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Title: Draft BS EN 15011 Cranes - Bridge and gantry cranes.

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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 Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.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.**
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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	Comment (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

Cranes - Bridge and gantry cranes

Appareils de levage à charge suspendue - Ponts
roulants et portiques de levage

Krane - Brücken- und Portalkrane

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 147.

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.



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European foreword

This document (prEN 15011:2025) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by SFS.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 15011:2020.

The main changes compared with EN 15011:2020 are as follows:

- Clause 4, List of significant hazards was moved to Annex A. Tables, annexes and references were renumbered accordingly;
- updated reference documents;
- revised subclauses 4.1, 4.2.1.3.1;
- added new subclause 6.5;
- deleted Clause A.4;
- added new subclause 4.3.4.4;
- added new Annex J.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document.

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

Introduction

This document has been prepared to be a harmonized standard to provide one means for bridge and gantry cranes to conform with the essential health and safety requirements of the Machinery Regulation, as mentioned in Annex ZA.

As many of the hazards related to bridge and gantry cranes relate to their operating environment and use, it is assumed in the preparation of this document that all the relevant information relating to the use and operating environment of the crane has been exchanged between the manufacturer and the user, covering such issues as, for example:

- clearances;
- requirements concerning protection against hazardous environments;
- processed materials, such as potentially flammable or explosive material (e.g. coal, powder type materials).

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 document.

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

1 Scope

This document applies to bridge and gantry cranes, including semi-gantry cranes, able to travel by wheels on rails, runways or roadway surfaces, and to gantry cranes without wheels mounted in a stationary position.

NOTE 1 Light crane systems (assembly of lifting devices, crane bridges, trolleys and tracks; wall-mounted, pillar and workshop jib cranes) are covered by EN 16851:2017+A1:2020.

This document specifies requirements for all significant hazards, hazardous situations and events relevant to bridge and gantry cranes when used as intended, foreseeable misuse and under conditions foreseen by the manufacturer (see Annex A).

NOTE 2 Automated operation can be subject to additional requirements. Guidance is given in Annex J.

This document does not include requirements for the lifting of persons.

The specific hazards due to potentially explosive atmospheres, ionising radiation and operation in electromagnetic environment beyond the scope of EN IEC 61000-6-2 are not covered by this document.

This document is not applicable to bridge and gantry cranes manufactured before the date of its publication.

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 81-43:2025, *Safety rules for the construction and installation of lifts - Special lifts for the transport of persons and goods - Part 43: Lifts for cranes*

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 894-2:1997+A1:2008, *Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 2: Displays*

EN 12077-2:2024, *Cranes safety - Requirements for health and safety - Part 2: Limiting and indicating devices*

EN 13001-1:2015, *Cranes - General design - Part 1: General principles and requirements*

EN 13001-2:2021, *Crane safety - General design - Part 2: Load actions*

EN 13001-3-1:2025, *Cranes - General Design - Part 3-1: Limit states and proof competence of steel structure*

EN 13001-3-2:2014, *Cranes - General design - Part 3-2: Limit states and proof of competence of wire ropes in reeving systems*

EN 13001-3-3:2014, *Cranes - General design - Part 3-3: Limit states and proof of competence of wheel/rail contacts*

EN 13001-3-4:2018, *Cranes - General design - Part 3-4: Limit states and proof of competence of machinery - Bearings*

EN 13001-3-5:2016+A1:2021, *Cranes - General design - Part 3-5: Limit states and proof of competence of forged and cast hooks*

EN 13001-3-6:2018+A1:2021, *Cranes - General design - Part 3-6: Limit states and proof of competence of machinery - Hydraulic cylinders*

EN 13135:2013+A1:2018, *Cranes - Safety - Design - Requirements for equipment*

EN 13157:2004+A1:2009, *Cranes - Safety - Hand powered cranes*

EN 13557:2024, *Cranes – Control devices and control stations*

EN 13586:2020, *Cranes - Access*

EN 14492-2:2019, *Cranes - Power driven winches and hoists - Part 2: Power driven hoists*

EN 50742:—,¹ *Safety of machinery - Protection against corruption*

EN IEC 60204-11:2019, *Safety of machinery - Electrical equipment of machines - Part 11: Requirements for equipment for voltages above 1 000 V AC or 1 500 V DC and not exceeding 36 kV (IEC 60204-11:2018)*

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

HD 60364-4-41:2017,² *Low voltage electrical installations - Part 4-41: Protection for safety - Protection against electric shock (IEC 60364-4-41:2005/A1:2017, modified)*

EN 60825-1:2014,³ *Safety of laser products - Part 1: Equipment classification and requirements (IEC 60825-1:2014)*

EN 60947-5-5:1997,⁴ *Low-voltage switchgear and controlgear - Part 5-5: Control circuit devices and switching elements - Electrical emergency stop device with mechanical latching function (IEC 60947-5-5:1997, IEC 60947-5-5:1997/A2:2016)*

EN 62745:2017,⁵ *Safety of machinery - Requirements for cableless control systems of machinery (IEC 62745:2017)*

EN ISO 20607:2019, *Safety of machinery - Instruction handbook - General drafting principles (ISO 20607:2019)*

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 4871:2009, *Acoustics - Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

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)*

¹ Under preparation with CLC/TC 44X/WG 2. Stage 10.99 realized on 2023-12-13.

² As impacted by HD 60364-4-41:2017/A11:2017 and HD 60364-4-41:2017/A12:2019.

