INTERNATIONAL STANDARD

ISO 17842-1

Second edition
2023-09

Safety of amusement rides and amusement devices —

Part 1: Design and manufacture

Sécurité des manèges et des dispositifs de divertissement —

Partie 1: Conception et fabrication

Reference number
ISO 17842-1:2023(E)

© ISO 2023



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2023 – All rights reserved

Contents

Page

Foreword ... **vi**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **4**

4 Requirements for design analysis and examination ... **9**

4.1 Design documents ... 9
4.1.1 General ... 9
4.1.2 Design risk assessment ... 9
4.1.3 Description of design and operation of an amusement device ... 9
4.1.4 Design and manufacturing drawings ... 9
4.1.5 Principles of analysis ... 10
4.2 Selection of materials ... 11
4.2.1 General ... 11
4.2.2 Recommended steels ... 11
4.2.3 Aluminium alloys ... 11
4.2.4 Timber ... 11
4.2.5 Plastic composites ... 12
4.2.6 Concrete ... 12
4.2.7 Fasteners for structural components ... 12
4.2.8 Standards relating to ropes, chains, safety devices, connectors and adapters ... 12
4.3 Design loads ... 13
4.3.1 General ... 13
4.3.2 Permanent actions ... 13
4.3.3 Variable actions ... 14
4.3.4 Seismic forces ... 18
4.3.5 Applicable coefficients ... 18
4.3.6 Load combinations ... 19
4.3.7 Fatigue combinations ... 20
4.4 Structural analysis — Principles ... 20
4.4.1 General ... 20
4.4.2 Analysis principles for various types of devices ... 21
4.4.3 Other railways with track-bound vehicles ... 26
4.4.4 Conventional railways ... 26
4.4.5 Suspended railways (or coasters) ... 26
4.5 Verification of stability ... 27
4.5.1 General ... 27
4.5.2 Overturning ... 27
4.5.3 Sliding ... 27
4.5.4 Lifting ... 28
4.6 Ground anchorages ... 29
4.6.1 General ... 29
4.6.2 Design load bearing capacity of weight anchors ... 29
4.6.3 Design load bearing capacity of rod anchors ... 29
4.6.4 Testing of anchors (numbering) ... 31
4.6.5 Calculation of loads on anchors ... 31
4.6.6 Further requirements ... 32
4.6.7 Ground support for packing ... 32
4.7 Verification of strength ... 33
4.7.1 General ... 33
4.7.2 Predominantly static stress ... 34
4.7.3 Fluctuating stress ... 34
4.7.4 Bolts ... 36
4.7.5 Ropes, chains, safety devices, connectors and adapters ... 38

© ISO 2023 – All rights reserved

4.8 Structural design and construction ... 40
4.8.1 Arrangement, accessibility ... 40
4.8.2 Locking and safety devices for fasteners ... 40
4.8.3 Joints intended for regular dismantling ... 41
4.8.4 Designing of components subject to fluctuating loads ... 41
4.8.5 Supports ... 41
4.8.6 Central masts ... 41
4.8.7 Prevention of corrosion and rot ... 41

5 Requirements for design and manufacture of rides and structures ... 42
5.1 Risk reduction by prevailing design and safety measures ... 42
5.1.1 General ... 42
5.1.2 Risk assessment ... 42
5.1.3 Risk reduction for platforms, ramps, floors, stairs and walkways ... 43
5.1.4 Risk reduction using barriers, fencing and guarding ... 47
5.1.5 Guarding of machinery parts ... 51
5.1.6 Risk reduction in the case of access and egress ... 51
5.1.7 Risk reduction for passenger units ... 53
5.1.8 Requirements for special provisions ... 64
5.2 Supplementary safety requirements for various types of amusement devices ... 65
5.2.1 Amusement rides with horizontal and/or vertical axis ... 65
5.2.2 Amusement rides with horizontal axis ... 67
5.2.3 Rail-guided channel or track-bound devices ... 68
5.2.4 Dodgem/bumper cars ... 71
5.2.5 Speedways/go-karts ... 74
5.2.6 Mini-motorbikes for children ... 75
5.2.7 Boat rides ... 76
5.2.8 Flume rides ... 77
5.2.9 Helter skelters, slides ... 78
5.2.10 Side shows, booths, win-a-prize and sales stands, mazes, halls of mirrors, funhouses, labyrinths, hammers, ring the bell and similar ... 79
5.2.11 Shooting stands and trailers, shooting devices ... 81
5.3 Mechanical systems ... 83
5.3.1 Hydraulic and pneumatic devices ... 83
5.3.2 Lifting and elevating units being integral part of an amusement ride ... 84
5.4 Manufacture and supply ... 87
5.4.1 Manufacturer ... 87
5.4.2 Quality assurance — Quality plan ... 88
5.4.3 Manufacturing process ... 89
5.5 Documentation supplied with amusement device ... 91
5.5.1 Manuals ... 91
5.5.2 Special information ... 93
5.5.3 Drawings and diagrams ... 93
5.6 Design documentation ... 93
5.6.1 General ... 93
5.6.2 Description of installation and technical specification/information ... 94
5.7 Amusement Device log ... 95
5.7.1 General ... 95
5.7.2 Content ... 95
5.8 Official technical dossier ... 96
5.8.1 General ... 96
5.8.2 Content ... 96
5.8.3 Identification marking ... 97

