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Interested committees:

Title: Draft BS EN 81-43 Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods. Part 43: Lifts for cranes.

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- iii) requires additional national guidance or information

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 43: Lifts for cranes

Règles de sécurité pour la construction et l'installation
des élévateurs - Élévateurs particuliers destinés au
transport des personnes et des matériaux - Partie 43:
Élévateurs pour appareils de levage à charge
suspendue

Sicherheitsregeln für die Konstruktion und Installation
von Aufzügen - Besondere Aufzüge für den Transport
von Personen und Gütern - Teil 43: Kranführeraufzüge

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 10.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 81-43:2021) has been prepared by Technical Committee CEN/TC 10 “Lifts, escalators and moving walks”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 81-43:2009.

The main modification are:

- Revision of requirements for design/calculation (5.2) and integration of requirements for earthquakes;
- design requirement to introduce the reference to EN 13001-1 and EN 13001-2 for the calculation have been revised and requirements for earthquakes have been added;
- Performance level in accordance with EN ISO 13849-1 have been added;
- A new Annex A (informative) identifying the specific requirements for temporary installed lifts/permanent installed lifts has been added;
- A new Annex B (normative) for lifts installed on tower cranes have been added.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) / Regulation(s).

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

Introduction

This document is one of a series of standards produced by CEN/TC 10/SC 1 as part of the CEN programme of work to produce machinery safety standards.

This document is a Type C standard as stated in EN ISO 12100:2010.

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 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 and hazardous events are covered are indicated in the scope of this standard.

This document gives details for the complete installation.

In order to achieve a safe installation of a lift on a crane, negotiations shall take place between the crane user organization and the manufacturer of the lift and the manufacturer of the crane, about the interfaces (e.g. lift way protection, supporting structure, power supplies, suitability of alarm devices, ...) regarding the responsibility for these requirements. For installation of a lift on a tower crane, see Annex B (normative).

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

1 Scope

1.1 This document specifies the safety requirements for the construction and installation of power operated lifts attached to cranes and intended for access to workplaces on cranes, by authorized persons. This includes intended use, erection, dismantling, inspection and maintenance. The lift serves defined landing levels and has a load carrying unit which is:

- a) designed for the transportation of persons and materials;
- b) guided;
- c) travelling vertically or along a path within 15 degrees maximum from the vertical;
- d) supported by rack and pinion or suspended by steel wire ropes;
- e) travelling with a speed not more than 1,0 m/s for permanent installed lifts and not more than 0,4 m/s for temporary installed lifts.

NOTE Annex A identifies the specific requirements applicable to the permanent installed lifts, respectively to the temporary installed lifts.

1.2 This document identifies hazards as listed in Clause 4 that arise during the various phases in the life of such equipment and describes methods for the elimination or reduction of these hazards when used as intended by the manufacturer.

1.3 This document does not specify the additional requirements for:

- a) operation in severe conditions (e.g. extreme climates, strong magnetic fields);
- b) noise;
- c) operation subject to special rules (e.g. potentially explosive atmospheres);

NOTE Directive 2014/34/EU concerning equipment and protective systems intended for use in potentially explosive atmospheres can be applicable to the type of machine or equipment covered by this document. The present standard is not intended to provide means of complying with the essential health and safety requirements of Directive 2014/34/EU.

- d) electromagnetic compatibility (emission, immunity);
- e) handling of loads the nature of which could lead to dangerous situations;
- f) the use of combustion engines;
- g) hydraulic drive units;
- h) hazards occurring during manufacturing process;

1.4 This document is not applicable to:

- a) builders hoists according to EN 12158-1:2000+A1:2010, EN 12158-2:2000+A1:2010 and EN 12159:2012 and transport platform according to EN 16719:2018;
- b) elevating control stations according to EN 14502-2:2005+A1:2008;

- c) lifts according to EN 81-20:2014 and EN 81-50:2014;
- d) work platforms carried on the forks of fork trucks;
- e) work platforms;
- f) funiculars;
- g) lifts specially designed for military purposes;
- h) mine lifts;
- i) theatre elevators.

1.5 This document deals with the complete lift design but excludes the design of the crane. It includes the base frame and base enclosure of the lift but excludes the design of any concrete, hard core, timber or other foundation arrangement. It includes the design of mast ties and the design of anchorage parts between the mast tie and the crane structure. This document also includes the design of the landing gates and their fixings.

