



BSI Standards Publication

Cranes – Power driven winches and hoists

Part 2: Power driven hoists

National foreword

This British Standard is the UK implementation of EN 14492-2:2019. It supersedes BS EN 14492-2:2006+A1:2009, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MHE/3/-/6, Winches, hoists, lifting blocks and accessories.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Krane - Kraftgetriebene Winden und Hubwerke - Teil 2: Kraftgetriebene Hubwerke

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European foreword

This document (EN 14492-2:2019) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2019, and conflicting national standards shall be withdrawn at the latest by December 2019.

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

This document supersedes EN 14492-2:2006+A1:2009.

CEN/TC 147 WG 17 has reviewed EN 14492-2:2006+A1:2009 to adapt the standard to the technical progress, new requirements and changes in standards referenced; the main topics are:

- the design and calculation references to EN 13001-1, EN 13001-2 and EN 13001-3-1 are adopted in the document FEM-documents FEM 1.001, FEM 9.901 are no longer referenced;
- the design and calculation to EN 13001-3-2, *Limit states and proof of competence of wire ropes in reeving systems* is adopted in the document. The standard ISO 4308-1:2003, in the Chapter 5.7 Rope drives is no longer referenced.
- the design and calculation to EN 13001-3-5, *Limit states and proof of competence of forged hooks* is adopted in the document. The standards DIN 15400, UNI 9465 in the Annex H (informative) are no longer referenced;
- a guidance of relationships between the FEM and ISO-Classification (Hoist Classification) and the new Classification according to the EN 13001 series is added; see Annex C;
- the EN 14492-2 references to EN 13135;
- this document will supersede EN 14492-2:2006+A1:2009 and the relevant clauses of EN 14492-1:2006+A1:2009 winches dealing with lifting applications.

This is the second part of the standard “Cranes — Power driven winches and hoists”. The parts of the standard are:

- *Part 1: Power driven winches*
- *Part 2: Power driven hoists* [the present document]

For the relationship with other European Standards for cranes, see Annex O.

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).

For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European standard is a harmonized standard to provide one means for power driven hoists to conform to the essential health and safety requirements of the EU Directive 2006/42/EC (Machinery) and essential safety requirements of EU Directive 2014/34/EU (ATEX).

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this European Standard.

This European Standard is a type C standard as stated in EN ISO 12100.

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

1 Scope

This document is applicable to the design, information for use, maintenance and testing of power driven hoists, compact or open construction, with or without trolleys for which the prime mover is an electric, hydraulic or pneumatic motor. They are designed for the lifting and lowering of loads that are suspended on hooks or other load lifting attachments. Hoists can be used either in cranes, in other machines, e.g. rail dependent storage and retrieval equipment, monorail conveyors or by itself.

This document is applicable to the following types of hoist:

- a) rope hoist;
- b) chain hoist;
- c) belt hoist, except belt hoist with steel belts as hoisting media;
- d) NGL building hoists including supporting structures;
- e) Winches used for lifting operation.

This document is not applicable of the following hazards:

- f) this document does not cover hazards related to builders hoists for the transport of goods as defined in Noise Outdoor Directive (OND) 2000/14/EC;
- g) this document does not cover hazards related to the lifting of persons.

This document does not specify additional requirements for hazards related to the use of hoists in explosive atmospheres in underground mines.

The significant hazards covered by this document are identified in Clause 4.

This document is not applicable to power driven hoists that are manufactured before the date of publication of this document by CEN.

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

EN 818-1:1996+A1:2008, *Short link chain for lifting purposes — Safety — Part 1: General conditions of acceptance*

EN 818-7:2002+A1:2008, *Short link chain for lifting purposes — Safety — Part 7: Fine tolerance hoist chain, Grade T (Types T, DAT and DT)*

EN 1127-1, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 12077-2:1998+A1:2008, *Cranes safety — Requirements for health and safety — Part 2: Limiting and indicating devices*

EN 12644-2, *Cranes — Information for use and testing — Part 2: Marking*

- EN 13001-1, *Cranes — General design — Part 1: General principles and requirements*
- EN 13001-2, *Crane safety — General design — Part 2: Load actions*
- EN 13001-3-1, *Cranes — General Design — Part 3-1: Limit States and proof competence of steel structure*
- EN 13001-3-2, *Cranes — General design — Part 3-2: Limit states and proof of competence of wire ropes in reeving systems*
- EN 13001-3-3, *Cranes — General design — Part 3-3: Limit states and proof of competence of wheel/rail contacts*
- EN 13001-3-5, *Cranes — General design — Part 3-5: Limit states and proof of competence of forged hooks*
- EN 13135, *Cranes — Safety — Design — Requirements for equipment*
- EN 13411-3, *Terminations for steel wire ropes — Safety — Part 3: Ferrules and ferrule-securing*
- EN 13411-4, *Terminations for steel wire ropes — Safety — Part 4: Metal and resin socketing*
- EN 13411-6, *Terminations for steel wire ropes — Safety — Part 6: Asymmetric wedge socket*
- EN 13411-7, *Terminations for steel wire ropes — Safety — Part 7: Symmetric wedge socket*
- EN 13557:2003+A2:2008, *Cranes — Controls and control stations*
- EN 60034-5, *Rotating electrical machines — Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification (IEC 60034-5)*
- EN 60079-0:2012, *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2011)*
- EN 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection (IEC 60079-14)*
- EN 60204-32:2008, *Safety of machinery — Electrical equipment of machines - Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*
- EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*
- EN 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2)*
- EN 61000-6-3, *Electromagnetic compatibility (EMC) — Part 6-3: Generic standards — Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3)*
- EN 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4)*
- EN ISO 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)*

EN ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components (ISO 4413:2010)*

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

EN ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871)*

EN ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections (ISO 11201:2010)*

EN ISO 11688-1, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1)*

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

EN ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces (ISO 13732-1)*

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

EN ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design (ISO 13850:2015)*

EN ISO 80079-36, *Explosive atmospheres — Part 36: Non-electrical equipment for explosive atmospheres — Basic method and requirements (ISO 80079-36)*

EN ISO 80079-37, *Explosive atmospheres — Part 37: Non-electrical equipment for explosive atmospheres — Non-electrical type of protection constructional safety "c", control of ignition sources "b", liquid immersion "k" (ISO 80079-37)*

ISO 606, *Short-pitch transmission precision roller and bush chains, attachments and associated chain sprockets*

ISO 4301-1:1986, *Cranes and lifting appliances — Classification — Part 1: General*¹⁾

ISO 4306-1, *Cranes — Vocabulary — Part 1: General*

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

ISO 12482, *Cranes — Monitoring for crane design working period*

¹⁾ ISO 4301:1986 is "time based" approached and changed in the updated versions.

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100, ISO 4306-1 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>

3.1.1

belt drive

system of belts as hoisting medium including related belt pulleys, belt drums and belt anchorages

Note 1 to entry: Belts in transmissions of drive forces are excluded.

3.1.2

chain drive

system of fine tolerance steel link chains, roller chains, driven and non-driven chain wheels and chain anchorages

3.1.3

chain anchorage

arrangement comprising the parts which connect the loaded chain end termination to the major load bearing structure, e.g. pins, bolts, tension rods

3.1.4

belt anchorage

arrangement comprising the parts which connect the belt end termination to the major load bearing structure, e.g. pins, bolts, tension rods, the belt fastening on the drum are not included

3.1.5

working coefficient for ropes, chains and belts

ratio between the minimum breaking force and the maximum static tensile force of the ropes, chains and belts under rated capacity m_{RC}

3.1.6

direct control

main power circuit is directly controlled by the hand controlled actuator without additional means between the actuator and the main power circuit

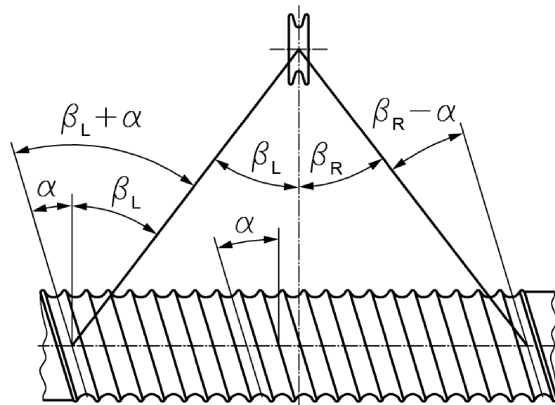
3.1.7

fleet angle

angle between the rope axis and the groove direction of a drum or sheave, at the point where rope enters the drum or sheave

Note 1 to entry: In the Figure 1 the fleet angles are β_L , β_R , $\beta_L + \alpha$ and $\beta_R - \alpha$.

