the plate width shall be 0,20 m and the length of the plate shall be the length of the pallet.

After the test, the pallet shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Pallets or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

If rollers are damaged during the test, it is permissible to replace them.

5.3.3.3.2.2 Torsional test

A torsional test is only required if the pallets are fitted with trailer rollers.

The pallet design shall be such that the structure can accommodate torsional loading equivalent to a ± 2 mm displacement of the trailer wheel centre, moving in an arc whose centre is the chain wheel centre. The ± 2 mm displacement is related to a trailer wheel to chain wheel centre distance of 400 mm. This ratio shall be maintained, when the 400 mm dimension is varied (see [Annex F](#) for test examples).

The dynamic load shall be adjusted to achieve a deflection with a tolerance of - 5 % during the test. It shall be applied with one frequency between 5 Hz and 20 Hz for at least 5×10^6 cycles whereby an undisturbed sinusoidal force flow shall be achieved.

For pallets with a smaller length than 0,30 m, the plate width shall be 0,20 m and the length of the plate shall be the length of the pallet.

After the test, the pallet shall show no indication of crack initiation.

Permanent deformation shall not be greater than 4 mm, measured at the tread surface. Pallets or their component parts, e.g. inserts or fixings, shall be securely attached and not become loose.

5.3.4 Guiding of steps, pallets and belt

The lateral displacement of the steps or pallets out of their guiding system shall not exceed 4 mm at either side and 7 mm for the sum of clearances measured at both sides and the vertical displacement shall not exceed 4 mm for steps and pallets and 6 mm for belts.

This requirement applies only to the usable area of the steps, pallets or belt.

Treadway supports for belts shall be provided at intervals not exceeding 2 m along the centre line of the treadway. These supports shall be located at a level not more than 50 mm below the underside of the treadway when it is loaded under the conditions required by [5.3.3.2.4](#).

5.3.5 Clearance between steps or pallets

The clearance between two consecutive steps or pallets in any usable position measured at the tread surface shall not exceed 6 mm (see [Figure 5](#), details Y, Z, [Figure 9](#), detail S and [Figure 10](#), detail U). For steps the measurement shall be carried out as the dimensions of the gaps are indicated in [Figure 5](#). For pallets the measurements shall be done according to [Figures 9](#) and [10](#).

Demarcation (e.g. groove in the step tread) shall be provided to highlight at the landings the rear edge of the steps.

In the area of the transition curves of moving walks with meshed front edges and rear edges of the pallets, this clearance is permitted to be increased to 8 mm (see [Figure 10](#), detail V).

5.3.6 Missing step or pallet device

The operation of the escalator/moving walk is only permitted with a complete step/pallet band. Missing step/pallet shall be detected by a safety device or function in accordance with [5.12.2.7.11](#).

5.4 Drive unit

5.4.1 Driving machine

5.4.1.1 General

A drive unit shall not operate more than one escalator or moving walk.

5.4.1.2 Speed

5.4.1.2.1 The speed of an unloaded escalator shall not deviate by more than ± 5 % from the nominal speed at nominal frequency and nominal voltage.

5.4.1.2.2 The nominal speed of the escalator shall not exceed:

- 0,75 m/s for an escalator with an angle of inclination α up to 30°;
- 0,50 m/s for an escalator with an angle of inclination α of more than 30° up to 35°.

5.4.1.2.3 The nominal speed of moving walks shall be not higher than 0,75 m/s.

Deviating from the above a nominal speed up to 0,90 m/s is permitted provided the width of the pallets or the belt does not exceed 1,10 m, and at the landings, the pallets or the belt move horizontally for a length of at least 1,60 m before entering the combs.

The before mentioned requirements do not apply to moving walks with acceleration paths or moving walk systems with direct transition to moving walks travelling at different speeds.

5.4.1.3 Link between operational brake and step, pallet or belt drive

5.4.1.3.1 For the link between the operational brake and the step, pallet or belt drive, preferably non-friction driving elements should be used such as shafts, gear wheels, multiplex chains, two or more single chains. Where friction elements are used such as trapezoidal belts (flat belts are not permitted) an auxiliary brake in accordance with [5.4.2.2](#) shall be used.

5.4.1.3.2 The design of all driving elements shall be of nominal infinite fatigue life.

Safety factors of all driving elements shall be at least 5 for static calculations. In the case of trapezoidal belts, at least 3 belts shall be applied.