1.6 This document also deals with the information to be exchanged between the manufacturer of the lift and the crane user organization or the manufacturer of the crane.

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 81-20:2014, *Safety rules for the construction and installation of lifts — Lifts for the transport of persons and goods — Part 20: Passenger and goods passenger lifts*

EN 81-50:2014, *Safety rules for the construction and installation of lifts — Examinations and tests — Part 50: Design rules, calculations, examinations and tests of lift components*

EN 894-1:1997+A1:2008, *Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 1: General principles for human interactions with displays and control actuators*

EN ISO 14118:2018, *Safety of machinery - Prevention of unexpected start-up (ISO 14118:2017)*

EN 1808:2015, *Safety requirements on suspended access equipment — Design calculations, stability criteria, construction — Tests*

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

EN 1999-1-1:2007, *Eurocode 9: Design of aluminium structures - Part 1-1: General structural rules*

EN 12159:2012, *Builders hoists for persons and materials with vertically guided cages*

EN 13001-2:2014, *Cranes — General design — Part 2: Load actions*

EN 13001-3-1:2012+A2:2018, *Cranes — General design — Part 3-1: Limit states and proof of competence of steel structures*

EN 13586:2004+A1:2008, *Cranes — Access*

EN 14439:2006+A2:2009, *Cranes - Safety - Tower cranes*

EN 60204-32:2008, *Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines*

EN 60529:1991, *Degrees of protection provided by enclosures (IP-Code) (IEC 60529:1991)*

EN IEC 60947-4-1:2019, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1:2000)*

EN 60947-5-1:2017, *Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices*

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1:2015, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13854:2019, *Safety of machinery - Minimum gaps to avoid crushing of parts of the human body (ISO 13854:2017)*

EN ISO 13856-3:2013, *Safety of machinery - Pressure-sensitive protective devices - Part 3: General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices (ISO 13856-3:2013)*

EN ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

EN ISO 14119:2013, *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection (ISO 14119:2013)*

EN ISO 14120:2015, *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards (ISO 14120:2015)*

ISO 3864-1:2011, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

ISO 4309:2017, *Cranes — Wire ropes — Care and maintenance, inspection and discard*

ISO 6336-1:2019, *Calculation of load capacity of spur and helical gears — Part 1: Basic principles, introduction and general influence factors*

ISO 6336-2:2019, *Calculation of load capacity of spur and helical gears — Part 2: Calculation of surface durability (pitting)*

ISO 6336-3:2019, *Calculation of load capacity of spur and helical gears — Part 3: Calculation of tooth bending strength*

ISO 6336-5:2019, *Calculation of load capacity of spur and helical gears — Part 5: Strength and quality of materials*

3 Terms and definitions

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

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

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

3.1

lift

machine with a car which is guided and intended for transport between different levels

3.2

rated load

maximum load which the lift has been designed to carry in service

3.3

rated speed

travelling speed of the car in m/s for which the equipment has been designed

3.4

wire rope lift

lift which uses wire rope as the load suspension system

3.5

supporting structure

crane and its foundations, giving vertical or horizontal support to the mast of the lift

3.6

rack and pinion lift

lift which uses a toothed rack and pinion as the load suspension system

3.7

base frame

lowest framework of the lift, upon which vertical loads are supported

3.8

top support

upper framework of the lift, from which vertical loads are suspended

3.9

guide rails

rigid elements which determine the travel way of the load carrying unit, that may form part of the mast

3.10

mast

lift mast is the structure that supports the load carrying unit

3.11

mast section

indivisible piece of mast, between two adjacent mast joints

3.12

mast tie

connection system between the mast of the lift and the supporting structure, providing horizontal support for the mast

3.13

liftway

total space which is travelled by the load carrying unit

3.14

car

load carrying unit including floor, walls, gates and roof

3.15

stopping distances

distance the load carrying unit moves from the moment, when the control or safety circuit is broken until the load carrying unit has come to a full stop

3.16

overspeed safety device

combination of overspeed detecting device (3.17) and safety gear (3.18)

3.17

overspeed detecting device

device which, when the lift attains a predetermined speed causes the safety gear to be triggered/applied