³ As impacted by EN 60825-1:2014/A11:2021 and by two Corrigenda EN 60825-1:2014/A11:2021/AC:2022-03 and EN 60825-1:2014/AC:2017-06

⁴ As impacted by EN 60947-5-5:1997/A1:2005, EN 60947-5-5:1997/A11:2013 and EN 60947-5-5:1997/A2:2017

⁵ As impacted by EN 62745:2017/A11:2020

EN ISO 11688-1:2009, *Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1: Planning (ISO/TR 11688-1:1995)*

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

EN ISO 13849-1:2023, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2023)*

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

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

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

ISO 2631-1:1997,⁶ *Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration - Part 1: General requirements*

ISO 3864-1:2011, *Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings*

ISO 3864-2:2016, *Graphical symbols - Safety colours and safety signs - Part 2: Design principles for product safety labels*

ISO 3864-3:2024, *Graphical symbols - Safety colours and safety signs - Part 3: Design principles for graphical symbols for use in safety signs*

ISO 3864-4:2011, *Graphical symbols - Safety colours and safety signs - Part 4: Colorimetric and photometric properties of safety sign materials*

ISO 4306-1:2007, *Cranes - Vocabulary - Part 1: General*

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

ISO 7752-5:2021, *Cranes - Control layout and characteristics - Part 5: Bridge and gantry cranes*

ISO 12488-1:2012, *Cranes - Tolerances for wheels and travel and traversing tracks - Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010, EN ISO 3744:2010, EN ISO 11201:2010, ISO 4306-1:2007 and the following apply.

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

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

⁶ As impacted by ISO 2631-1:1997/Amd1:2010A

3.1

bridge crane

crane with its bridge girders directly supported on rail tracks by travelling (end) carriages

Note 1 to entry: Light crane systems are defined in EN 16851.

Note 2 to entry: Building structures, where hoists are mounted, are not regarded as bridge cranes.

[SOURCE: ISO/DIS 4306-1:2023, 1.1.1.1]

3.2

gantry crane

crane with the bridge girders supported either on rail tracks or on flat surface by legs

Note 1 to entry: Building structures, where hoists are mounted, are not regarded as gantry cranes.

Note 2 to entry: See ISO 4306-5, e.g. RTG cranes.

[SOURCE: ISO/DIS 4306-1:2023, 1.1.1.2]

3.3

rated capacity

m_{RC}

maximum net load (the sum of the payload and non-fixed load-lifting attachment) that the crane is designed to lift for a given crane configuration and load location during normal operation

Note 1 to entry: The term Safe Working Load (SWL) can differ from rated capacity.

[SOURCE: ISO 4306-1:2007, 6.1.8, modified]

3.4

hoist load

m_H

sum of the masses of the load equal to the rated capacity, the fixed lifting attachment and the hoist medium

Note 1 to entry: This is equivalent to gross load defined in ISO 4306-1:2007.

3.6

underhung crane

crane travelling suspended on the bottom of the track beams

[SOURCE: ISO/DIS 4306-1:2023, 1.6.2, modified]

3.7

directly acting lifting force limiter

limiter acting directly in the chain of drive elements and limiting the transmitted force

Note 1 to entry: Those limiters can be, for example, friction torque limiters, pressure limiting valves. Directing acting rated capacity limiters generally have no response delay.

3.8

indirectly acting lifting force limiter

limiter determining the transmitted force by measured signals and switching off the energy supply for the operation and, if required, triggering application of the brake torque

4 Safety requirements and/or protective measures

4.1 General

4.1.1 General

Bridge and gantry cranes shall comply with the safety requirements and/or protective measures of Clause 4. In addition, these cranes shall be designed in accordance with the principles of EN ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document.

4.1.2 Safety related standards

Bridge and gantry cranes shall be designed and constructed in such a way as to prevent failure from fatigue and wear, taking due account of their intended use and any reasonably foreseeable misuse.

Cranes shall be in accordance with the following standards, except as otherwise required in this document:

- EN 13001-1:2015, *Cranes — General design — Part 1: General principles and requirements*;
- EN 13001-2:2021, *Cranes — General design — Part 2: Load actions*;
- EN 13135:2013+A1:2018, *Cranes — Safety — Design — Requirements for equipment*;
- EN 12077-2:2024, *Cranes safety — Requirements for health and safety — Part 2: Limiting and indicating devices*;
- EN 13586:2020, *Cranes — Access*;
- EN 60204-32:2008, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*.

Cranes designed for high-risk applications, e.g. handling hot molten metal, shall meet the relevant requirements given in EN 13135:2013+A1:2018, 5.9 and EN 13001-2:2021, 4.3.2.

The requirements of this document are not applied to power driven hoist units, designed in accordance with EN 14492-2:2019, and incorporated in a bridge or gantry cranes.

4.2 Requirements for strength and stability

4.2.1 Load actions

4.2.1.1 Selection of operating conditions

The operating conditions and the design duty (classification) that are selected and used as the basis of design, in accordance with EN 13001-1:2015, 4.3 and EN 13001-2:2021, Clause 4, shall be specified in the technical file of the crane. Examples of the operating conditions are:

- operational temperature limits;
- in-service wind speed limit;
- the wind characteristics, as defined in EN 13001-2:2021, 4.2.4.2, for out-of-service condition;
- high risk provisions (if any) taken in-to account;
- displacement limits for the crane runway in the loaded condition.

For cranes located outdoors, the recurrence period in accordance with EN 13001-2:2021, 4.2.4.2 for out of service wind shall be not less than:

- 25 years for cranes located permanently outdoors;
- 5 years for indoor cranes which can occasionally be parked outdoors.

Guidance for specifying the operation duty is given in Annex B.

NOTE For information needed for the derivation of classification parameters, see also ISO 9374-5.

4.2.1.2 Selection of loads and load combinations

The basic load combinations for the load calculation shall be selected in accordance with EN 13001-2:2021, 4.3.

4.2.1.3 Determination of dynamic factors

4.2.1.3.1 Dynamic effect on mass of the crane

The masses of the crane shall be multiplied with factor $\phi_1 = 1 + \delta$ when calculating the stresses in load combinations in accordance with EN 13001-2:2021, 4.3.

For masses with unfavourable gravitational load effect the factors shall be taken as $\delta = 0,10$ and $\phi_1 = 1,10$, and for masses with favourable gravitational load effect as $\delta = -0,05$ and $\phi_1 = 0,95$. Factor ϕ_1 for unfavourable gravitational load effect need not be taken greater than factor ϕ_2 of 4.2.1.3.2. Alternatively, ϕ_1 may be determined by dynamic analysis.

4.2.1.3.2 Dynamic effects when hoisting a grounded load

Dynamic effects and the related load actions shall be taken into account as specified in EN 13001-2:2021, 4.2.2.2.1.