Annex A (normative) **Electrical equipment and control systems ... 98**

Annex B (informative) **Control systems — Best practices ... 109**

Annex C (informative) **Guidance on design of passenger containment ... 111**

Annex D (informative) **Amusement device log for an amusement device ... 116**

© ISO 2023 – All rights reserved

Annex E (informative) **List of hazards, hazardous situations and events for spectators and passengers during the operation and use of amusement rides** **139**
Annex F (informative) **Guest behaviour** **143**
Annex G (informative) **Limited accessibility to amusement devices** **147**
Annex H (informative) **Safety envelope for passengers** **149**
Annex I (informative) **Acceleration effects on passengers** **152**
Bibliography **164**

© ISO 2023 – All rights reserved

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 Technical Committee ISO/TC 254, *Safety of amusement rides and amusement devices*.

This second edition cancels and replaces the first edition (ISO 17842-1:2015), which has been technically revised.

The main changes are as follows:

— the normative references have been updated;

— the terms and definitions have been revised;

— alignment with EN 13814 series from 2019;

— the general risk assessment has been supplemented by the operator-side risk assessment;

— the safety distances of passenger units have been fundamentally revised;

— the requirements for personal restraint systems have been supplemented by additional monitoring;

— new Annex I contains the acceleration effects on passengers to align with ASTM F2291-21.

A list of all parts in the ISO 17842 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.

© ISO 2023 – All rights reserved

Safety of amusement rides and amusement devices —

Part 1:
Design and manufacture

1 Scope

This document specifies the minimum requirements necessary to ensure the safe design, calculation, manufacture and installation of mobile, temporary or permanently installed amusement ride machinery and structures, which are intended for use by persons as a leisure activity. The amusement rides and amusement devices include for example, roundabouts, swings, boats, Ferris wheels, roller coasters, chutes, booths, side shows and structures for artistic aerial displays. They are intended to be installed both repeatedly without degradation or loss of integrity, and temporarily or permanently in fairgrounds and amusement parks or any other locations.

This document is not applicable to grandstands, construction site installations, scaffolding, removable agricultural structures, simple coin operated children's amusement devices, carrying up to three children, and recreational devices like waterslides or summer toboggan runs, playground equipment, rope courses, climbing wall, inflatable, trampolines, swimming pool equipment, etc.

NOTE For all the equipment not covered by the requirements of ISO 17842-1, the relevant standards apply.

Nevertheless, this document can be used in the design of any similar structural or passenger carrying amusement device not explicitly mentioned herein.

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.

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 1141, *Fibre ropes — Polyester — 3-, 4-, 8- and 12-strand ropes*

ISO 1181, *Fibre ropes — Manila and sisal — 3-, 4- and 8-strand ropes*

ISO 1346, *Fibre ropes — Polypropylene split film, monofilament and multifilament (PP2) and polypropylene high-tenacity multifilament (PP3) — 3-, 4-, 8- and 12-strand ropes*

ISO 2307, *Fibre ropes — Determination of certain physical and mechanical properties*

ISO 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

ISO 3834-3, *Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements*

ISO 3834-4, *Quality requirements for fusion welding of metallic materials — Part 4: Elementary quality requirements*

ISO 4014, *Fasteners — Hexagon head bolts — Product grades A and B*

ISO 4016, *Fasteners — Hexagon head bolts — Product grade C*

© ISO 2023 – All rights reserved

ISO 4017, *Fasteners — Hexagon head screws — Product grades A and B*

ISO 4018, *Fasteners — Hexagon head screws — Product grade C*

ISO 4032, *Fasteners — Hexagon regular nuts (style 1)*

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 9554, *Fibre ropes — General specifications*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*