3.18

safety gear

mechanical device for stopping and maintaining stationary the lift car on the guide rail, rack or rope

3.19

slack rope

rope, normally under tension, from which all external loads have been removed

3.20

wire rope termination

adaptation at the end of a wire rope permitting attachment

3.21

landing

level in the crane structure intended for loading and unloading the load carrying unit

3.22

guard rail

fixed equipment, other than gates, which is used to prevent people from falling or from reaching hazardous areas

3.23

normal operation

usual operating conditions for the lift when in use for carrying loads but excluding routine maintenance, erection, dismantling etc. of the lift

3.24

in service

condition during use of the lift when the load carrying unit is in any position, loaded or unloaded, moving or stationary

3.25

out of service

installed condition when the load carrying unit is positioned such that it is provided with the most shelter from the wind. This is normally, but not necessarily, ground level. The load carrying unit is unloaded

3.26

competent person

designated person, suitably trained, qualified by knowledge and practical experience, and provided with the necessary instructions to enable the required procedures to be carried out

3.27

overrun

travel of the car beyond the normal stopping positions at its uppermost and its lowermost landing

3.28

authorised person

person having permission and competency to use the lift

3.29

temporary installed lifts for cranes

lifts attached to or installed inside tower cranes for temporary construction works for a limited period of time

Note 1 to entry: A temporary situation is given when either the lift or the tower crane, with the lift remaining on or in the cranes structure, is being dismantled after completion of the temporary works.

3.30

permanent installed lifts for cranes

lifts attached to cranes and intended for access to workplaces by authorised persons, not covered by 3.29

3.31

safety rope

steel wire rope, only carrying the load when the safety device is activated

3.32

lift landing platform

platform and access means intended to provide access and rest at a landing level located between the tower crane own accesses and the landing gate of a lift

Note 1 to entry The lift landing platform can be integrated into the rest platform of the tower crane.

3.33

unlocking zone

zone, extending above and below the landing level, in which the car floor has to be to enable the corresponding landing door to be unlocked

4 List of significant hazards

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 this type of machinery and which require action to eliminate or reduce the risk. The significant hazards are based upon EN ISO 12100:2010. Also shown are the subclause references to the safety requirements and/or protective measures in this document. Before using this document, it is important to carry out a risk assessment of lifts to check that it has the hazards identified in this clause.

Table 1 — Hazards relating to the general design and construction of lifts for persons and materials

Group	Significant hazard in accordance with EN ISO 12100:2010, Table B.1	Clause/suclause of the EN
<i>General, for many machines relevant</i>		
1	Mechanical hazards	
1.1	Due to machine parts or workpieces, e.g. — by potential energy (falling objects, height from the ground, gravity)	5.5.3, 5.6.1.2
	— by kinetic energy (acceleration, deceleration, moving/rotating elements)	5.6.1.2
	— by mechanical strength (break-up)	5.6.2, 7.1.2.5
1.2	by stored energy, e.g.: — elastic elements (springs)	5.7.4.1
1.3	Crushing	5.5.2, 5.5.3, 5.5.4, 5.5.6, 5.7.2, 7.1.2.7.1, 7.1.2.8
1.4	Shearing	5.5, 5.6.1.2, 5.7.2, 7.1.2.7.1, 7.1.2.8
1.5	Cutting or severing	5.5, 5.6.1.2, 5.7.2, 7.1.2.7.1, 7.1.2.8
1.6	Entanglement	5.7.2
1.7	Drawing-in or trapping	5.5.2, 5.5.3, 5.5.6, 5.6.1.2, 5.6.1.5, 5.7.2.3, 7.1.2.7, 7.1.2.8
1.8	Impact	5.4.3, 5.6.2, 7.1.2.5, 7.1.2.7, 7.1.2.8
1.10	Friction or abrasion	5.5.2, 5.5.3, 7.1.2.7, 7.1.2.8
1.12	Slipping, tripping and falling	5.5, 5.6.1, 7.1.2.7, 7.1.2.8
1.13	Instability	5.2, 5.3, 5.4.1, 5.4.2, 5.6.3, 7.1.2.7, 7.1.2.8
2	Electrical hazards	
2.1	Touching live parts	5.8, 7.1.2.7, 7.1.2.10
2.2	Parts which have become live under fault conditions	5.8, 7.1.2.7, 7.1.2.10
2.5	Electromagnetic phenomena	NC
2.7	Short-circuit	5.8.2
2.8	Overload	5.8.2
8	Ergonomic hazards	
8.1	Unhealthy postures or excessive effort	5.1, 7.1.2.7, Annex B