The dynamic factor ϕ_2 shall be determined by one of the following methods, which shall not be mixed or cross referenced with each other in any way:

- a) applying the method given in EN 13001-2:2021, 4.2.2.2.1, where stiffness class HC and the hoist drive class HD are specified for the crane;
- b) using analytic modelling, where the crane and trolley structures, hoisting mechanism and the hoist drive system are taken into account. Design value of the hoisting speed shall be selected in accordance with the HD class (EN 13001-2:2021, 4.2.2.2.2) for each relevant load combination. Annex D gives an analytic solution for a particular type of bridge crane to determine the factor ϕ_2 and can be used where applicable;
- c) measuring of the hoist rope force. Hoisting shall be assumed to commence from a rope tightness condition at a maximum hoisting speed, which can be attained by taking into account the characteristics of the hoist drive system.

4.2.1.3.3 Load caused by travelling on uneven surfaces

The dynamic actions on the crane by travelling, with or without hoist load, on roadway or on rail tracks shall be considered by the specific factor ϕ_4 .

For continuous rail tracks or welded rail tracks with finished ground joints without notches (steps or gaps) the specific factor $\phi_4 = 1$.

For roadways or rail tracks with notches (steps or gaps) the specific factor ϕ_4 shall be calculated in accordance with EN 13001-2:2021, 4.2.2.4. For rubber tyred cranes the flexibility of tyres shall be taken into account.

The factor ϕ_4 for steps may be set equal to 1,0, separately in any of the following cases:

- the step is 1 mm or less and the natural frequency of a single mass model of the crane, including the masses of the trolley and the hoist load, is 4 Hz or less;
- the wheel subject to the step is arranged in a hinged, multi-wheel bogie system;
- rubber tyred cranes.

The factor ϕ_4 for gaps may be set equal to 1,0, separately in any of the following cases:

- the gap is 5 mm or less and the natural frequency of a single mass model of the crane, including the masses of the trolley and the hoist load, is 8 Hz or less;
- the wheel subject to the gap is arranged in a hinged, multi-wheel bogie system;
- rubber tyred cranes.

Where the factor ϕ_4 is set to 1,0 both for steps and for gaps, the corresponding load combination of EN 13001-2:2021, 4.3 may be omitted.

4.2.1.3.4 Loads caused by acceleration of drives

For crane drive motions, the change in load effect, ΔS , caused by acceleration or deceleration is presented by the following equation:

$$\Delta S = S_{(f)} - S_{(i)} \quad (1)$$

where

- $S_{(f)}$ is the final load effect;
- $S_{(i)}$ is the initial load effect.

The change in load effects, ΔS , is caused by the change of drive force, ΔF , given by the equation:

$$\Delta F = F_{(f)} - F_{(i)} \quad (2)$$

where

- $F_{(f)}$ is the final drive force; and
- $F_{(i)}$ is the initial drive force.

Loads induced in a crane by acceleration or deceleration caused by drive forces may be calculated using rigid body kinetic models. The load effect S shall be applied to the components exposed to the drive forces and where applicable to the crane and the hoist load as well. As a rigid body analysis does not directly reflect elastic effects, the load effect S shall be calculated by using a dynamic factor ϕ_5 defined in EN 13001-2:2021, 4.2.2.5 as follows:

$$S = S_{(i)} + \phi_5 \times a \times m \quad (3)$$

and

$$\phi_5 = \phi_p \times \phi_A \quad (4)$$

where

- $S_{(i)}$ is the initial load effect caused by $F_{(i)}$;
 ϕ_A is the amplification factor;
 ϕ_p is the factor for effect of sequential positioning movements;
 a is the acceleration or deceleration value;
 m is the mass for which applies.

The factor ϕ_A shall be taken from Tables 1 and 2 unless more accurate factors are available from elastic model calculations or measurements. The factor ϕ_p shall be taken from Table 3.

Where the force S is limited by friction or by the nature of the drive mechanism, this frictional force shall be used instead of calculated force S .

Table 1 — Factor ϕ_A for travel, traverse and slewing mechanism

Drive type	Factor ϕ_A		
	Dead weight of moved masses		Weight of freely suspended load
	Typical backlash for gearbox	Considerable backlash, e.g. open gears	
Stepless speed control (e.g. frequency control)	1,2	1,5	2,0
Multi step speed control (e.g. slip ring motor with rotor resistors)	1,6	2,0	2,0
Two step speed control (e.g. pole changeable squirrel cage motor with creep speed)	1,8	2,2	2,0
Single speed control (e.g. squirrel cage motor without creep speed)	2,0	2,4	2,0

Table 2 — Factor ϕ_A for hoist mechanism

Drive type	Factor ϕ_A lifting	Factor ϕ_A lowering
Stepless speed control	1,05	1,10
Multi step speed control	1,15	1,20
Two step speed control	1,20	1,35
Single speed control	1,20	1,30

Factors in Tables 1 and 2 take account for switching on/off the speed and speed change.

Table 3 — Factor ϕ_p

Class of load positioning in accordance with EN 13001-1:2015	ϕ_p
P_0 and P_1	1,0
P_2	1,15
P_3	1,3
For freely suspended load the factor ϕ_p is set to 1,0.	

Positioning movements can increase the total load effects, when made in non-optimal manner. This is taken into account by factor ϕ_P dependent upon the class P. Guidance for determining the class P is given in Annex C.

4.2.1.4 Loads caused by skewing

4.2.1.4.1 General

Skewing forces for top running cranes and trolleys shall be calculated in accordance with 4.2.1.4.2 to 4.2.1.4.4. More guidance and examples are given in Annex E, which provides a simplified method for calculating the forces generated when considering both RIGID and FLEXIBLE crane structures. Skewing forces for underhung cranes shall be calculated in accordance with 4.2.1.4.5.

The skewing forces shall be addressed to load combination B. Where the crane is provided with continuously active anti-skew devices, the forces, without the benefit of anti-skew devices (e.g. failure of the device), shall be addressed to load combination C.

Where two bridge or gantry cranes are linked by articulated connection beams, they shall be considered as a single crane.