This safety factor is determined as the ratio between the breaking force of the driving element and the static force to which the driving element is subjected when the escalator or inclined moving walk carries the structural rated load according to [5.2.5](#) together with the tension force of the tensioning device.

For horizontal moving walks the dynamic forces according to [5.4.2.1.3.3](#) respectfully [5.4.2.1.3.4](#) together with the tension force of the tensioning device shall be used to determine the safety factor.

NOTE Driving elements are the parts which are moving and hence dynamically loaded, e.g. shaft, gear wheels, multiplex chains. The fixation of these parts in the truss has to be done according to the specific requirements of these components (e.g. Eurocode for the truss, welding and screws according to the relevant standards).

5.4.1.4 Hand winding device

If a hand winding device is provided it shall be easily accessible and safe to operate (see [7.2.1.3](#) and [7.4.1 g](#)) for instructions).

If the hand winding device is removable a safety device or function according to [5.12.2.7.16](#) shall be provided.

Crank handles or perforate hand wheels are not permitted.

5.4.2 Braking system

5.4.2.1 Operational brake

5.4.2.1.1 General

5.4.2.1.1.1 Escalators and moving walks shall have an operational braking system by which they:

- a) can be brought to rest with an uniform deceleration;
- b) can be maintained stationary.

See also [5.12.3.5](#).

5.4.2.1.1.2 Operational braking by electro-mechanical brake.

For operational braking by electro-mechanical brake the requirements of [5.4.2.1.2](#) apply.

5.4.2.1.1.3 Operational braking by electrical braking.

For electrical braking (e.g. electrical braking with inverter) the requirements according [5.4.2.1.1](#) a) shall be fulfilled.

An electro-mechanical brake according to [5.4.2.1.2](#) is required and also to be initiated under the conditions of [5.12.3.5.2](#)

5.4.2.1.1.4 Operational braking by other means.

Where the operational brake is effected by other means an auxiliary brake in accordance with [5.4.2.2](#) shall be provided.

5.4.2.1.1.5 Brakes that can be released by hand shall require continuous application of manual pressure to keep them open.

5.4.2.1.2 Electro-mechanical brake

The normal lifting of the electro-mechanical brake shall be by a continuous flow of electric current. The braking operation shall be effective immediately after the electric brake circuit is opened.

The brake force shall be generated by guided compression spring(s). Electrically generated self-excitation of the brake releasing device shall be impossible.

5.4.2.1.3 Brake load and stopping distances for operational brake

5.4.2.1.3.1 Determination of the brake load for escalators

[Table 2](#) shall be applied for the determination of the brake load for escalators.

Table 2 — Determination of brake load for escalators

Nominal width z_1	Brake load per step
up to 0,60 m	60 kg
more than 0,60 m up to 0,80 m	90 kg
more than 0,80 m up to 1,10 m	120 kg

The number of steps to be considered is determined by “rise h_{13} divided by maximum visible height of the step riser” (see x_1 in [Figure 8](#)).

For the purpose of a test, the total brake load is permitted to be distributed over two-thirds of the number of steps thus obtained.

5.4.2.1.3.2 Stopping distances for the escalator

The stopping distances for unloaded upwards, unloaded downwards and loaded downward moving escalators (see [5.4.2.1.3.1](#)) shall be as given in [Table 3](#).

Table 3 — Stopping distances for escalators

Nominal speed v	Stopping distance between
0,50 m/s	0,20 m and 1,00 m
0,65 m/s	0,30 m and 1,30 m
0,75 m/s	0,40 m and 1,50 m

For intermediate nominal speeds the stopping distances shall be interpolated.

The stopping distances shall be measured from the time the electric stopping device is actuated.

The deceleration, measured on a downward moving escalator, in the direction of travel shall not exceed 1 m/s^2 during the operation of the braking system. For measuring purposes, the raw deceleration signal shall be band-limited using a 4,0 Hz low-pass two-pole Butterworth filter.

It is recommended to achieve the shortest possible stopping distance within the given deceleration limit.

5.4.2.1.3.3 Determination of the brake load for moving walks

[Table 4](#) shall be applied for the determination of the brake load for moving walks.

Table 4 — Determination of brake load for moving walks

Nominal width z_1	Brake load per 0,4 m length
up to 0,60 m	50 kg
more than 0,60 m up to 0,80 m	75 kg
more than 0,80 m up to 1,10 m	100 kg
more than 1,10 m up to 1,40 m	125 kg
more than 1,40 m up to 1,65 m	150 kg

To determine the brake load for moving walks which in their length overcome several inclinations (differences in level), only the downward moving sections shall be considered.