Group	Significant hazard in accordance with EN ISO 12100:2010, Table B.1	Clause/suclause of the EN
8.2	Inadequate consideration of anatomy	5.5, 5.7.2, 7.1.2.7
8.3	Insufficient means for evacuation/emergency exit	5.6.1.5
8.4	Inadequate local lighting	5.5.7, 5.8.8, 7.1.2.8
8.5	Design or location of indicators and visual displays units	5.9.1, 7.3
8.6	Design, location or identification of control devices	5.9.1, 7.2, 7.3
8.9	Human error during operation	5.6.3, 5.9, 7.1.2.7, 7.1.2.8, 7.1.2.10
9	Hazards associated with the environment in which the machine is used	
9.1	Lightning	5.8.1
9.2	Moisture	5.8.3
9.4	Snow, water, wind, temperature	5.2.2.10, 5.2.2.14, 5.8.1, 5.8.3
9.6	Dust and fog	5.8.3, 5.7.4.10
10		
10.1	Failure/disorder of the control system and control circuits	5.9, 5.10, 7.1.2.7, 7.1.2.8
10.4	Failure of the power supply	5.7.4.1, 5.9
12	Hazards due to: — assembly and installation — setting cleaning — fault-finding — maintenance	
12.1	Maintenance	5.7.2, 5.8, 5.9, 7.1.2.10
12.2	Insufficient means of access during use, setting and maintenance	5.7.2, 5.8, 5.9, 7.1.2.8, 7.1.2.10
12.4	Being trapped in a machine	5.5.6.2, 5.5.6.3, 5.6.1.5, 5.10.2
<i>Supplementary, due to the mobility of machinery</i>		
17	Hazards linked to work position (including driving station) on the machine	
17.1	Fall of persons during access to or at/from the work position	5.5
17.3	Mechanical hazards at the work position, such as: — contact with the wheels — rollover and overturning — slipping during access — fall of objects, penetration by objects — contact of persons with machine parts or tools (pedestrian controlled machines)	5.5
17.4	Insufficient visibility from the work position	5.5
18	Hazards due to the control system	
18.1	Inadequate location of manual controls	5.9.1, 7.3

Group	Significant hazard in accordance with EN ISO 12100:2010, Table B.1	Clause/suclause of the EN
18.2	Inadequate design of manual controls and their mode of operation	5.9.1, 7.3
22	Mechanical hazards caused by load falls, collisions, machine tipping	
22.1	Lack of stability	5.2; 5.3, 5.4.1, 5.4.2, 7.1.2.7
22.2	Uncontrolled loading, overloading, overturning moments exceeded	5.6.3
22.4	Unexpected/unintended movement of loads	5.6.2, 5.7.4, 7.1.2.5
22.6	Collision of more than one machine	Annex B, 7.1.2, 7.1.2
22.8	Derailment	5.4.1, 5.6.2, 7.1.2.5
22.9	Insufficient mechanical strength of parts	5.2, 5.3, 5.6.3, 5.7
22.10	Inadequate design of pulleys and drums	5.7.3.2
22.11	Inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine	5.7.3.2
22.12	Lowering of the load under the control of friction brake	5.10
22.13	Abnormal conditions of assembly/use/maintenance	6.3, 7.1.2.7.3 j)
22.14	Effect of load on persons (impact by load or counterweight)	Annex B
<i>Supplementary, for machinery presenting particular hazards due to the lifting of persons</i>		
27	Mechanical hazards	
27.1	Due to: — inadequate mechanical strength — inadequate working coefficients — failing of loading control	5.2, 5.6.1, 5.6.2, 5.6.3, 5.7.3.2, 7.1.2.5, 7.1.2.7
27.2	Failing of controls in person carrier (function, priority)	5.9.8.1
27.3	Overspeed of person carrier	5.4.3, 5.6.2, 5.7.4.5, 7.1.2.5, 7.1.2.10
27.4	Falling of persons from person carrier	5.6.1
NC	No covered.	