NOTE 1 The method given in EN 13001-2:2021, 4.2.3.4 is applicable to rigid structures. Cranes can possess both rigid and flexible characteristics; therefore, a more general method is required as given here. With this method also flexible structures, uneven number of wheels, unequally distributed wheel loads as well as different types of guide means and anti-skewing devices can be considered.

NOTE 2 Forces arising from skewing are generated when the resultant direction of rolling movement of the travelling crane no longer coincides with the direction of the runway rail, and when the front positive guiding means come to contact with the rail. This is caused by tolerances and inaccuracies, which arise in the manufacture of the crane (bores of track wheels) and that of the runway's rail (bends, kinks). The values and distribution of these forces depend chiefly upon the clearances between the runway rail and the wheel flanges or guide rollers and the latter's location, also on the number, arrangement, bearing arrangement and rotational speed synchronisation of the track wheels and structural flexibility.

NOTE 3 Anti-skew device is a mechanical or electrical system to reduce skewing forces. The use of anti-skew devices with travel motions reduces the guiding forces between the rail and guiding means. It also reduces the lateral slip forces of the wheels, but some lateral slip remains due to wheel alignment tolerances and lateral deformations of structures.

4.2.1.4.2 Skew angle

The skew angle shall be calculated as follows in Figure 1:

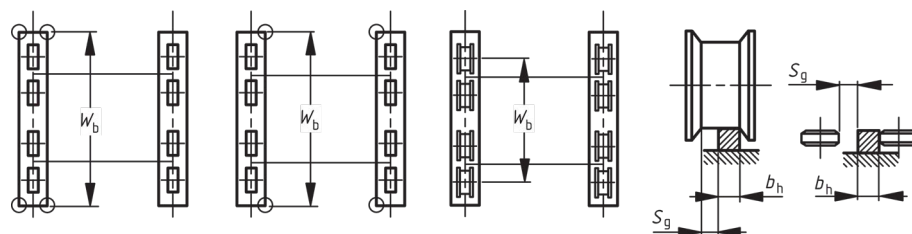


Figure 1 — Parameters of skew angle

The total skew angle to be considered in design is

$$\alpha = \alpha_g + \alpha_w + \alpha_t$$

where

α is the skew angle to be considered in design;

α_g is the skew component s_g/w_b ;

α_w is the component due to wear - rail and wheel flange/guide roller;

α_t is the component due to alignment tolerances of rail/wheel.

The values for skew angles shall be determined in accordance with Table 4.

Table 4 — Skew angle computation

Skew component	Skew angle resulting from	Flanged wheels	Guide rollers
α_g	Track clearance	$\alpha_g = (s_{g \min} / W_b) \text{ rad};$ when $s_g \leq \frac{4}{3} s_{g \min}$ $\alpha_g = \left(0,75 \times \frac{s_g}{W_b} \right) \text{ rad};$ when $s_g > \frac{4}{3} s_{g \min}$	
	Crane travelling; Recommended minimum track clearances	$s_{g \min} = 10 \text{ mm}$	$s_{g \min} = 5 \text{ mm}$
	Trolley traversing; Recommended minimum track clearances	$s_{g \min} = 4 \text{ mm}$	$s_{g \min} = 2 \text{ mm}$
α_t	Tolerances (wheel alignment and straightness of the rail)	$\alpha_t = 0,001 \text{ rad}$	
α_w	Wear of wheel flanges/rollers and rails	$\alpha_w = \left(0,10 \times \frac{b_h}{W_b} \right) \text{ rad}$	$\alpha_w = \left(0,03 \times \frac{b_h}{W_b} \right) \text{ rad}$

For underhung cranes b_h shall be taken as the sum of the wheel contact widths on the same axis.

The skew angle shall be $\alpha \leq 0,015 \text{ rad}$ to achieve good travel behaviour of the crane or the trolley.

4.2.1.4.3 Friction slip relationship

The following simplified empirical relationship shall be used to calculate the friction coefficient for longitudinal and lateral slip:

$$\mu_f = \mu_0 \left(1 - e^{-250 \times \sigma} \right) \quad (5)$$

where

μ_f is the slip coefficient;

μ_0 is the friction factor. In the absence of an experimentally determined value, the following shall be used:

$\mu_0 = 0,3$ for steel wheels and brass wheels;

$\mu_0 = 0,2$ for wheels made of spheroidal cast iron ;

e is the base of natural logarithms, 2,718;

σ is the slip factor.

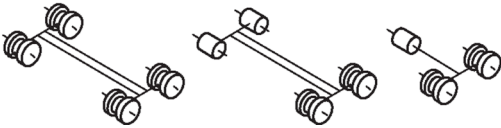
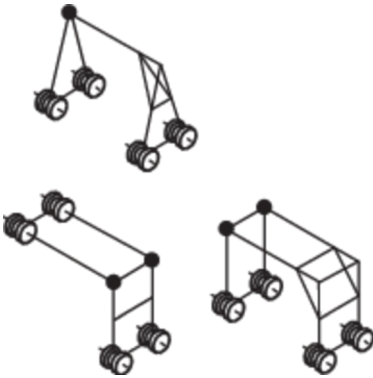
The slip factor is the ratio of the slip distance – transverse and/or longitudinal – to the corresponding travel distance. For the transverse slip the slip factor is equal to the instantaneous total skewing angle (α or $\alpha + \Delta\alpha$). See E.3.2.

4.2.1.4.4 Selection of calculation methods

Either of two simplified calculation methods shall be used: either a RIGID or FLEXIBLE method. The RIGID method assumes the structures of the crane and the runway to be rigid. The FLEXIBLE method assumes the structure to be flexible. In cases of doubt the FLEXIBLE method shall be utilized.

Calculation models to be adopted relative to the crane/trolley structural configuration are listed within Table 5.