Note 2 to entry: For an un-grooved drum, set the angle $\alpha = 0$.



Key

β_L, β_R	fleet angles on the pulley
$\beta_L + \alpha, \beta_R - \alpha$	fleet angles on the drum
α	angle of the grooves on the drum

Figure 1 — Fleet angle

3.1.8

force transmission

two or more connected parts which transmit forces

3.1.9

hoist

machine for lifting and lowering loads, freely suspended or guided or supported on inclined planes, over predetermined distances, with or without trolleys

Note 1 to entry: For examples see Annex A.

3.1.10

hoist load

m_H

suspended load which includes all the masses of a load equal to the rated capacity of the hoist, the hoist medium and the fixed load lifting attachments, e.g. hooks, grabs, magnets, lifting beams, vacuum lifters

3.1.11

hoist medium

part of the hoist and is either rope, belt, steel link chain or roller chain

3.1.12**hydraulic components**

elements (e.g. switches, valves, filters) interconnected and forming an operational hydraulic system

3.1.13**hydraulic overpressure**

pressure exceeding the rated pressure

3.1.14**rated pressure**

maximum pressure in hydraulic or pneumatic systems at which the component is intended to operate for a number of repetitions sufficient to assure adequate service life

3.1.15**hydraulic transmission**

<energy and signal> supply, control and distribution of energy by means of pressurized fluid

3.1.16**indirect control**

main power circuit is controlled by additional means between the hand controlled actuator and the main power circuit

3.1.17**maximum speed**

maximum of all speeds in hoisting or lowering direction

Note 1 to entry: For inverter driven hoists, this speed can occur at the maximum frequency but with a load smaller than the rated capacity of the hoist.

3.1.18**NGL building hoist****Non Guided Load building hoist**

multi layer rope drum hoist with a rated capacity of up to 500 kg characterised by frequent temporary installation on the construction site by the use of interchangeable supporting structures matching with the hoists frame

3.1.19**power source**

energy to drive the prime mover of a hoist, e.g. electrical, hydraulic, pneumatic

3.1.20**rated capacity** **m_{RC}**

maximum load that the hoist is designed to lift

Note 1 to entry: In the case of hoists with multi-layer winding, this applies independent of the layer of the rope on the drum.

3.1.21**rated capacity limiter**

device that automatically prevents the hoist from handling loads in excess of its rated capacity, taking into account the dynamic effects during normal operational use

Note 1 to entry: This can be achieved by limiting the force flow (direct acting rated capacity limiter) or by switching off the energy supply to the lifting drive and stopping the lifting movement (indirect acting rated capacity limiter).

Note 2 to entry: This is the same as Lifting force limiter as used in EN 13001-2.

3.1.22

rated hoisting speed

linear speed of the load when lifting the rated capacity of the hoist:

- in case of electric motors, at rated voltage and rated frequency as indicated on the nameplate;
- in case of hydraulic motors, at rated flow as indicated on the nameplate;
- in case of pneumatic motors, at rated pressure as indicated on the nameplate

Note 1 to entry: For rope hoists, the speed at the lowest rope-layer on the drum. For NGL building hoists, the average hoisting speed for the declared vertical path.

3.1.23

rated lowering speed

linear speed of the load when lowering the rated capacity of the hoist:

- in case of electric motors, at rated voltage and rated frequency as indicated on the nameplate;
- in case of hydraulic motors, at rated flow as indicated on the nameplate;
- in case of pneumatic motors, at rated pressure as indicated on the nameplate

Note 1 to entry: For rope hoists, the speed at the lowest rope-layer on the drum. For NGL building hoists the average lowering speed for the declared vertical path.

3.1.24

rope anchorage

arrangement comprising the parts which connect the rope end termination to the major load bearing structure, e.g. pins, bolts, compensating levers, tension rods, the rope fastening on the rope drum are not included

3.1.25

rope drive

system of ropes running on rope drums and over rope sheaves, compensation sheaves, rope anchorage and fastening on the rope drum

3.1.26

compensating sheave

sheave for balancing rope forces, allowing an unlimited movement of rope

3.1.27

rope end termination

arrangement that has direct contact with the rope in order to allow its connection to e.g. rope anchorage and hook

3.1.28

rope fastening on the rope drum

all parts with which the rope is fastened on the rope drum

3.1.29**construction winch**

power-operated, temporarily installed lifting appliance which is equipped with means for lifting and lowering a suspended load

Note 1 to entry: Definition is based on the Directive 2000/14/EC.

Note 2 to entry: Construction winch is a hoist in terms of this European Standard.

3.2 Symbols and abbreviations

For the purpose of this document, the symbols and abbreviations given in Table 1 apply.

Table 1 — Symbol and abbreviations

Symbols, abbreviations	Description
C	is the rigidity of the hoist, hoist medium and the supporting structure [N/m]
C_{rm}	is the rigidity per meter of a rope, respectively chain, respectively belt [N]
C_{med}	is the rigidity of the hoist medium (rope or chain or belt) [N/m]
F	is the drive force reduced to hook path, [N]
$F_{max,L}$	is the maximum force [N]
F_{Lim}	is the force limit [N]
F_{trig}	is the triggering-force [N]
g	is the acceleration due to gravity (9,81) [m/s ²]
h_a	is the average hoisting displacement in [m]
HD1-HD5	are the Classes of the type of hoist drive and its operation method
i_{Gear}	is the gear ratio
K_{2A}	is the environmental correction factor (see EN ISO 3744:2010, 4.3.2) [dB]
L_{p1}	is the sound pressure level measured at a distance of $d_1 = 1$ m from the source of sound
L_{pr}	is the sound pressure level to be determined at a distance of d_r from the source of sound
L_{pf}	is the average A-weighted emission sound pressure level on the measurement surface (hemisphere) [dB]
L_W	is the sound power level [dB]
$M_{Fstatic}$	is the torque of the brake when it is slipping with a speed lower than 100 rpm [Nm]
M_{Load}	is the torque that is induced into output shaft of the gearbox under static conditions with m_{RC} [Nm]
P	load path [m]
S_{ang}	is the smallest offered reeving
$S_{n/k}$	is the rope force stress resultant [N]

Symbols, abbreviations	Description
S_0	is the reference area, set equal to 1 [m ²]
S_{test}	is the test reeving
T	is the total duration of use in h, according to ISO 4301-1:1986
U_{test}	is the increased number of the test cycles
U_{vor}	is the number of required cycles for classification according the A-class
$U(A)$	Design number of full load cycles of the selected A-class according Table K.1
U_1	is the number of full load cycles with lifting the load from the floor
U_2	is the max. number of load cycles with and without lifting the load from the floor
$v_{l,r}$	is the rated lowering speed in [m/s]
v_h	Is the selected speed in accordance with type of hoist drive and its operating method
$v_{h,r}$	is the rated hoisting speed in [m/s]
$v_{h,cs}$	is the steady hoisting creep speed in [m/s]
f_{Last}	is the load variation factor
k	is number of ropes winded on the drums
l_H	is the hook path [m]
m	is the mass of the load, [kg]
m_H	is the hoist load [kg]
m_R	are the moments of inertia reduced to hook path of motor, brake, gearbox, drum, [kg]
m_{RC}	is the rated capacity of the hoist [kg]
n	is the number of load bearing ropes, chains, belts
Δt_{bt}	is the motion braking time affected by the combined hoist medium tension and brake torque [s]
Δt_{IAL}	is the time lapse after attaining load level αm_{RC} to when actual motion braking commences [s]
$\ddot{X}_{n/k}$	is the acceleration of the load, [m/s ²]
α	is the triggering-factor (NOTE Used in Chapter 5.2.2)
α	angle of the grooves on the drum
β_L, β_R	fleet angles on the pulley
r	is the radius of the hemisphere (distance of the microphone from the main noise source of the hoist unit see M.4.1) [m]
η	is the combined efficiency factor of the gearbox and the load bearing elements (e.g. rope, chain)
ϕ_L	is the force-limit factor

Symbols, abbreviations	Description
ϕ_{DAL}	is the force-limit factor for direct acting rating capacity limiters
ϕ_{IAL}	is the force limit factor for indirect acting rated capacity limiters

4 List of significant hazards

Table 2 contains all the significant hazards, hazardous situations and events that could result in risks to persons during normal use and foreseeable misuse, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of machinery and which require action to minimize the risk.