5 Safety requirements and/or protective measures

5.1 General

The design of the lift shall consider intended use, erection, dismantling, inspection and maintenance.

Machinery shall comply with the safety requirements and/or protective measures of this clause.

In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for hazards relevant but not significant, which are not dealt with by this document (e.g. sharp edges).

The design of all components that have to be handled during erection e.g. mast sections, shall have their weight assessed against manual handling. Where the permissible weight for manual handling is exceeded, the manufacturer shall give recommendations in the instruction handbook concerning suitable lifting equipment.

All removable and detachable covers shall be retained by captive fastenings.

Specific design requirements for the installation of lift on tower cranes are given in Annex B, B.2.

5.2 Load combinations and calculations

5.2.1 The structure of the lift shall be designed and constructed in such a way that its strength is satisfactory under all intended conditions, including erection and dismantling.

The design of the structure of the lift as a whole and each part of it shall be based on the effects of any possible combination of loads as specified in this subclause. The load combinations shall consider the least favourable locations of the car and load relative to the mast and its ties, both during the vertical passage of the car and any horizontal movement of the car. Ties between the mast and the supporting structure are considered to be part of the lift structure.

These load combinations are summarized in Table 2.

Use of forces, load combinations and formulas in accordance with EN 81-20:2014 is accepted for permanent installed lifts. Forces and load combinations not covered by EN 81-20:2014 such as mobility, wind forces and rated load shall be calculated according to this document.

Table 2 — Load combinations and safety factors

Categories of loads	Clause in this document	Loads	No.	Load combinations A			Load combinations B			Load combinations C									
				γ_p	A1	A2	γ_p	B1	B2	γ_p	C1	C2	C3	C4	C5	C6	C7	C8	C9
Regular loads	5.2.2.1	All dead weights with the exception of the car a)	1	1,22	ϕ_1	ϕ_1	1,16	ϕ_1	ϕ_1	1,1	1	1	ϕ_1	1	ϕ_1	1	1	1	1
	5.2.2.2	Dead weights of the unloaded car	2	1,22	μ_1	1	1,16	μ_1	1	1,1	1	1	1	1	1	1	μ_1	μ_2	μ_1
	5.2.2.4	Rated load evenly distributed	3	1,34	μ_1		1,22	μ_1		1,1		1	1	1	1	1	μ_1	μ_2	
	5.2.2.4.2	Loading and unloading	4	1,34		1	1,22		1	1,1									
	5.2.2.12	Vertical forces due to mobility	5	1,34	ϕ_4	ϕ_4	1,22	ϕ_4	ϕ_4	1,1							–		
	5.2.2.12	Horizontal forces due to mobility	6	1,34	ϕ_5	ϕ_5	1,22	ϕ_5	ϕ_5	1,1							–		
Occasional loads	5.2.2.10	Wind in service a)	7				1,22	1	1	1,1									
	EN 13001-2	Snow and ice a)	8				1,22	1	1	1,1	1								
	EN 13001-2	Temperature a)	9				1,16	1	1	1,05	1								
Exceptional loads	5.2.2.10	Wind out of service a)	10							1,1	1								
	5.2.2.11	Forces created by the buffers of the lift	11							1,1		ϕ_7							
	5.2.2.12	Forces created by the buffers of the crane a)	12							1,1			ϕ_7						
	5.9.5	Forces created by emergency stop of the lift	13							1,1				ϕ_5					
	EN 13001-2	Forces created by emergency stop of the crane a)	14							1,1					ϕ_5				
	5.2.2.14	Forces due to seismic accelerations a)	15							1,1						1			

Categories of loads	Clause in this document	Loads	No.	Load combinations A			Load combinations B			Load combinations C									
				γ_p	A1	A2	γ_p	B1	B2	γ_p	C1	C2	C3	C4	C5	C6	C7	C8	C9
	5.2.2.10	Forces due to erection and dismantling of the lift, incl. wind loads a)	16							1,1							1		
	5.2.2.13	Evenly distributed test load	17							1,1									μ_1
Overall safety factor γ_f (for allowable stress design)		Steel		1,48			1,34			1,22									
		Aluminium		1,71			1,55			1,41									
Resistance coefficient γ_m		Steel		1,1			1,1			1,1									
		Aluminium		1,28			1,28			1,28									