5.4.2.1.3.4 Stopping distances for moving walks

The stopping distances for unloaded upwards, unloaded downwards and loaded downward moving inclined moving walks (see [5.4.2.1.3.3](#)) shall be as given in [Table 5](#). This applies also for unloaded and loaded horizontal moving walks in both directions.

Table 5 — Stopping distances for moving walks

Nominal speed, v	Stopping distance between
0,50 m/s	0,20 m and 1,00 m
0,65 m/s	0,30 m and 1,30 m
0,75 m/s	0,40 m and 1,50 m
0,90 m/s	0,55 m and 1,70 m

For intermediate nominal speeds the stopping distances shall be interpolated.

The stopping distances shall be measured from the time the electric device for stopping is actuated.

The deceleration, measured on a downward moving or horizontal moving walk, in the direction of travel shall not exceed 1 m/s^2 during the operation of the braking system. For measuring purposes, the raw deceleration signal shall be band-limited using a 4,0 Hz low-pass two-pole Butterworth filter.

It is recommended to achieve the shortest possible stopping distance within the given deceleration limit. For moving walks a brake test under no load will be sufficient.

For loaded moving walks, the manufacturer shall prove the stopping distances by calculation [see [6.2 c](#)].

5.4.2.2 Auxiliary brake

5.4.2.2.1 Escalators and inclined moving walks shall be equipped with auxiliary brake(s) if:

- a) the connection between the operational brake (see [5.4.2.1](#)) and the driving sprockets of the steps/ pallets or the drum of the belt is not accomplished by shafts, gear wheels, multiplex chains, or more than one single chain, or
- b) the operational brake has not an electro-mechanical brake according to [5.4.2.1.2](#), or
- c) the rise h_{13} exceeds 6 m (see also [H.2](#)).

The connection between the auxiliary brake and the driving sprockets of the steps/ pallets or the drum of the belt shall be accomplished by shafts, gear wheels, multiplex chains or more than one single chain. It is not permissible for the connection to comprise friction drives, i.e. clutches.

5.4.2.2.2 The auxiliary braking system shall be dimensioned in such a way that escalators and moving walks travelling with brake load downward are brought to rest by effective retardation and maintained stationary.

The deceleration of 1 m/s^2 downward shall not be exceeded under all operating conditions. For measuring purposes, the raw deceleration signal shall be band-limited using a 4,0 Hz low-pass two-pole Butterworth filter.

Upon operation of auxiliary brakes it is not necessary to keep the stopping distances defined for the operational brake (see [5.4.2.1.3](#)).

5.4.2.2.3 Auxiliary brakes shall be of the mechanical (friction) type.

5.4.2.2.4 Auxiliary brakes shall stop according to [5.12.3.5.3](#).

The activation of the auxiliary brake shall be detected by electrical safety device or function according to [5.12.2.7.4](#).

5.4.2.2.5 Auxiliary brake(s) are permitted to operate together with the operational brake when in case of power failure or of an interruption of a safety circuit the stopping conditions according to [5.4.2.1.3.2](#) and [5.4.2.1.3.4](#) are kept; otherwise a simultaneous operation of the auxiliary and the operational braking system is only permitted under the conditions of [5.4.2.2.4](#).

5.4.2.3 Protection against risks of excessive speed and unintentional reversal of the direction of travel

A safety device or function according to [5.12.2.7.2](#) and [5.12.2.7.3](#) shall be provided.

5.4.3 Steps and pallets drive

5.4.3.1 The steps of escalators shall be driven by at least two chains of which at least one shall be located on each side of the step.

The pallets of moving walks are permitted to be driven by only one chain if the parallel movement of the pallets in the usable area is ensured by other mechanical measures.

A safety device or function according to [5.12.2.7.5](#) shall be provided to detect breakage or undue elongation of the step/pallet chains.

5.4.3.2 The step/pallet chain design shall be of nominal infinite fatigue life.

The safety factor against breaking of each chain shall be at least 5 (see [5.4.1.3.2](#)) with respect to structural steel according to EN 10025-1:2004 in combination with EN 10025-2:2004, EN 10025-3:2004, EN 10025-4:2004, EN 10025-5:2004 and EN 10025-6:2004+A1:2009 and with respect to quenched and tempered steel according to EN 10083-1:2006 in combination with EN 10083-2:2006 and EN 10083-3:2006. The chain shall be subject to a tensile test.

When more than one chain is used it is assumed that the load is equally distributed over the chains.