NOTE 1 n.a. considered during risk assessment analysis and decided to be not significant.

NOTE 2 The significant hazards are based upon EN 12100.

Table 2 — List of significant hazards and associated requirements

	Hazards	Relevant clause(s) in this European Standard
1	Mechanical hazards due to: machine parts or workpieces, e.g.: a) shape; b) relative location; c) mass and stability (potential energy of elements which may move under the effect of gravity); d) mass and velocity (kinetic energy of elements in controlled or uncontrolled motion); e) inadequacy of mechanical strength	5.1, 5.12.3 n.a. 5.1, I.5 5.4, 5.12.2, 5.12.4 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, I.5
	— accumulation of energy inside the machinery, e.g.: a) elastic elements (springs); b) liquids and gases under pressure; — the effect of vacuum	5.4 5.10, 5.11 5.11.4.3
1.1	Crushing hazard	5.1, 5.7.2, 5.7.4, 5.7.10, 5.12.3, I.4.1
1.2	Shearing hazard	5.1, I.4.1
1.3	Cutting or severing hazard	5.1, 5.8.3, I.4.1
1.4	Entanglement hazard	5.1, 5.7.2, 5.7.4, 5.8.3
1.5	Drawing-in or trapping hazard	5.1, 5.7.2, 5.7.4, 5.8.3
1.6	Impact hazard	5.1, 5.8.2, I.1, I.4.1
1.7	Stabbing or puncture hazard	5.1, I.4.1
1.8	Friction or abrasion hazard	5.1, 5.7.2, 5.7.4, 5.7.10, 5.8.1
1.9	High pressure fluid injection or ejection hazard	5.11.4.2, 5.11.5, 5.11.6.3

	Hazards	Relevant clause(s) in this European Standard
1.10	Slipping, tripping and falling	n.a.
2	Electrical hazards due to:	
2.1	Contact of persons with live parts (direct contact)	5.2.1, 5.13, 5.13.4
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	5.2.1, 5.13, 5.13.4
2.3	Approach to live parts under high voltage	5.13.1
2.4	Electrostatic phenomena	5.13
2.5	Thermal radiation or other phenomena such as the projection of molten particles and chemical effects from short circuits, overloads etc.	5.13
2.6	Electromagnetic phenomena	n.a.
3	Thermal hazards, resulting in:	
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources	5.1, 5.11.6.5 5.11.6.6, 5.15
3.2	Damage to health by hot or cold working environment	n.a.
3.3	dehydration	n.a.
4	Hazards generated by noise, resulting in:	
4.1	Hearing loss (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	5.14, 7.2, Annex M
4.2	Interference with speech communication, acoustic signals etc.	5.14, Annex M
5	Hazards generated by vibration due to:	
5.1	Use of hand-held machines resulting in a variety of neurological and vascular disorders	n.a.
5.2	Whole body vibration, particularly when combined with poor postures	n.a.
6	Hazards generated by radiation due to:	
6.1	Low frequency, radio frequency radiation, micro waves	F.2
6.2	Infrared, visible and ultraviolet light	n.a.
6.3	X and gamma rays	n.a.
6.4	Alpha, beta rays, electron or ion beams; neutrons	n.a.
6.5	Lasers	F.2
6.6	Ionizing radiation source	n.a.
7	Hazards generated by materials and substances (and their constituent elements) processed or used by the machinery due to:	
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes, and dusts	5.4, 5.10.1, 5.11.1, 5.12.2

	Hazards	Relevant clause(s) in this European Standard
7.2	Fire or explosion hazard	5.11.6.5, 5.11.6.6, 5.15, Annex F
7.3	Biological or microbiological (viral or bacterial) hazards	n.a
7.4	Use/application of pesticides	n.a
8	Hazards generated by neglecting ergonomic principles in machinery design as, e.g. hazards from:	
8.1	Unhealthy postures of excessive effort	5.2.1, I.4.2.5
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	n.a.
8.3	Neglected use of personal protection equipment	n.a.
8.4	Inadequate local lighting	7
8.5	Mental overload and under-load, stress	n.a.
8.6	Human error, human behaviour	5.2.1
8.7	Inadequate design, location or identification of manual controls	5.2.1, 5.13
8.8	Inadequate design or location of visual display units	5.2.1, 5.13
8.9	Insufficient means for evacuation/emergency exit	n.a
8.10	Repetitive activity	n.a.
9	Combination of hazards	
10	Unexpected start-up, unexpected overrun/overspeed (or any similar malfunction) from:	
10.1	Failure/disorder of the control system	5.2.1, 5.2.3, 5.2.5, 5.4, 5.10.3, 5.10.4, 5.10.5.1, 5.11.6.1, 5.11.6.2, 5.12.2, 5.13.4, 5.13.7, 5.13.8.2
10.2	Restoration of energy supply after an interruption	5.2.1, 5.2.3, 5.10.5.1, 5.13
10.3	External influences on electrical equipment	5.12.2, 5.13
10.4	Other external influences (gravity, wind etc.)	5.4, 5.12.4, I.5
10.5	Errors in the software	5.2.5, 5.13
10.6	Errors made by the operator (due to mismatch of machinery with human characteristics and abilities, see 8.6)	n.a.
10.7	Overspeed during operation	5.13.8.3
11	Impossibility of stopping the machine in the best possible conditions	5.2.1, 5.2.3, 5.10.5.1, 5.10.1, 5.11.6.1, 5.12.2, 5.13.4, 5.13.7
12	Variations in the rotational speed of tools	n.a.
13	Failure of the power supply	5.4, 5.10.2.2, 5.11.6.2, 5.12.2, 5.13, 5.13.8.2
14	Failure of the control circuit	5.2.1, 5.2.3, 5.2.5, 5.4, 5.10.3, 5.10.4, 5.10.5.1, 5.11.5, 5.11.6.1, 5.12.2, 5.13
15	Errors of fitting	5.5, 5.12.4, 5.13, 7, I.4.1, I.4.2, I.6
16	Break-up during operation	5.1, 5.4, 5.5, 5.7.9, 5.8.4, 5.9.2

	Hazards	Relevant clause(s) in this European Standard
17	Falling or ejected objects or fluids	5.12.4, I.4.1
18	Loss of stability / overturning of machinery	I.4.1, I.5
19	Slip, trip and fall of persons (related to machinery)	I.4.1
Additional hazards, hazardous situations and hazardous events due to mobility		
20	Relating to the travelling function:	
20.1	Movement when starting the engine	n.a.
20.2	Movement without a driver at the driving position	5.2.1
20.3	Movement without all parts in a safe position	5.2.1
20.4	Excessive speed of pedestrian controlled machinery	n.a.
20.5	Excessive oscillations when moving	n.a.
20.6	Insufficient ability of machinery to be slowed down, stopped and immobilised	5.2.1, 5.2.3, 5.10.3, 5.10.4
21	Linked to the work position (including driving station) on the machine due to:	
21.1	Fall of persons during access to (or at/from) the work position	n.a.
21.2	Exhaust gases/lack of oxygen at the work position	n.a.
21.3	Fire (flammability of the cab, lack of extinguishing means)	n.a.
21.4	Mechanical hazards at the work position: — contact with the wheels; — rollover and overturning — slipping during access; — fall of objects, penetration by objects; — break-up of parts rotating at high speed; contact of persons with machine parts or tools (pedestrian controlled machines).	n.a.
21.5	Insufficient visibility from the work positions	7.2.
21.6	Inadequate lighting	n.a.
21.7	Inadequate seating	n.a.
21.8	Noise at the work position	5.14, Annex M
21.9	Vibration at the work position	n.a.
21.10	Insufficient means for evacuation/emergency exit	n.a.
22	Due to the control system:	
22.1	Inadequate location of manual controls	5.2.1, 5.13
22.2	Inadequate design of manual controls and their mode of operation	5.2.1, 5.10.3, 5.10.4, 5.11.5, 5.11.6.1, 5.13
23	From handling the machine (lack of stability)	5.1
24	Due to the power source and to the transmission of power:	
24.1	Hazards from the engine and the batteries	n.a.