Index:	
a)	Load according to EN 13001-2 or the product standard of the crane (see Annex C)
Parameter:	
γ_p	Partial safety factor
γ_m	Resistance coefficient
γ_f	Overall safety factor
μ_1	Impact factor on moving loads in case of normal travelling (5.2.2.5)
μ_2	Impact factor on moving loads in case of activation of overspeed safety device (EN 81-20:2014, Table 14, k_1)
ϕ_1	Dynamic factor for hoisting and gravity effects acting on the mass of the crane (EN 13001-2)
ϕ_4	Dynamic factor for loads caused by travelling on uneven surface (EN 13001-2)
ϕ_5	Dynamic factor for loads caused by acceleration of all crane drives (EN 13001-2)
ϕ_7	Dynamic factor for loads due to buffer forces (EN 13001-2)
Load combination definitions:	
A – Load combinations A contain loads for normal use of crane and lift	
A1	Normal use of the lift and normal use of the crane (lifting and lowering of crane load)
A2	Loading and unloading of the lift and normal use of the crane
B – Load combinations B contain loads for normal use combined with occasional loads	
B1	A1+ wind in service, snow and ice and temperature
B2	A2+ wind in service, snow and ice and temperature
C – Load combinations C contain loads for normal use combined with exceptional loads	
C1	Lift and crane out of service
C2	Lift contacts the buffer
C3	Crane contacts the buffer
C4	Emergency-stop of the lift
C5	Emergency-stop of the crane
C6	Excitation of lift and crane due to seismic loads, where applicable
C7	Erection and dismantling of the lift
C8	Triggering of overspeed safety device of the lift
C9	Overload test with 1,25-times of rated load

5.2.2 When calculating the lift structure and every related component, the following forces and loads shall be taken into account:

5.2.2.1 All dead weights with the exception of the car and equipment which moves together with the car.

5.2.2.2 Dead weights of the unloaded car and all equipment which moves together with the car.

5.2.2.3 Dead weight of landing platforms and gates, if supported by the lift.

5.2.2.4 Rated load

5.2.2.4.1 Rated load evenly distributed over the floor area of the car. Where the uniform distribution of the rated load over the full area of the car floor is less than $4,0 \text{ kN/m}^2$ then, for calculation purposes a minimum of $4,0 \text{ kN/m}^2$ shall be placed over the whole area of the car floor.

5.2.2.4.2 For rated loads greater than $5,0 \text{ kN}$ the forces during loading and unloading (see Figure 1) shall be considered as the concurrent effect of a vertical force and a horizontal force, each calculated as follows:

- a vertical force F_V of $2,0 \text{ kN}$ per $1,0 \text{ m}$ width of the car entrance, but not less than $1,5 \text{ kN}$;
- a horizontal force F_H of 10% of the rated load, but not less than $0,3 \text{ kN}$;

both forces acting in the middle of the width of the car entrance, at floor level. The stresses in the mast and also in the car shall be calculated for at least the following application points of the loading and unloading forces:

- a) the car threshold;
- b) the leading edge of any ramp or other extension, which is not supported by the landing.

At the same time any remaining part of the rated load shall be applied in the centre of the car floor (F_{V1}).

Equivalent forces shall be used to design the landing threshold and all relevant supporting structures. Information shall be given in the instruction handbook with regard to these forces.