5.4.3.3 The chains shall be tensioned continuously. A safety device or function according to [5.12.2.7.6](#) shall be provided to detect movement of the tensioning device. Springs working in tension are not permitted for the tensioning device. When weights are used for tensioning they shall be safely retained should their suspension break.

5.4.4 Belt drive

5.4.4.1 The factor of safety of the belt including splicing shall be at least 5 (see [5.4.1.3.2](#)) for the dynamic forces according to [5.4.2.1.3.3](#) respectively [5.4.2.1.3.4](#). The calculation shall be carried out for the worst case.

5.4.4.2 The belt shall be driven by drums and be tensioned continuously and automatically. A safety device or function according to [5.12.2.7.6](#) shall be provided to detect movement of the tensioning device. Springs working in tension are not permitted for the tensioning device. When weights are used for tensioning they shall be safely retained should their suspension break.

5.5 Balustrade

5.5.1 General

Balustrades shall be installed on each side of the escalator or moving walk.

5.5.2 Dimensions of balustrade

5.5.2.1 In the inclined section the vertical height h_1 from step nose or pallet surface or belt surface to top of the handrail shall be not less than 0,90 m and not exceed 1,10 m (see [Figures 5](#) and [6](#)).

5.5.2.2 The balustrades shall have no parts on which a person would normally stand.

Appropriate measures shall be taken to discourage people from climbing on the outsides of the balustrade if there is a danger of people falling from them.

To ensure this, on escalators and moving walks devices (see 1 in [Figure 7](#)) shall be provided on the lower outer decking at a point $(1\ 000 \pm 50)$ mm above the floor level (see h_9 in [Figure 7](#)) where the bottom of the device intersects with the balustrade decking and shall extend to a length l_5 of at least 1 000 mm parallel with the balustrade decking where no stepping is possible. The device shall extend to at least a height in line with the top of the handrail not conflicting with the requirements of b_{10} and b_{12} .

Where escalators or moving walks are located adjacent to walls, devices (see 2 in [Figure 7](#)) to restrict access to the balustrade decking shall be provided at the top and bottom ends of these walls when the lower outer decking width b_{13} exceeds 125 mm. On adjacent parallel arrangements, this protection shall be provided when the combined balustrade decking width b_{14} exceeds 125 mm. The device shall extend to the height h_{10} .

All exposed fastener heads for the devices shall be of the vandal resistant type.

Where handrail level balustrade decking are provided between escalators/inclined moving walks and adjacent walls, anti-slide devices (see 3 in [Figure 7](#)) shall be provided on the balustrade decking when the distance b_{15} between the structure of the building (wall) and the centreline of the handrail is greater than 300 mm. These devices shall consist of objects fastened to the balustrade decking, no closer than 100 mm

to the handrail (see b_{17}) and spaced no greater than 1 800 mm apart. The height h_{11} shall be not less than 20 mm. The devices shall have no sharp corners or edges.

The above mentioned also applies to adjacent escalators/inclined moving walks when the distance b_{16} between the centrelines of the handrails is greater than 400 mm.

5.5.2.3 Balustrades shall be designed to resist the simultaneous application of a static lateral force of 600 N and a vertical force of 730 N, both equally distributed over a length of 1 m and acting on the top of the handrail guiding system in the same place.

5.5.2.4 The parts of the balustrade facing the steps, pallets or belt shall be smooth and flush. Covers not in the direction of travel shall not project more than 3 mm. They shall be rigid and have rounded or bevelled edges. Covers of such nature are not permitted at the skirting.

Cover joints in the direction of travel (in particular between the skirting and the interior panel) shall be arranged and formed in such a manner as to eliminate any risk of harm caused by trapping.

Gaps between the interior panels of the balustrade shall be not wider than 4 mm. The edges shall be rounded off or bevelled.

When a force of 500 N is applied to the interior panel at any point of the panelling at right angles to the surface over a square or round area of 2 500 mm², there shall be no gap greater than 4 mm and no permanent deformation.

If glass is used for the interior panel it shall be toughened glass. The minimum thickness of 6 mm shall apply to single layer balustrades. When multi-layer glass balustrades are used, they shall be laminated toughened glass, the thickness of at least one layer shall also be not less than 6 mm.

5.5.2.5 The horizontal distance (measured at right angles to the direction of travel) between the interior panel at lower points shall be equal to or less than the horizontal distance measured at points higher up.