ISO 9692-1, *Welding and allied processes — Types of joint preparation — Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels*

ISO 9692-2, *Welding and allied processes — Joint preparation — Part 2: Submerged arc welding of steels*

ISO 9692-3, *Welding and allied processes — Types of joint preparation — Part 3: Metal inert gas welding and tungsten inert gas welding of aluminium and its alloys*

ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections*

ISO 10325, *Fibre ropes — High modulus polyethylene — 8-strand braided ropes, 12-strand braided ropes and covered ropes*

ISO 10474:2013, *Steel and steel products — Inspection documents*

ISO 10547, *Polyester fibre ropes — Double braid construction*

ISO 10554, *Polyamide fibre ropes — Double braid construction*

ISO 10556, *Fibre ropes of polyester/polyolefin dual fibres*

ISO 10572, *Mixed polyolefin fibre ropes*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13854:2017, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13849-2, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14118, *Safety of machinery — Prevention of unexpected start-up*

ISO 14119, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

ISO 14120, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14731, *Welding coordination — Tasks and responsibilities*

© ISO 2023 – All rights reserved

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 17635:2016, *Non-destructive testing of welds — General rules for metallic materials*

ISO 17842-2:2022, *Safety of amusement rides and amusement devices — Part 2: Operation and use*

ISO 17842-3, *Safety of amusement rides and amusement devices — Part 3: Requirements for inspection during design, manufacture, operation and use*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60204-32, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines*

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

IEC 60364-5-54, *Electrical Installation of buildings — Part 5-54: Selection and erection of electrical equipment — Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60364-7-740, *Electrical Installation of buildings — Part 7-740: Requirements for special installations or locations — Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses*

IEC 61558-1, *Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests*

IEC 61800-5-2, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional*

IEC 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC 62305 (all parts), *Protection against lightning*

EN 818 (all parts), *Short link chain for lifting purposes — Safety*

EN 1069-1+A1, *Water slides — Part 1: Safety requirements and test methods*

EN 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

EN 1090-3, *Execution of steel structures and aluminium structures — Part 3: Technical requirements for aluminium structures*

EN 1090-3:2008, *Execution of steel structures and aluminium structures — Part 3: Technical requirements for aluminium structures*

EN 1261, *Fibre ropes for general service — Hemp*

EN 1677 (all parts), *Components for slings — Safety*

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

EN 1993-1-8, *Eurocode 3: Design of steel structures — Part 1-8: Design of joints*

EN 1993-1-9:2005, *Eurocode 3: Design of steel structures — Part 1-9: Fatigue*

EN 1999-1-1, *Eurocode 9: Design of aluminium structures — Part 1-1: General structural rules*

EN 12195-2, *Load restraint assemblies on road vehicles — Safety — Part 2: Web lashing made from man-made fibres*

© ISO 2023 – All rights reserved

EN 12385 (all parts), *Steel wire ropes — Safety*

EN 13411 (all parts), *Terminations for steel wire ropes — Safety*

EN 13889+A1, *Forged steel shackles for general lifting purposes — Dee shackles and bow shackles — Grade 6 — Safety*

EN 14399 (all parts), *High-strength structural bolting assemblies for preloading*

EN 50172, *Emergency escape lighting systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
amusement device
arrangement of equipment that produces the desired effect of amusement or entertainment when the *patron* (3.26) moves through it or on it primarily by his or her own action, or any other system that is not covered by the term *amusement ride* (3.2)

Note 1 to entry: In this document, the term "amusement device" is used to refer to an amusement device or *amusement ride* (3.2).

3.2
amusement ride
device that is designed to entertain the *passengers* (3.26) during motion including the consequence of biomechanical effect

Note 1 to entry: In this document, the term "amusement device" is used to refer to an *amusement device* (3.1) or amusement ride.

Note 2 to entry: See ISO/TS 17929 for the definition of biomechanical effect.

3.3
attendant
competent person (3.6) appointed to work under the supervision of an *operator* (3.25), to assist in the operation of a device available for use by the public

3.4
barrier
device intended to prevent the user from falling and from passing beneath a barrier

Note 1 to entry: A barrier can also be used as a fence.

3.5
closed restraint
restraint in a position in which the *restraint* (3.35) is intended to remain during the operation of the amusement device in order to restrain the *passenger* (3.26)

3.6
competent person
person who can demonstrate the knowledge and skills acquired through training, qualifications or experience, or a combination of all, enabling that person to perform a specified task

© ISO 2023 – All rights reserved