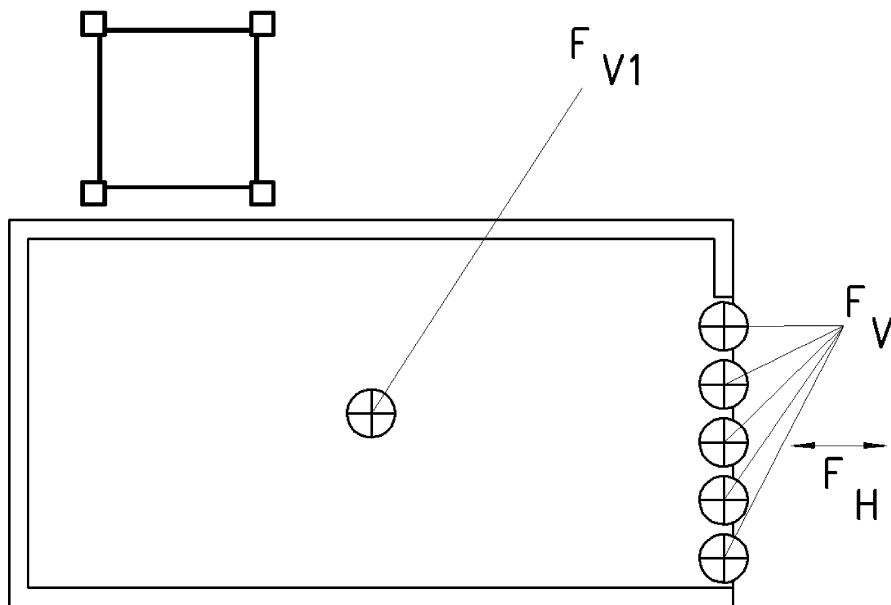


Figure 1 — One example of forces during loading and unloading

5.2.2.5 The effect of moving loads shall be determined by taking the weight of all actual loads (car, rated load, wire ropes etc.) and multiplying them by an impact factor $\mu_1 = (1,1 + 0,264v)$ where v is the rated speed in m/s .

5.2.2.6 To determine the forces produced by an operation of the overspeed safety device, the sum total of the travelling load shall be multiplied by the factor according to EN 81-20:2014, 5.7.4.4.

A lower factor, but not less than 1,2 can be used if it can be verified by test under all conditions of loading up to 1,3 times rated load including any inertia effects of the drive unit.

5.2.2.7 The car roof, if intended to be accessible for erection, dismantling, maintenance or emergency escape, shall be designed to withstand a load of at least 2,0 kN placed on the least favourable square area of 1,0 m². The roof shall also withstand a load of 1,2 kN applied on any area of 0,1 × 0,1 m without permanent deformation.

5.2.2.8 The car roof intended not to be used as support for persons shall withstand load of 1,2 kN applied on any point of 0,1 × 0,1 m without breakage.

5.2.2.9 The car floor surface shall be designed to withstand without permanent deformation a static force of 1,5 kN or 25 % of the rated load, whichever is the greater, the force applied on the least favourable square area of 0,1 m × 0,1 m.

5.2.2.10 Loads due to wind

5.2.2.10.1 General

Loads due to wind shall be calculated according to EN 13001-2.

When calculating wind load on the car it shall be assumed that the car walls are solid and an aerodynamic coefficient of $c = 1,2$ shall be applied. The factor 1,2 covers both the shape factor and the shielding factor. If justified, lower values may be applied.

The aerodynamic wind pressure $q(z)$ is calculated by the general equation:

$$q(z) = \rho / 2 * v(z)^2$$

where

$q(z)$	is the equivalent static wind pressure in [N/m ²];
$\rho = 1,25 \text{ kg/m}^3$	is the density of the air;
$v(z)$	is the equivalent static wind velocity corresponding to the 3 s gust wind velocity in [m/s];
z	is the height above the surrounding ground level in [m].

In all cases it shall be assumed that the wind can blow horizontally in any direction and the least favourable direction shall be taken into account.

5.2.2.10.2 In service wind

Irrespective of the height above ground, the minimum value of the wind pressure shall be $q(3) = 250 \text{ N/m}^2$, which corresponds to a gust wind velocity of $v(3) = 20,0 \text{ m/s}$.

5.2.2.10.3 Out of service wind

For out of service wind condition, regional storm wind velocities according to EN 13001-2:2014, Table 8 shall be applied. As a minimum requirement, the wind velocity of region C shall be used.

In EN 13001-2:2014, the reference wind velocity to consider the regional meteorological conditions is given with a recurrence interval of once in 50 years as the basic value. Depending on the installation time of the crane and the lift different recurrence periods have to be selected:

— for permanent installed lifts a recurrence period $R = 50$ years shall be used;

- for temporary installed lifts a recurrence period $R = 25$ years may be used.

If specific values are given in the product standards of the crane, those shall be taken (see Annex C).

5.2.2.10.4 Erection and dismantling wind

Irrespective of the height above ground, the minimum value of the wind pressure shall be $q(3) = 100 \text{ N/m}^2$, which corresponds to a gust wind velocity of $v(3) = 12,5 \text{ m/s}$.