5.5.2.6 The lower inner decking and the interior panel shall have an angle of inclination γ of at least 25° to the horizontal (see [Figure 6](#)). This does not apply to the horizontal part of the lower inner decking that directly joins the interior panel (see b_4 in [Figure 6](#)).

5.5.2.6.1 The horizontal part b_4 up to the interior panel shall be less than 30 mm.

5.5.2.6.2 The width b_3 , measured horizontally, of each lower inner decking inclined at an angle of less than 45° to the horizontal shall be less than 0,12 m (see [Figure 6](#)).

5.5.3 Skirting

5.5.3.1 The skirting shall be vertical, plain, and butt-jointed

NOTE However, special arrangements instead of butt-jointing (e.g. sliding joints) will possibly be necessary for long moving walks at the points where they pass over building expansion joints.

5.5.3.2 The perpendicular (i.e. 90°) distance h_2 between top edge of skirting or bottom edge of projecting cover joints or the lower edge of the rigid part of skirt deflectors and the line of the step nose or the tread surface of the pallets or belt shall be not less than 25 mm (see [Figure 6](#)).

5.5.3.3 The skirting including lighting and other devices shall yield not more than 4 mm under a single force of 1 500 N acting at the most unfavourable point at right angles to the surface over a square or round area of 2 500 mm². No permanent deformation shall result from this. This shall be met up to a height of 25 mm above the line of the step nose or the tread surface of the pallets or belt. Above the height of 25 mm the force requirements of the balustrade of 500 N (see [5.5.2.4](#)) shall be fulfilled. See [Figure 5](#) detail R.

5.5.3.4 On escalators, the possibility of trapping between skirting and steps shall be minimized.

For this purpose, the following four conditions shall be fulfilled:

- a) sufficient rigidity of the skirting according to [5.5.3.3](#);
- b) clearances to be in accordance with [5.5.5.1](#);
- c) installation of skirt deflectors which fulfil the following requirements:
 - They shall consist of a rigid and a flexible part (e.g. brushes, rubber profiles).
 - They shall have a minimum projection of 33 mm and a maximum of 50 mm from the vertical face of the skirt panels.
 - They shall withstand a force of 900 N uniformly distributed on the projected area of the rigid part over a rectangular area of 600 mm² vertically to the line of attachment of the rigid part without detachment or permanent deformation.
 - The rigid parts shall have a horizontal projection of between 18 mm and 25 mm and withstand the defined strength requirements. The horizontal projection of the flexible part shall have a minimum of 15 mm and a maximum of 30 mm.
 - A distance of between 25 mm and 30 mm shall be provided between the lowest part of the underside of the rigid part and perpendicular to the line of the step nose, throughout the inclined portion of travel.
 - The distance between the lowest part of the underside of the rigid part of the skirt deflector and the top of any step cleat in the transition and horizontal areas shall be between 25 mm and 55 mm.
 - The lower surface of the rigid part shall be bevelled not less than 25° upward and the upper surface shall be bevelled not less than 25° downward from skirt panel.
 - Deviating from [Figure 3 a\)](#), it is permitted to provide a flat surface perpendicular to the skirt with a width ≤ 5 mm that is followed by an increasing downward (on the top)/upward (on the bottom) convex slope. The shape shall reach an inclination of 25° at least in half of the horizontal projection of the rigid part ([Figure 3 b\)](#)).
 - If there is a flat surface perpendicular to the skirt followed by straight slope (≥25°) on the top a width ≤ 10 mm and on the bottom a width ≤ 5 mm is permitted ([Figure 3 c\)](#)).
 - The deflectors shall be designed with rounded edges. Fastening heads and joint connections shall not extend into the path of travel.
 - The terminal end piece shall be tapered to give a flush interface with the skirting. The terminal end piece of any deflector device shall end not less than 50 mm and maximum 150 mm prior to the comb intersection line.
 - If the skirt deflector is an extension of the lower inner decking, [5.5.2.6.2](#) applies. If the skirt deflector is attached or an integral part of the skirting, [5.5.3.1](#) applies.
- d) use of suitable materials or suitable type of lining underneath the deflector device in order to achieve a coefficient of friction for rubber with a testing lubricant less than 0,45. This rubber is defined as SBR-rubber consisting of SBR caoutchouc, mineral fillings, processing additives, crosslinking agents with a density of (1,23 ± 0,2) g/cm³, and a Shore D-hardness 50 ± 3 according to ISO 868:2003. Testing lubricant is defined as a solution composed of sodium dodecyl sulfate (purity ≥ 99 %) de-ionized or distilled water (for information on test methods, see [Annex K](#)).