	Hazards	Relevant clause(s) in this European Standard
24.2	Hazards from transmission of power between machines	n.a.
24.3	Hazards from coupling and towing	n.a.
25	From/to third persons due to:	
25.1	Unauthorised start-up/use	5.2.1
25.2	Drift of a part away from its stopping position	5.12.2
25.3	Lack or inadequacy of visual or acoustic warning means	5.16.3, 5.16.4
26	Insufficient instructions for the driver/operator	7
Additional hazards, hazardous situations and hazardous events due to lifting		
27	Mechanical hazards and hazardous events:	
27.1	From load falls, collisions, machine tipping caused by:	
27.1.1	Lack of stability	5.1, I 4.1, I.5,
27.1.2	Uncontrolled loading – overloading – overturning moments exceeded	5.2.2, 5.11.3, I.1, I.4.1
27.1.3	Uncontrolled amplitude of movements	5.2.1, 5.2.4, 5.4, 5.13.8.1, 5.13.8.2, I.4
27.1.4	Unexpected/unintended movement of loads	5.2.1, 5.2.2.3, 5.4, 5.10.2.2, 5.11.3, 5.11.6.2, 5.13.8.1 5.13.8.2, I.4.1
27.1.5	Inadequate holding devices/accessories	5.1, 5.6, 5.7.6, 5.7.9, 5.8.4, 5.9.4, 5.9.5, I.4.1
27.1.6	Collision of more than one machine	n.a.
27.2	From access of persons to load support	n.a.
27.3	From derailment	5.12.4, I.4.1
27.4	From insufficient mechanical strength of parts	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.11, 5.12, I.5
27.5	From inadequate design of pulleys, drums	5.7.1, 5.7.2, 5.7.4, 5.7.5, 5.7.6, 5.7.10, 5.9.1, 5.9.3, 5.9.4
27.6	From inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine	5.7, 5.8, 5.9
27.7	From lowering of the load under the control of friction brake	5.4
27.8	From abnormal conditions of assembly/testing/use/maintenance	7, I.4.1
	From the effect of load on persons (impact by load or counterweight)	5.2.1, 5.12.2, 7, I.4.1
28	Electrical hazards	
28.1	From lightning	5.13
29	Hazards generated by neglecting ergonomic principles	n.a.
29.1	Insufficient visibility from the driving position	7
Additional hazards, hazardous situations and hazardous events due to underground work		

	Hazards	Relevant clause(s) in this European Standard
30	Mechanical hazards and hazardous events due to:	
30.1	Lack of stability of powered roof supports	n.a.
30.2	Failing accelerator or brake control of machinery running on rails	5.2.1, 5.12.2
30.3	Failing or lack of dead man's control of machinery running on rails	5.2.1, 5.2.3, 5.3, 5.10.4, 5.11.5
31	Restricted movement of persons	n.a.
32	Fire and explosion	n.a.
33	Emission of dust, gases etc.	n.a.
Additional hazards, hazardous situations and hazardous events due to the lifting or moving of persons		
34	Mechanical hazards and hazardous events due to:	
34.1	Inadequate mechanical strength — inadequate working coefficients	n.a.
34.2	Failing of loading control	n.a.
34.3	Failing of controls in person carrier (function, priority)	n.a.
34.4	Overspeed of person carrier	n.a.
35	Falling of person from person carrier	n.a.
36	Falling or overturning of person carrier	n.a.
37	Human error, human behaviour	n.a.

5 Safety requirements and/or protective measures

5.1 General

Hoists shall comply with the safety requirements and/or protective measures of this clause. In addition, the hoist shall be designed in accordance with the principles of EN ISO 12100 for hazards relevant but not significant, which are not dealt with by this European Standard.

Hoists shall be classified in line with EN 13001-1. Replacement of chains and belts during the design life of the hoist may be assumed in the design, in analogy to ropes in accordance with EN 13001-3-2. This shall be expressed as a design number of chains or belts used during the total design life of the hoist.

The following design parameters shall be documented in the design calculations of a hoist:

- rated load,
- load distribution, either by average load, load spectrum factor or class Q of load spectrum factor,
- number of work cycles,
- average vertical load movement in a loaded part of a work cycle, typically sum of hoisting and lowering distances,
- average horizontal load movement in a loaded part of a work cycle, where relevant
- number of ropes, chains or belts taken for the total design life of the hoist.

The above parameters of use (except rated load) may be specified through classification of a hoist.

The classification of hoist shall be in accordance with Annex B. A guidance is given in Annex C.

Where a hoist class is specified, the S-class for stationary (non-rotating) structural parts can be taken from Table B.3.

Hoists shall be designed for loads and load combinations in accordance with EN 13001-2, relevant to the intended use of a hoist.

Structural parts of hoists shall be designed for the specified use in accordance with EN 13001-3-1. Alternatively, advanced and recognized theoretical or experimental methods may be used. This includes also the experimental determination of the fatigue strength of special details. In these cases, the reference shall be mentioned.

Mechanical and electrical equipment of hoists shall conform to EN 13135 and EN 60204-32, except as otherwise given in this standard.

Additional requirements for certain applications are as follows:

- a) hoists shall be in accordance with Annex D for high risk applications, e.g. when transporting hot molten masses
- b) hoists shall be in accordance with Annex E when holding stationary loads above persons;
- c) supporting-structures for NGL building hoists shall be in accordance with Annex I.

Information for certain applications are given by:

- d) hoists should be in accordance with Annex G when operating in aggressive environments and outdoors;
- e) hoists should be in accordance with Annex H when operating at low temperatures.

Accessible parts shall not have sharp edges, sharp angles or protruding parts that can cause injury. This can be achieved by e.g. deburring, flanging, trimming or sand blasting.

Connections and individual components of hoists shall incorporate features so that they cannot self-loosen.

Moving transmission parts (shafts, fans, wheels, gears, belts, couplings) shall be designed, positioned or guarded in order to protect against the risks associated with possible contact of exposed persons during the intended use.

Risk of burn during hoisting operation caused by contact between the operator's skin and hot surfaces of the hoist shall be reduced by following the principles of EN ISO 13732-1.

The test procedure for verification of the design of hoists shall be in accordance with Annex J. Hoists and trolleys shall be designed taking into account the static and dynamic forces which may occur at intended use. Forces which occur due to the activation of the rated capacity limiter and the Emergency-Stop-Function shall be taken into account.

5.2 Devices

5.2.1 Control devices

Devices for starting and stopping manually-controlled hoists shall be fitted with hold-to-run control elements so that the drive energy supply is interrupted when the actuating elements are released.

Actuating elements of control devices shall incorporate features that prevent unintentional operation or not wanted movements of the load (see EN 13557:2003+A2:2008, 5.2.3.1.2). Actuating elements of

control devices shall incorporate features and be arranged and marked in such a way that their assignments, direction of operation and switching state are unmistakably recognizable, using pictograms (symbols), where appropriate.

5.2.2 Rated capacity limiters and indicators

5.2.2.1 General

Hoists with a rated capacity of 1 000 kg or more shall be fitted with a rated capacity limiter.

The rated capacity limiter shall be designed to prevent overloading of the hoist and the trolley. It shall also limit the forces transmitted to the supporting structure, which are to be provided by the manufacturer (see 7.2). Overloading means exceeding the designed operating forces.

A rated capacity limiter may also be incorporated within the supporting structure into which a hoist is fitted.

Rated capacity limiters shall be in accordance with EN 12077-2.

Rated capacity limiters shall operate to override the controls of the hoist as required in EN 12077-2:1998+A1:2008, 5.4.2.1. This requirement can be fulfilled either by direct acting rated capacity limiter or by indirect acting rated capacity limiter.

For hoists for which the rated capacity does not vary with the position of the load the risk assessment shows that no hazard occurs from the load when the rated capacity limiter was triggered. These hoists do therefore not require rated capacity indicators as defined in EN 12077-2.

5.2.2.2 Setting

5.2.2.2.1 General

The rated capacity limiter shall limit the forces to a level equal to or less than the designed operating forces (as defined in EN 12077-2:1998+A1:2008, 5.4.1.2).

5.2.2.2.2 Direct acting rated capacity limiters

The setting shall be such that a load equal to 110 % of the rated capacity of the hoist can be lifted in order to perform the dynamic overload test, see Clause 6, this without changing the setting of the rated capacity limiter.

The limiter shall prevent the hoisting of a load higher than 160 % of the rated capacity of the hoist.