Table 5 — Calculation models of bridge and gantry cranes

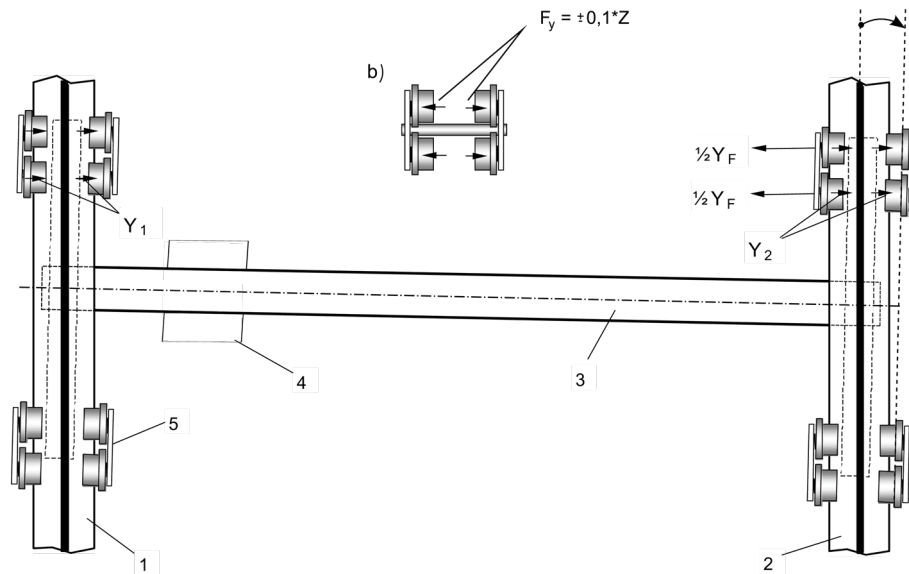
Type	Structural configuration	Applicable method for calculation of loads due to skewing:
A	 Bridge crane, trolley. Even, horizontal, stiff. Guide means on one or both end carriages.	Method RIGID
B	 Crane with articulation, respectively crane with flexible support (● = articulation about an axis parallel with crane track). Guide means on both end carriages.	Each end carriage shall be calculated separately with the method RIGID. Concerning the skewing forces the crane divides into two independent, individually guided carriages.
C	 Crane without articulation. Guide means on both end carriages.	Method RIGID.
	 Crane without articulation. Guide means on only one end carriage.	The method depends on the flexibility of the structure. The decision is made by the result of the method RIGID.

Type	Structural configuration	Applicable method for calculation of loads due to skewing:
D	Procedure: a) Calculate the skewing forces with the method RIGID; b) Supply a fixed support for the end carriage with guide means. Supply a floating support for the unguided end carriage (see Figure E.2c)). Apply the forces calculated with method RIGID to the floating end carriage. The originally parallel end carriages receive an angle position $\Delta\alpha$ to each other. Calculate $\mu_f(\alpha + \Delta\alpha)$ in accordance with 4.2.1.4.3; c) If $\mu_f(\alpha + \Delta\alpha) / \mu_f(\alpha) > 1,15$ then the skewing forces shall be calculated with the method FLEXIBLE. Otherwise the calculation with the method RIGID is sufficient. E.g.: $\mu_f(\alpha + \Delta\alpha) = \mu_0 \left(1 - e^{-250 \times (\alpha + \Delta\alpha)} \right) \text{ and } \mu_f(\alpha) = \mu_0 \left(1 - e^{-250 \times \alpha} \right) .$	

4.2.1.4.5 Skewing forces for underhung cranes

The skewing forces of the underhung cranes, having rigid structure and running on the bottom flanges of rigidly fixed runway beams, shall be calculated with the same principles as the top running cranes. See E.2. However, the guiding force F_y may be divided on two-wheel flanges of a leading bogie. The lateral forces of the trailing bogies may be ignored. Figure 2 represents an example of the structures and a set of the most critical skewing force combinations.

For configurations where either a runway beam (or both of them) or the bogies on one of the runways, can float laterally, the lateral forces F_{y1} and F_{y2} are balanced by separate guiding forces F_y on both leading bogies. In these cases, the guiding forces $1/2 F_y$ shall be taken conventionally as 20 % of the maximum static vertical force F_z of the wheel. F_{y1} and F_{y2} , frictional forces are then 10 % of the vertical wheel force of each wheel. The guiding forces, F_y , and frictional forces, F_{y1} and F_{y2} , balance each other separately on both runways, forming internal force systems within the bogies (element b) in Figure 2), and also local internal force systems within the bottom runway flanges. These forces balanced locally do not impose external forces on the crane structure.



Key

- 1 bottom flange and cut web of runway beam No. 1
- 2 bottom flange and cut web of runway beam No. 2
- 3 crane girder; end carriage beams under the runways not shown
- 4 hoist trolley with load
- 5 4-wheel bogies at each corner of the crane
- F_{y1} transverse frictional skewing forces applied between the wheels and the top surface of the bottom flange of the runway 1
- F_{y2} transverse frictional skewing forces applied between the wheels and the top surface of the bottom flange of the runway 2
- F_y guiding force applied to the wheel flanges of the guiding bogie
- $F_{y, min}$ minimum transverse forces to be also considered in bogie design as shown in element b)
- F_z maximum wheel force in vertical direction

Figure 2 — Skewing forces of underhung crane

Besides the skewing, the lateral forces on the bogies of the underhung cranes are created also by acceleration of the crane loaded asymmetrically and by acceleration of the hoist trolley and load. These forces shall be considered in accordance with 4.2.1.3.4.

4.2.1.5 Overload condition

The maximum force, which effects on the crane, when a lifting force limiter operates, shall be calculated and taken into account in the relevant load combination of EN 13001-2:2021, 4.3.

4.2.1.6 Test loads

The overload test loads to be taken into account in calculation shall be in accordance with 5.3.2.

4.2.1.7 Design basis for multi-point lifting in cases where the lifting forces are not equalized

For cranes, which are equipped with two or more lifting points for lifting a single load, e.g. container lifting frame, the loading on an individual lifting point will depend upon the position of the load centre of gravity with respect to the lifting points. Location of centres of gravities with relevant loads shall be specified in the technical file and in the operating instructions.

In force calculations both the case of a mid-air load suspension and a load being grounded, possibly in an inclined position or on an inclined plane, shall be considered. The forces from the latter case (inclined grounding) shall be addressed to one of the load combinations A, B or C based upon its frequency of occurrence.

The proof of static strength for the lifting points shall be based upon the maximum force resulting from the hoist load and maximum load eccentricity. The maximum force possible in each lifting point shall be considered as a regular load in all relevant load combinations A, B and C in accordance with EN 13001-2:2021, 4.3. Due consideration shall be given to the effect of horizontal load actions on the forces in the lifting points.