5.2.2.11 Forces created by the buffers shall be calculated allowing for a retardation of 1 g.

5.2.2.12 Forces due to mobility and deflection of the crane:

a) vertical force:

- a vertical force F_v depending on the speed of the crane caused by travelling on uneven surface (EN 13001-2:2014, 4.1.2.3);

b) horizontal moving parts:

- 1) horizontal forces due to the movements of the crane structure to which the lift is fitted (e.g. travelling, slewing etc. as well as emergency stops);
- 2) a horizontal force F_H according to the acceleration and deceleration of the crane shall be taken into account:

- $F_H = m \times a$;
- a = acceleration and deceleration [m/s^2];
- m = mass [kg] (all loads, moving with the crane);

c) buffer forces due to the crane motion;

d) horizontal forces due to deflection of the crane structure to which the lift is fitted, see 5.4.2. For lifts installed on tower cranes, see Annex B.

Information shall be given in the instruction handbook with regard to these forces.

5.2.2.13 For overload testing a load of 1,25 rated load shall be used evenly distributed on the lift car floor.

5.2.2.14 Loads due to seismic accelerations

Loads due to seismic accelerations shall be calculated according to EN 1998-1:2004. Thereby the crane location, i.e. the regional seismic conditions and the local subsoil conditions, and the dynamic characteristics of the crane together with the lift, i.e. the natural frequency and the damping characteristics, have to be taken into account.

In EN 1998-1:2004, the reference peak ground acceleration to consider the regional seismic conditions is given with a recurrence interval of once in 475 years as the basic value. Depending on the installation time of the crane and the lift different recurrence periods have to be selected:

- For permanent installed lifts a recurrence period $R = 475$ years shall be used.
- For temporary installed lifts, loads due to seismic accelerations to be considered only on request of the users. A recurrence period $R = 100$ years may be used.

The proof of competence shall be based on the limit states method according to EN 13001-2:2014. If specific values are given in the product standards of the crane, those shall be taken (see Annex C).

5.2.3 Proof of static strength

5.2.3.1 Generally

For the proof of static strength, consider generally EN 13001-3-1:2012+A2:2018 for steel. This includes guidance for the analysis of structural members and their connections (e.g. fatigue, welding, bolts). For aluminium consider EN 1999-1-1:2007.

5.2.3.2 Limit design stresses for steel and aluminium

The limit design stresses are given as:

The limit design stress $f_{R,d}$, used for the design of structural members, is calculated as follows:

$$f_{R,d} = \frac{f_{yK}}{\gamma_m} \quad \text{for normal stresses} \quad (1)$$

$$f_{R,d} = \frac{f_{yk}}{\sqrt{3} \times \gamma_m} \quad \text{for shear stresses} \quad (2)$$

$f_{y,k}$ is the nominal value of the yield strength of the material.

5.2.4 Fatigue stress analysis of drive and braking system components

5.2.4.1 A fatigue stress analysis shall be made for all load bearing components and joints, which are critical to fatigue, such as shafts and gearing. This analysis shall take into account the degree of stress fluctuation and the number of stress cycles, which can be a multiple of the number of load cycles.

To determine the number of stress cycles, the manufacturer shall take the following into account:

- a) 50 % of the movements with 50 % of the rated load in the car;
- b) 50 % of the movements with empty car;
- c) for the calculation of the drives each movement consists of acceleration from rest to rated speed travel at rated speed for nominal travel distance – deceleration to full stop (see also 7.1.2.10).

For each component the least favourable combination of upwards and downwards movements shall be taken into account.

The number of movements is based on $1,6 \times 10^5$ – intermittent duty (e.g. 20 years, 50 weeks per year, 80 hours per week, 1 movement per hour). Nominal travel distance shall be 35 m.

The number of movements for lifts installed on tower cranes under construction site conditions is based on $1,6 \times 10^4$ – intermittent duty (e.g. 10 years, 40 weeks per year, 40 movements per week). Nominal travel distance shall be 50 m.

5.2.4.2 Each shaft shall possess a minimum safety factor of 2,0 against the appropriate endurance limit, taking into account all notch effects.

5.3 Base frame

The base frame shall be designed to accommodate all forces acting on it generated by the lift and be able to transfer them onto the supporting surface. Special consideration shall be given to the forces described in 5.2.2.12.