5.2.2.2.3 Indirect acting rated capacity limiters

The limiter system shall be such that lifting of a grounded load greater than 1,1 times the rated capacity triggers the lifting capacity limiter.

In a single level triggering system this is achieved by setting the triggering factor (α) to a value corresponding to 1,1 times the rated capacity increased with the design value of the dynamic factor ϕ_2 . Typically the triggering factor α should be less or equal to 1,25. For limiter systems with two triggering levels and an in-built time delay, see EN 15011.

A load greater than α times the rated capacity shall not be lifted over a distance greater than the maximum rated hoisting speed multiplied by 1 s.

5.2.2.3 Maximum force

5.2.2.3.1 General

The maximum force $F_{\max,L}$ occurs when the rated capacity limiter operates -

The maximum force, which applies to the hoist and the trolley when the rated capacity limiter has operated, shall be calculated according to Formula (1)

$$F_{\max,L} = (\phi_L \times m_{RC} + (m_H - m_{RC})) \times g \quad (1)$$

where

$F_{\max,L}$ is the maximum force [N];

ϕ_L is the force-limit factor;

The force-limit factor ϕ_L depends on the type of limiter:

$\phi_L = \phi_{DAL}$ in case of direct acting limiter (see 5.2.2.3.2);

$\phi_L = \phi_{IAL}$ in case of indirect acting limiter (see 5.2.2.3.3);

m_H is the hoist load [kg];

m_{RC} is the rated capacity of the hoist [kg];

g is the acceleration due to gravity (9,81) [m/s²].

The maximum force $F_{\max,L}$ shall be assigned to load combination C as specified in EN 13001-2.

The mass of the hoist medium can be neglected if it is less than 5 % of the rated capacity of the hoist plus the mass of the fixed load lifting attachments.

5.2.2.3.2 Direct acting rated capacity limiters — maximum force

Direct acting rated capacity limiters act directly in the chain of drive elements and limit the transmitted force. Those limiters are for example friction torque limiters and pressure limiting valves. Direct acting rated capacity limiters generally have no response delay and require no braking path.

The most frequently used limiters for direct limitation are friction torque limiters, which are set to the force limit as given in Formula (2):

$$F_{\lim} = (\phi_{DAL} \times m_{RC} + m_H - m_{RC}) \times g \quad (2)$$

where

$F_{\lim}$ is the force limit [N];

ϕ_{DAL} is the force-limit factor for direct acting rating capacity limiters;

m_{RC} is the rated capacity of the hoist [kg];

m_H is the hoist load [kg];

g is the acceleration due to gravity (9,81) [m/s²].

For friction torque limiters, the factor ϕ_{DAL} shall be less than or equal to 1,6.

On hydraulically acting rated capacity limiters (e.g. pressure relief valves), the factor ϕ_{DAL} shall be less than or equal to 1,4. On pneumatically acting rated capacity limiters, the factor ϕ_{DAL} shall be less or equal 1,6.

For direct acting rated capacity limiters the maximal force $F_{\max,L}$ as defined in Formula (1) is equal to the force limit $F_{\lim}$ in Formula (2); see Formula (3):

$$F_{\max,L} = F_{\lim} \quad (3)$$

where

$F_{\max,L}$ is the maximum force [N];

$F_{\lim}$ is the force limit [N].

5.2.2.3.3 Indirect acting rated capacity limiters – maximum force

Indirect acting rated capacity limiters measure the transmitted force using a sensor and switch off the energy supply for the lifting operation and, if required, apply the brake torque. The force when the limiter starts operating is called the triggering-force. Evaluation of that force and filtering of interference signals require time and act as a switch-off-delay. This delay is called response-time. After the response-time the limiter switches off the energy-supply.

The triggering-force shall be calculated by Formula (4):

$$F_{\text{trig}} = (\alpha \times m_{\text{RC}} + m_{\text{H}} - m_{\text{RC}}) \times g \quad (4)$$

where

F_{trig} is the triggering-force [N];

α is the triggering-factor ;

m_{RC} is the rated capacity of the hoist [kg];

m_{H} is the hoist load [kg];

g is the acceleration due to gravity (9,81) [m/s²].

The triggering-factor includes the maximum tolerance of the limiter, resulting from its design and construction.

The factor ϕ_{IAL} for indirect acting rated capacity limiters shall be calculated as given in Formula (5) or determined through a test:

$$\phi_{\text{IAL}} = \alpha + \frac{\left(C \times v_{\text{h}} \left(\Delta t_{\text{IAL}} + \frac{\Delta t_{\text{bt}}}{2} \right) \right)}{(m_{\text{RC}} \times g)} \quad (5)$$

where

ϕ_{IAL} is the force limit factor for indirect acting rated capacity limiters ;

v_{h} is the hoisting speed [m/s]. The appropriate speed shall be selected from Table 3;

m_{RC} is the rated capacity of the hoist [kg];

C is the rigidity of the hoist, hoist medium and the supporting structure [N/m];

Δt_{IAL} is the time lapse after attaining load level $\alpha \cdot m_{\text{RC}}$ to when actual motion braking commences [s];

Δt_{bt} is the motion braking time affected by the combined hoist medium tension and brake torque [s];

g is the acceleration due to gravity (9,81) [m/s²].

When the rigidity of the supporting structure is unknown at the hoist design stage, it shall be assumed to be rigid.

The rigidity of the hoist medium can be calculated by the following Formula (6):

$$C_{med} = \frac{C_m \times n}{l_H} \quad (6)$$

where

C_{med} is the rigidity of the hoist medium (rope or chain or belt) [N/m];

C_m is the rigidity per meter of a rope, respectively chain, respectively belt [N];

n is the number of load bearing ropes, chains, belts;

l_H is the hook path [m].

For indirect acting rated capacity limiters the maximum force $F_{max,L}$ as defined in Formula (1) is not equal to the triggering-force F_{trig} in Formula (4).

The maximum force $F_{max,L}$, as defined in Formula (1) shall be evaluated by Formula (7)

$$F_{max,L} = (\phi_{IAL} \cdot m_{RC} + m_H - m_{RC}) \times g \quad (7)$$

where

$F_{max,L}$ is the maximum force [N];

ϕ_{IAL} is the force limit factor for indirect acting rated capacity limiters;

m_{RC} is the rated capacity of the hoist [kg];

m_H is the hoist load [kg];

g is the acceleration due to gravity (9,81) [m/s²].

Table 3 — Values for v_h for estimation of ϕ_{IAL}

Hoisting speed	Type of hoist drive and its operating method				
	HD 1	HD 2	HD 3	HD 4	HD 5
v_h	$v_{h,max}$	$v_{h,cs}$	$v_{h,cs}$	$0,5 \cdot v_{h,max}$	0
where HD1: Creep speed is not available or the start of the drive without creep speed is possible; HD2: Hoist drive can only start at creep speed of at least a preset duration; HD3: Hoist drive control maintains creep speed until the load is lifted off the ground; HD4: Step-less hoist drive control, which performs with continuously increasing speed; HD5: Step-less hoist drive control automatically ensures that the dynamic factor ϕ_2 does not exceed $\phi_{2,min}$. $v_{h,max}$ is the maximum hoisting speed; $v_{h,cs}$ is the steady hoisting creep speed.					

NOTE For further information see EN 13001-2:2014, Annex B for illustration of the types of hoist drives.

Indicative values of ϕ_L for different types of rated capacity limiters are given in Annex K.

5.2.2.4 Additional requirements for friction torque limiters

Requirements for friction torque limiters depend on their position in the force flow, and whether the slipping of the friction force limiter is monitored or not.

The first characterizing factor is the position of the friction force limiter: whether it is situated inside the force flow when the brake is engaged (Type 1) or outside (Type 2). Figure 2 shows two general principles as an example. Several different arrangements that fulfil the same function are possible.

The second characterizing factor is the monitoring of slipping of the friction torque limiter: in Type 1B and 2B the monitoring exists and the hoist control system switches off automatically, when slipping is detected. Type 1A and 2A systems do not have the monitoring of slipping.

Requirements:

Friction torque limiters of Type 1A and 2A used as rated capacity limiters shall be such that, when triggered, the torque which can be transmitted over a duration period of time of 60 s shall not exceed the maximum value specified by the manufacturer, and the lifting force shall be sufficient to hold a load equal to the rated capacity of the hoist in the lifting motion and when the motor is at standstill. After this period of time of 60 s, the rated capacity of the hoist may lower at an average speed of not more than half the rated lowering speed whilst the motor is operated upwards; in this case, this speed is determined over a distance of at least 3 m.