The proof of fatigue strength shall take into account the whole range of centre of gravity locations, the frequency of occurrence of these locations and distribution of load values. The resulting fatigue loading shall be expressed by a series of forces on the lifting points and their respective frequencies of occurrence. Horizontal load actions and inclined grounding shall be considered in case they appear in load combination A.

4.2.2 Limit states and proof of competence

4.2.2.1 Limit states and proof of competence of structural members

The limit states and dimensioning of structural members and connections shall be in accordance with EN 13001-3-1:2025.

4.2.2.2 Limit states of mechanical components

Design requirements and dimensioning of ropes in rope drives shall be in accordance with EN 13001-3-2:2014.

Design requirements and dimensioning of wheel/rail contacts shall be in accordance with EN 13001-3-3:2014.

Design requirements and dimensioning of bearings shall be in accordance with EN 13001-3-4:2018.

Design requirements and dimensioning of hooks shall be in accordance with EN 13001-3-5:2016+A1:2021.

Design requirements and dimensioning of hydraulic cylinders shall be in accordance with EN 13001-3-6:2018+A1:2021.

For other components, the load effects and required life (number of cycles) shall be derived from the service and load conditions specified in 4.2.1 and they shall not exceed the limit states specified in the component instructions.

4.2.2.3 Local stresses from wheel loads

Trolley wheels generally transmit vertical and horizontal wheel loads. The effects of these wheel loads on the supporting structure shall be taken into account in combination with global stresses.

Distribution of wheel loads of a crane or a trolley shall not be considered equalised unless equalising is ensured by appropriate arrangements (e.g. pinned bogies, balancers, flexibility of structures).

Stresses in the web under the rail, resulting from vertical wheel loads, shall be calculated in conformance with EN 13001-3-1:2025, Annex C. When passing over girder cuts (e.g. from main girder to cantilever), the effective distribution length is halved, which shall be taken into account in the calculation.

In cranes with the trolley traversing on the lower flange of the girder, the local stresses shall be determined according to Annex F.

The local stress due to the wheel load shall be combined with the global normal and shear stresses for the determination of the equivalent stress in accordance with the principles given in EN 13001-3-1:2025, 5.3.4.

For fatigue assessment in accordance with EN 13001-3-1:2025, Clause 6:

- the total number of wheel overruns at the mostly loaded position shall be taken into account;
- For top-running trolleys, where the weld joint of flange/web is subjected to transverse compressive stresses, the weld may be regarded as a fail-safe component for transverse compressive stresses, when selecting the specific resistant factor γ_{mf} ;
- For under hung hoists travelling on the bottom flange of a girder, the weld between web and bottom flange shall be regarded as a non fail-safe component, when selecting the specific resistant factor γ_{mf} .

4.2.2.4 Proof of strength of lifting points

Lifting points (holes and lugs) used for erection and maintenance purposes shall be calculated in accordance with EN 13001-3-1:2025, Clause 5, taking into account the following:

- the proof of fatigue strength may be omitted;
- in the proof of static strength, a partial safety factor equal to 1,34 on the lifting force and a load factor of 1,5 shall be taken. This load factor covers the dynamic effect during hoisting and inaccuracies in the dead weight estimates;
- a misalignment of five degrees between the plane of a lifting lug and the direction of the lifting force shall be assumed;
- in the joint of a lug to the main structure, the proof for combined stresses, those in the lug with the simultaneous stresses in the main structure, shall be done in accordance with EN 13001-3-1:2025, Clause 5;
- the strength of the main structure at the connection to a lug shall be proven for the same force as the lug.

Lifting points influence as notch cases to the fatigue of the main structure. This shall be taken into account in the proof of fatigue strength of the main structures in regular load cases.

4.2.2.5 Elastic deflection

The elastic deflections of the crane structure shall not have a detrimental influence on the function of the crane. Guidance is given in ISO 22986:2007.

The design value of the elastic deflection shall be provided, see 6.3.2.

4.2.2.6 Vibration frequencies of crane structures

Vibrations shall not have influence on usability, fatigue strength and load positioning accuracy of the crane.

NOTE ISO 22986:2007 gives guidance on the natural frequencies of crane structures. The amplitude and duration of vibrations can be reduced e.g. by using stepless controls.

4.2.3 Stability

4.2.3.1 General requirements

A crane is considered to be stable, when the overturning moment calculated with specified loads and factors is smaller than the stabilizing moment about any tipping axis.

The partial safety factors for the proof of stability of the crane shall be taken from EN 13001-2:2021, 4.3.

4.2.3.2 Design of tie-downs

Where the stability of the crane does not conform to 4.2.3.1 in out-of-service wind conditions, it shall be equipped with tie-downs. The tie-downs shall be designed with the partial load factors in accordance with the EN 13001-2:2021, 4.3.

The additional risk coefficient factors for design of tie-downs and their fastening points shall be taken as follows:

- for steel sections $\gamma_n = 1,20$;
- for wire ropes and chains $\gamma_n = 1,60$.

4.2.3.3 Stability of rubber tyred gantry crane (RTG)

Rubber tyred gantry cranes shall remain stable when they experience an immediate tyre deflation whilst travelling at maximum operational speed down a maximum incline in both the loaded and unloaded conditions.

4.3 Electrotechnical equipment

4.3.1 Physical environment and operating conditions

When the physical environment or the operating conditions are outside those specified in EN 60204-32:2008, 4.4 the specification of the electrical equipment shall be amended accordingly. Attention shall be given to wind chill effects and solar heat gain.

4.3.2 Electrical supply

High voltage equipment (exceeding 1 kV AC or 1,5 kV DC) shall comply with EN IEC 60204-11:2019. All references to EN 60204-1 in EN IEC 60204-11:2019 shall be considered as references to the respective clauses in EN 60204-32:2008.

Where a collector system is used for the incoming supply and it cannot be totally enclosed to prevent danger to personnel and damage by the operation of the crane or associated activities, the provisions of EN 60204-32:2008, 12.7.1 shall apply.