For Type 2A the lowering of the load with max half of the rated speed may start also inside the 60 s of the test.

Friction torque limiters of Type 1B and 2B used as rated capacity limiters shall be such that, when triggered and reset 3 times within 60 s, the torque which can be transmitted shall not exceed the maximum value specified by the manufacturer and the lifting force shall be sufficient to hold a load.

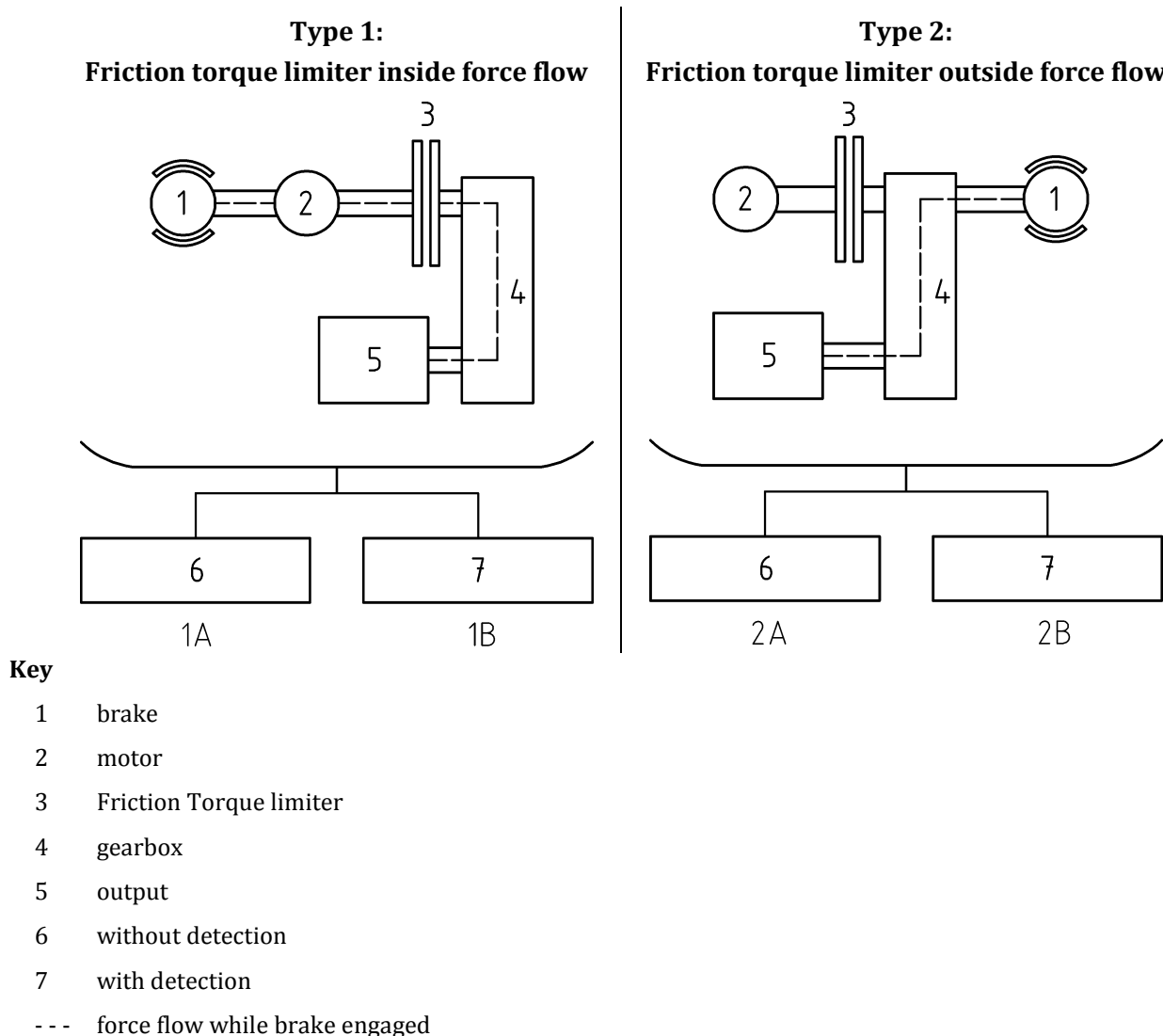


Figure 2 — Arrangements of Friction Torque limiters — Force Flow

5.2.3 Emergency stop function

Hoists shall be provided with an emergency stop function. The emergency stop function shall be available and operational at all times, regardless of the operating mode.

Electrically powered hoists shall be in accordance with 5.13.7, pneumatically powered hoists shall be in accordance with 5.10.5.1 and hydraulically powered hoists shall be in accordance with 5.11.6.1.

5.2.4 Hoisting and lowering limiters

5.2.4.1 General

Hoists shall be fitted with hoisting and lowering limiters in accordance with EN 12077-2:1998+A1:2008, 5.6.1.

Hoisting and lowering limiters include, for example, electrical limit switches, adjustable friction torque limiters, relief valves.

Friction torque limiters used as hoisting and lowering limiters shall fulfil the requirements of 5.2.2.4.

The following prescriptions shall apply in addition to those stated in EN 12077-2.

Electromechanical limiters shall have a positive opening system.

After operation of a limiter, it shall be ensured that the limiter does not return to its original position until the corresponding restricted area has been left by the actuating part.

The lowering limiter shall ensure that the minimum engagement of the lifting medium is maintained at all times during operation. The lowering limiter shall also stop the motion to prevent unwanted coiling in the reverse direction.

5.2.4.2 Second limiter (= backup limiter) for hoisting

For normal operation a second limiter, as defined in EN 12077-2:1998+A1:2008, 5.6.1.4, is not necessary.

A risk assessment based on the particular application may result in the need of a second limiter for certain motions. This second limiter shall not be approached during normal operation, whereas the first limiter can be approached during normal operation.

Based upon the risk assessment, a second limiter may be necessary, for example when the hoisting limiter is activated with regularity and this limiter is not designed for regularity.

Following operation of the second limiter, a restart shall only be possible by a reset action, e.g. by using a key-lockable hold-to-run control on the control stand, manual reset button on the hoist. The indication of a failure of the first limiter, as required in EN 12077-2:1998+A1:2008, is, that a reset action is necessary, after the second limiter has been triggered.

Following operation of the second limiter, a restart shall only be possible into the opposite direction.

Indication and reset action are not necessary, if the second limiter is a friction torque limiter or a fixed end stop (like an end buffer) designed to accommodate the movement energy.

5.2.5 Safety-related functions

All safety-related functions of controls shall fulfil at least the following requirements of EN ISO 13849-1:

- control circuits built with electromechanical, hydraulic and pneumatic components: at least Performance level c and at least category 1;
- control circuits built with electronic or programmable components, respectively: at least Performance Level c and category 2.

Safety related functions of the control systems are e.g.:

- rated capacity limiters, see 5.2.2;
- emergency stop device, see 5.2.3;
- hoisting and lowering limiters, see 5.2.4;
- motion limiter for trolley (see 5.12.1);
- protective measures (pneumatic), see 5.10.5;
- protective measures (hydraulic), see 5.11.6;
- power feed isolating and switching devices see 5.13.4.

In the following two cases, all safety-related functions of control systems, except power feed isolating and switching devices (see 5.13.4) shall conform to at least Performance Level d:

- lifting operations above pipes and tubes where the destruction of those pipes and tubes by a falling load can cause the escape of combustible gases or fluids;
- hoisting, lowering and travelling of hot molten masses or other goods with comparable hazards as acid or base.

Safety related functions of control devices, units and systems defined in 5.2.1, 5.10.3, 5.10.4 and 5.11.5 shall fulfil at least Performance level b and at least category 1.

STOP function in cable-less control systems, as laid down in EN 13557:2003+A1:2008, Annex C, C.3.1: at least Performance Level c and at least category 3.

5.3 Couplings

Couplings in the flow of hoisting forces, with the exception of friction torque limiters, shall be constructed so that in case of a failure of plastic or rubber parts, there is a positive engagement by metal parts.

5.4 Brakes for hoisting and lowering movements

Service brakes for vertical movements shall be designed in accordance with EN 13135, with the following additional requirements as given in this clause. Backup brakes for vertical movements shall be designed in accordance with EN 13135.

Hoists shall be designed in such a way that movements can be decelerated, the load can be held, and that unintended movements are avoided. In addition the rotating masses, the triggering limit of the rated capacity limiter and the maximum speed, e.g. in the event of a phase failure, shall be taken into account.

Brakes shall engage automatically when:

- a) the control device returns to its neutral position;
- b) the emergency stop function is activated;
- c) the external power supply to the brake is interrupted;
- d) the power supply of the corresponding drive (= motor) is interrupted or switched off.

In addition to letters a) to d),

in the case of 3-phase motors, brakes shall engage automatically when

- e) two phases of the power supply of the corresponding drive (= motor) are interrupted.

In case only one phase fails, see 5.13.8.1 and 5.13.8.2.

With spring loaded brakes, brake springs shall be compression springs and shall be guided.

If the braking-force is supplied by pre-stressed springs, the failure of any spring in the braking system shall not reduce the available braking torque by more than 20 %. This can be achieved, for example

- by using at least 5 springs;
- if less than 5 helical springs are used, they shall be dimensioned such, that the wire diameter is greater than the distance between the windings in the working condition to prevent screwing in of the two spring parts in the event of a wire break.

It shall be possible to check, adjust and replace the brake or the brake linings, when required in the user manual. The connection between brake lining and brake lining holder shall not permit unintentional release.

The brakes for hoisting movement shall fulfil the requirement of Formula (8).

$$M_B \geq 1,8 \times M_L \times \eta \quad (8)$$

where

- M_B is the specified holding torque of the brake applied to the brake shaft at speed equal to or lower than 100 rpm;
- M_L is the torque on the brake due to the rated load in static condition without mechanical efficiency
- η is the total mechanical efficiency of the load carrying mechanism, including e.g. gear transmissions and load suspension.

Definition of the braking torque:

Static: is the required torque which prevents the brake from slipping when being at standstill.

- In case of electrical braking (e.g. by pole switching or by inverter powered motors) the mechanical brake shall be capable of slowing down the hoist under full load, in lowering direction for minimum 4 times within 10 min (emergency switch off or power loss situation)
- to ensure the reaction time of the braking is such that it does not allow the rated load to accelerate to a lowering speed greater than 1,5 times the rated lowering speed. This requirement shall be fulfilled for the most unfavourable load/speed combination where variable speeds are used.

The specified speed limit of 150 % is the final speed resulting from the triggering and braking sequence, considering all the response delays in the system.

5.5 Gearbox

Gearboxes shall be designed in accordance with the EN 13135. Gears shall be supported and connected to the driving and driven mechanisms in such a way that no impermissible and uncontrolled stresses or deformations are produced in the gears or bearings.

The gear reducer shall be supported and connected to the driving and driven mechanisms in such a way that no impermissible and uncontrolled stresses or deformations are produced in the gears or bearings.

5.6 Load hooks

The proof of competence of forged hooks shall be in accordance with EN 13001-3-5.

Hooks shall be designed in accordance with EN 13135.

5.7 Rope drives

5.7.1 General

Rope drives with steel wire ropes shall be classified and dimensioned in accordance with EN 13001-3-2. The design number of ropes used during the total design life of the hoists shall be provided.

The maximum value of the individual rope angles in the highest hook position shall be taken as the basis for calculating the rope forces of multiple fall rope reeving arrangements. Additional rope forces need not be taken into consideration in multiple fall rope reeving if all angles between single rope and the vertical are less than or equal to $22,5^\circ$.

The fleet angle for grooved drums and rope sheaves should not exceed 4° for all ropes and 2° for rotation-resistant rope.

NOTE This is referring to EN 13135.

The amount of lateral deflection of ropes from the groove direction of drums and rope pulleys shall be such that the rope lead-off cannot come into contact with the tip of the groove section of the drum.

In case of grooved drums with single layer the rope lead-off shall not come into contact with adjacent windings.

In the case of rope sheaves, the amount of deflection shall only be such that the rope cannot come into contact with the edge of the groove section.

5.7.2 Rope drum

Measures on drums shall be provided, e.g. flanged drum end plates, frame/housing and rope guides, which prevent the ropes to run off the ends of the rope drums.

Flanged drum end plates shall protrude beyond the rope wound on the drum at the top layer by at least $1,5 \times$ the nominal rope diameter.

Single layer drums shall be grooved. Grooving shall be smooth and free from surface defects liable to damage the rope. The edges shall be rounded. These grooves shall have a radius of $(0,525 \text{ to } 0,56) \times$ nominal rope diameter.

The rope groove depth shall be 0,28 times the nominal rope diameter or greater.

The groove pitch shall provide sufficient clearance between adjacent rope turns on the drum, taking into account the rope tolerance.

The fixing point of the rope shall be easily accessible for maintenance and replacement of the rope.

Rope run-on points in the normal working position of the operating personnel and in the traffic area shall be guarded to prevent accidental ingress of parts of the human body.

For NGL building hoists, having more than one layer of rope on the drum and where the rope has a nominal diameter ≤ 8 mm, a grooved drum is not necessary.

5.7.3 Ropes

Ropes used as hoist medium in rope drives shall be selected for the particular application and be made of suitable materials so that they withstand the permissible stresses and are rated for a period of service that exceeds the inspection interval specified by the manufacturer.

In the case of a load suspended by a single-fall rope drive and not guided, rotation resistant ropes shall be used.

Discard criteria shall be recognizable from the outside. Discard criteria are described in ISO 4309.

Rope ends shall be made in such a way that the rope structure does not become detached.

For multi-layered NGL building hoists where the nominal rope diameter is ≤ 8 mm, the working coefficient shall be at least 5.

Ropes manufactured from material other than steel shall only be used if the wear conditions are known and the discard criteria are recognizable, in this case at least the following safety requirements connected to the specific application shall be considered:

- fatigue;
- environment;
- structure of rope;
- terminations;
- elasticity and plasticity of the rope;
- rope drum;
- sheaves;
- guides/rope runs;
- fastening;
- anchorage.

Ropes manufactured from material other than steel shall not be used in high risk applications.

The working coefficient for ropes other than steel shall be a minimum of 7.

Based on research and development results, a smaller working coefficient than the one given above may be used. The coefficient used shall be validated by tests performed by the manufacturer or qualified test facility and shall not lead to a level of safety below those of steel wire ropes for the equivalent rope drive.

NOTE 1 Information for the selection of synthetic ropes for power driven winches in regard to their material, construction, UV-resistance, temperature sensibility, abrasion resistance is given in EN ISO 9554:2010, "Fibre ropes — General specifications"; Table A.1.

NOTE 2 ISO/TC 96 SC 3 "Selection of ropes" is working on a document regarding "Safe Use of High Performance Fibre Ropes" at present.

5.7.4 Rope sheaves

Ropes sheaves shall be in accordance with EN 13135. Rope sheaves shall be provided with a suitable means of preventing the rope from jumping out of the grooves (e.g. when the rope is slack).

In working and traffic areas to which personnel have unlimited access, the components of the rope systems and rope run-on points shall be installed or guarded in such a way that crane operations can be conducted with a minimized risk of trapping or drawing-in of hands or arms into jamming-prone areas.

The distance between the edge of the sheave and the protective components shall be less than $0,5 \times$ nominal rope diameter.

If the rope sheave breaks, it shall not be possible for the rope to slip off the sheave shaft.

5.7.5 Rope guides/rope runs

Rope drives shall be arranged in such a way that damage to the ropes by contact between them and with fixed and moving structures is prevented.

Ropes shall be prevented in case of slack rope conditions from lifting off the rope winding and generate dangerous conditions during the intended use.

Slack rope situation caused by putting the load onto the floor and simultaneous and continuing movement into the direction lowering is not intended use.

Maximum fleet angle shall be such that the unwinding rope does not contact the neighbouring rope, or impact the edge of the empty groove.

5.7.6 Rope fastening onto the rope drum

Rope fastening onto the rope drum shall be made in such a way that at least 2,5 times the remaining static force at the fastening device is accommodated when the rated capacity is applied to the hoist taking into account the friction effect of the winding on the drum. The coefficient of friction between wire rope and contact surface shall be assumed to be $\mu = 0,1$.

There shall be at least two rope windings remaining on the drum before the fixing point of the rope in the lowest position of the load supporting device (e.g. hook).