4.3.3 Protection against electric shock by direct contact

Protection against electric shock by direct contact shall comply with EN 60204-32:2008, 6.2 with the following limitations:

- protection by barriers in accordance with HD 60364-4-41:2017⁷, is only acceptable in areas restricted to electrically skilled persons;
- protection by placing out of reach in accordance with EN 60204-32:2008, 6.2.6 is acceptable only in the case of conductor bars.

4.3.4 Control circuits and control functions

4.3.4.1 General

The provisions of EN 60204-32:2008, Clause 9 shall apply except as otherwise required in 4.3.4.2 and 4.3.4.3 of this document.

⁷ As impacted by HD 60364-4-41:2017/A11:2017 and HD 60364-4-41:2017/A12:2019.

All safety related functions of control systems, as specified in EN 13135:2013+A1:2018, 5.7.2, shall fulfil requirements of EN ISO 13849-1:2023:

- control circuits built with electromechanical, hydraulic and pneumatic components shall fulfil Performance Level c and category 1;
- control circuits built with electronic or programmable components, respectively, shall fulfil Performance Level c and category 2.

NOTE For cranes in high-risk applications, as specified in EN 13135:2013+A1:2018, 5.9 and EN 13001-2:2021, 4.3.2, a higher performance level can be required.

Cableless controls shall be in accordance with EN 62745:2017⁸.

4.3.4.2 Suspension (by-pass) of safeguarding for setting, testing and maintenance purposes

The provisions specified in EN 60204-32:2008, 9.2.4 shall apply.

Where means for temporary suspension of safeguarding is provided, the device for suspending shall be located inside an enclosure, access to which requires special tools, or other device not available for normal operation, such as a key-operated switch, shall be provided.

4.3.4.3 Combined start and stop controls

Combined start and stop controls as specified in EN 60204-32:2008, 9.2.6 shall not be used for crane motions.

4.3.4.4 Communications network

Where industrial communication network or similar is used as a part of control system, interruption in the communication shall stop the motions according to principles of EN 60204-32:2008, 9.2.5.3 and 9.2.7.3. Communication recovery after interruption shall not result in restarting of any movement.

When any part of the control system is connected to the internet or an external communication network, the control system shall be protected against corruption according to EN 50742:—¹.

When wireless communication, cableless control, industrial fieldbus, remote monitoring, telematic or any other similar connectivity feature is a part of safety-related control system (SCS), a security risk assessment and countermeasures against cybersecurity threats shall be taken.

NOTE More information can be found in CLC IEC/TS 63074:2024 and in the IEC 62443 series standards.

4.3.5 Operator interface and mounted control devices

4.3.5.1 General

Control devices mounted to the crane shall comply with the provisions EN 60204-32:2008, Clause 10 and 4.3.5.2 to 4.3.5.3 below.

4.3.5.2 Push-buttons

The colours of push-buttons shall be in accordance with EN 60204-32:2008, 10.2 and colours to be used are as follows unless otherwise stated in instruction for use:

- | | |
|----------------|--------|
| — Start/On: | Green; |
| — Stop/Off: | Black; |
| — Hold to Run: | White; |

⁸ As impacted by EN 62745:2017/A11:2020

- Reset: Blue;
- Emergency Stop: Red (with yellow background);
- The stop actuator of a cableless control station: Red;
- Other functions: Yellow or grey.

The function to be activated shall be indicated on or near to the button.

4.3.5.3 Devices for emergency stop

The provisions specified in EN 60204-32:2008, 9.2 shall apply, except as otherwise given in this document.

Devices shall also be provided in the following locations to stop the appropriate motions:

- on the crane structure at ground level on both sides or at each corner of a cabin controlled gantry crane;
- in the machinery room;
- any other location based on risk assessment.

Emergency stop devices located at control stations shall be of the palm or mushroom-headed push-button self-latching type complying with the provisions of EN 60947-5-5:1997⁹. The type of emergency stop devices for other locations shall be selected to achieve easy identification and access to them, and to avoid unintentional actuation.

Where the cableless control station is the only place of control on an overhead bridge or gantry crane, an emergency stop actuator on the crane in addition to the stop button on the cableless control is not required, provided all the following conditions apply:

- there are no operator access ways on the crane;
- the crane runway has no access facilities.

The requirements in EN 60204-32:2008, 9.2, according to which the resetting of the emergency stop or the stop function for cable-less controls, shall not initiate restarting, do not apply for manually controlled hoists with a single operating station and with a single emergency stop or a single stop button, located at that operating station.

4.3.5.4 Laser beams

The laser equipment, where fitted, shall conform to EN 60825-1:2014¹⁰.

4.3.6 Power driven motions

All power driven motions shall be power driven at all times.

Exempt is an emergency situation, when mechanical brakes can be manually released, and there are necessary provisions and instructions available to stop the motion and prevent a hazardous situation occurring.

⁹ As impacted by EN 60947-5-5:1997/A1:2005, EN 60947-5-5:1997/A11:2013 and EN 60947-5-5:1997/A2:2017

¹⁰ As impacted by EN 60825-1:2014/A11:2021 and by two Corrigenda EN 60825-1:2014/A11:2021/AC:2022-03 and EN 60825-1:2014/AC:2017-06

4.3.7 Batteries

Where batteries are used, they shall fulfil the following requirements:

- a) have a cover on the terminals that is not connected to ground;
- b) be protected against inadvertent movements;
- c) if the risk of hazardous gases exists, the battery room shall be ventilated.

4.3.8 Tandem operation of cranes/trolleys from a single control station

When two or more cranes/trolleys are used for handling a single load at the same time from a single control device, the control systems of the individual cranes/trolleys shall be interconnected to ensure that during tandem operation:

- the hoisting speeds are the same within the tolerances required for the particular application;
- the horizontal speeds are the same within the tolerances required for the particular application;
- any interruption of the operation on one crane/trolley shall have a corresponding effect on the other. This requirement does not apply to fully pneumatic or hydraulic powered and operated cranes/trolleys with horizontal speeds less than 15 m/min and hoisting speeds less than 2 m/min.