The fastening elements of the fixing point of the rope shall be selected taking into account the rope and drum contours. The rope shall not be led over edges.

5.7.7 Rope anchorage

Rope anchorage shall be such that bending of the rope and other additional stresses on the wire rope are avoided.

Rope anchorages for wire ropes of non-rotation resistant type, shall prevent the wire rope from twisting about its longitudinal axis.

Rope anchorage shall resist 2,5 times the static rope force resulting from the rated capacity of the hoist without permanent deformation.

5.7.8 Compensating lever

In rope systems with a compensating lever, means shall be provided to return the lever to the middle position after the extreme, inclined position of the lever has been reached

The compensating lever shall be fitted with a movement limitation device and with a limiter indicating that the extreme, inclined position of the lever has been reached.

In the case of redundant rope drives, the compensating lever shall be fitted with damping devices that minimize the impact forces if a rope breaks.

5.7.9 Rope end terminations

The rope-end terminations shall withstand, without permanent deformation, the rope force equal to 2,5 times the static rope force resulting from the rated capacity of the hoist.

The following rope end terminations of steel wire ropes are recommended and fulfil the requirement above:

- a) asymmetric wedge socket clevis, see EN 13411-6;
- b) symmetric wedge socket clevis, see EN 13411-7. This method of socketing shall be used only for rope diameters up to 8 mm;
- c) metal and resin socketing, see EN 13411-4;
- d) wire rope clamps and clamping, see EN 13411-3.

Wire rope grips and rope eyes in conjunction with wire rope grips shall not be used as rope-end terminations.

5.7.10 Traction Winches

The traction capacity shall be such that during intended use, tests and verification according to Clause 6 the rope does not slip or creep.

The traction capacity shall be proven either by calculation or by test, for 1,5 times the rated capacity for the intended number of pulling cycles. Wear and tear shall be taken into account, e.g. in case of winches where the traction depends on the state of wear of the groove.

The calculation of the traction capacity shall be in accordance with EN 81-50:2014, 5.11.

Means shall be provided to prevent the ropes from running off the sides of the traction sheave.

Where traction sheaves made of steel are grooved, the grooves shall correspond to the type and diameter of the rope intended to be used together with the winch. The groove surfaces, made of steel should have a roughness of not more than $Ra = 6,3$.

V-grooves without undercut groove base profile shall be stiff enough to prevent fundamental deformation, e.g. opening of the shape.

The undercut groove base profile width B of the traction sheave grooves shall not exceed 0,8 times the rope diameter or, if the rope diameter is less than 8 mm, 0,75 times the rope diameter (see Figure 3).

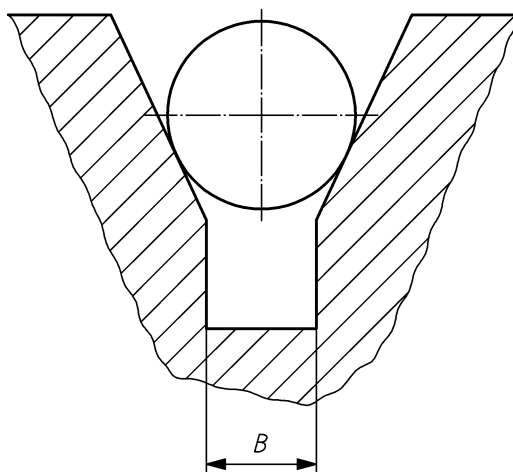


Figure 3 — Undercut groove base profile

5.8 Chain drives

5.8.1 General

Proof of competence for chain drives shall be made in accordance with EN 818-1:1996+A1:2008 and EN 818-7:2002+A1:2008, except as otherwise given in this standard. The calculation factors different from those in EN 818-7:2002+A1:2008 are given in Annex N and shall be applied.

The components of the chain drive (i.e. chain, chain drive sprockets, chain wheels and chain guides) shall match each other in terms of dimensions and materials. With the manufacturer's specified lubrication, chains shall be designed to be discarded due to wear before fatigue rupture.

Chain drive sprockets shall be made in one or two piece(s); in the case of two-piece chain sprockets, the arrangement of the two halves shall have positive engagement.

5.8.2 Chains

Chains shall be of short steel link type and in accordance with EN 818-1 and EN 818-7.

For roller chains identification marks shall be placed at least every 80 links on the chain for traceability-purposes.

The geometry of roller chains shall be in accordance with ISO 606. The working coefficient for roller chains shall be at least 6.

5.8.3 Chain guides

Chain drives shall be provided with a device which ensures that the chain runs properly over chain drive sprockets and chain guide wheels and which prevents the chain from jumping out, twisting and jamming.

In the working and transport zone, chain run-in points (for round steel and roller chains) on chain wheels and sprockets shall incorporate features which prevent manual ingress.

5.8.4 Chain anchorage

Chain anchorage devices shall withstand four times the static chain tensile force at rated capacity of the hoist without rupture.

Threaded connections on chain anchorage devices shall be locked to prevent self-loosening. The state of the fastening shall be verifiable.

5.8.5 Securing the chain from running off

The unloaded end of the chain shall be secured against running off the chain sprocket. This safety arrangement shall withstand the forces that occur when the end position is approached.

5.9 Belt drives

5.9.1 General

The drive shall be such that the belt is subject to uniform loading over its entire width under load conditions.

5.9.2 Belts

Belts used as load-bearing media in hoists shall be selected for the particular operating conditions, be made of materials such that they withstand the permissible stresses, and shall be rated for a period of service exceeding that specified by the manufacturer of the belt.

Discard criteria shall be based on externally recognizable belt conditions. A sufficient period of service shall remain between discard condition and rupture.

The materials of the belt shall be such that:

- a) environmental influences do not result in premature failure;
- b) damage caused by sharp edges or temperature influences do not lead to sudden failure of the belt;
- c) contact with the belt does not constitute a danger of injury due to the type of belt.

The working coefficient shall not be less than 5 for belts with a metallic inlay or not less than 7 for belts without metallic inlay.

5.9.3 Belt guide/belt pulleys/belt drum

The ratio of belt sheave and drum diameter to the rated belt thickness shall not be less than 18 ($D/s \geq 18$).

If a slack belt situation is possible, provisions shall be made to ensure tight winding of the belt. It shall be ensured that the belt is not able to run off the side of the pulley or drum. Rims shall be such that they do not damage the belt which runs against them.

If an inclined pull is possible, measures shall be taken to avoid excessive loading in the edge zones, e.g. moveable suspension of the lifting appliance.

In working and traffic areas to which personnel have access, the components of the belt systems and belt run-on points shall be installed or guarded in such a way that crane operations can be conducted with a minimized risk of trapping or drawing-in of hands or arms into jamming-prone areas.

5.9.4 Fastening to the drum

Belt drums shall incorporate features so that the belt can be securely attached to them without damage or bending.

Belt fastening onto the belt drum shall be made in such a way that at least 2,5 times the remaining static force at the fastening device is accommodated when the rated capacity is applied to the hoist taking into account the friction effect of the winding on the drum. The specific friction values of the particular materials shall be considered for calculation of the friction torque. It shall be assumed that lubricants are present on the materials.

A minimum of two windings shall always remain before the fixing point of the belt in the lowest position of the load supporting device (e.g. hook) and the belt shall not be capable of being wound onto the drum in the wrong direction.

5.9.5 Belt anchorage

Belt anchorage devices shall withstand four times the static belt tensile force at rated capacity of the hoist without destruction of the anchorage and its fastening elements.

Threaded connections on belt anchorage devices shall be locked to prevent self-loosening. The state of the fastening shall be verifiable.

5.10 Pneumatic equipment

5.10.1 General

Pneumatic equipment shall be in accordance with EN ISO 4414.

All components and materials of equipment shall be compatible and suitable for the anticipated ambient conditions.

Sufficient air pressure shall be available for all operating modes at any point of the equipment in order to fulfil all functions. A loss in pressure shall not result in hazards.

Due to the pneumatic drive characteristics, significant differences of lowering and lifting speed may exist.

5.10.2 Energy converters

5.10.2.1 Motors

Motors shall not create additional hazards by heating up nor by icing up.

5.10.2.2 Brakes

Hoists using pneumatically released brakes shall be such that unexpected load lowering is prevented.

This requirement is fulfilled, for example, if the brake releases only, when the motor provides a sufficient moment for holding the load or for controlling the load movement.