At horizontal speeds exceeding 60 m/min or hoisting speeds exceeding 20 m/min, the relevant motion control shall provide self-correcting synchronization and any interruption in the operation on one crane/trolley shall have a corresponding effect on the other.

Where the cranes can be used separately and in tandem, the controls shall be clearly marked accordingly.

4.4 Non-electrotechnical equipment

4.4.1 General

The mechanical, hydraulic and pneumatic equipment shall meet the requirements of EN 13135:2013+A1:2018, clause 5 except as otherwise required in this document.

4.4.2 Braking systems

4.4.2.1 General

All power-driven motions shall be equipped with a braking system that has always the capability to stop the motion. The braking systems shall be such that movements can be decelerated and unintentional movements avoided. The systems shall be capable of bringing a fully loaded crane to rest from the highest speed any motion can attain. Braking distance for horizontal movements shall not be longer than acceleration distance from start to maximum speed in accordance with EN 13135:2013+A1:2018, 5.3.3.4.

4.4.2.2 Mechanical brakes in power driven motions

Only power released brakes shall be used and they shall maintain their ability to stop the motion, at all times.

Brakes shall be protected from the ingress of substances within the environment, which are likely to have a detrimental effect on the performance of the brake.

Where electrical braking systems are used, the associated mechanical brake is only subjected to limited use. Therefore, attention shall be taken to maintain the specified mechanical braking torque, see 6.3.3.

Engaging of mechanical service brakes shall be in accordance with EN 13135:2013+A1:2018, 5.3.3.

4.4.2.3 Brakes for hoisting movements

The brakes shall be designed to exert a restraining torque of at least 60 % greater than the maximum torque transmitted to the brake from the maximum hoist load. In addition, the hoist brake shall comply with EN 13135:2013+A1:2018, 5.3.3.

Back-up braking, where required, shall be located:

- on the drum, or
- where acting through mechanical connection to the drum, be designed with the risk coefficient $\gamma_n = 1,60$ applied on the braking torque for all components in the kinematic chain between the back-up brake and the drum.

4.4.3 Hoisting equipment

4.4.3.1 Selection of serial hoist units

Where a hoist unit in accordance with EN 14492-2:2019 is used as a component in the crane, its selection shall be based on the same classification principles of EN 13001-1:2015, 4.3 as those of the crane.

4.4.3.2 Variable rated capacity

Where a crane is specified with variable rated capacity dependent upon trolley/crane position or crane configuration, the rated capacity limiters and indicators shall act accordingly.

Where a crane intended for transporting hot molten masses is operated with variable rated capacities, a selector switch and visual indication according to EN 13135:2013+A1:2018, 5.9.3.2.1 shall be provided to switch the rated capacity limiter to the respective operation.

4.4.3.3 Variable number of hoist units on the crane bridge

Where the hoist units are able to move from one bridge to another, thus creating a case where the total lifting capacity of the hoist units can exceed the rated capacity of the bridge the control system shall ensure that the crane bridge, irrespective of the number of hoist units and the suspended loads, is not overloaded.

4.4.3.4 More than one hoist unit permanently on the crane bridge

Where the total lifting capacity of the hoist units exceeds the rated capacity of the bridge, the control system shall ensure that the crane, irrespective of the loads suspended on the hoist units, is not overloaded.

4.4.3.5 Hooks for handling of hot molten metal

Hooks for hot molten handling shall be in accordance with EN 13135:2013+A1:2018, 5.9.3.2.5.

4.4.3.6 Boom hoisting

The boom hoist mechanism shall be provided with a back-up brake and a backup upper limiter according to EN 13135:2013+A1:2018, 5.3.3.5 and 5.9.3.2.7. The back-up brake shall be located:

- on the drum, or
- where acting through mechanical connection to the drum, be designed with the risk coefficient $\gamma_n = 1,60$ applied on the braking torque for all components in the kinematic chain between the back-up brake and the drum. The boom hoist mechanism shall be provided with two independent rope-reveeing systems. Failure of one rope shall be assumed as a load action, the forces determined as specified in EN 13001-2:2021, 4.3.2 and assigned to the appropriate load and stability combination C. Design of compensating beam and rope shall be in accordance with EN 13135:2013+A1:2018, 5.3.10 and 5.9.2.3.

When a boom rope becomes slack, the boom hoist shall be brought to a standstill (see also EN 13135:2013+A1:2018). When in the operating position, the boom shall be supported by other means than the ropes of the boom hoist. The trolley shall not fall out of the track, at the transit point between the bridge and the boom, whatever the position of the boom. The traversing trolley shall only be able to pass over to the boom when the boom is in its horizontal position.

4.4.4 Travelling and traversing

4.4.4.1 Friction drive capability

The drive systems shall be designed so that they are capable of stopping movements within specified distance taking into account maximum specified slope of runways, operational wind speed and load.

When evaluating acceleration/deceleration characteristics, the frictional coefficient between the steel rail and wheel shall not be taken greater than 0,14, in the case of rubber tyres on prepared ground surfaces not greater than 0,2.

4.4.4.2 Hand driven trolleys and cranes

Hand powered hoists, trolleys and where appropriate, hand powered cranes shall conform to EN 13157:2004+A1:2009 except as otherwise required in this subclause.

If the traversing and travelling movements of the trolley and/or the crane are hand driven the operating force required by operator, when transporting the rated load, shall not exceed:

- 250 N on a hand chain;
- 250 N on a one handed crank in the vertical plane;
- 400 N on a two handed crank in the vertical plane;
- 150 N on a one handed crank in the horizontal plane.

If the traversing and travelling movements are achieved by pushing the load, the horizontal force required shall not exceed 200 N, when transporting the rated load.

Hand operated gantry cranes which can be moved shall be equipped with a braking or arresting device to prevent unintentional crane movement.

4.4.4.3 Drive characteristics of the rubber tyred gantry crane (RTG)

The ratio of the wheel base and the height of the centre of gravity and the stiffness of structures of the rubber tyred gantry cranes shall be selected so that the operational accelerations and decelerations do not cause intolerable oscillations for the operator. The limit values shall be as specified in ISO 2631-1:1997¹¹.

4.4.4.4 Anchoring in out-of-service wind conditions

If the minimum foreseeable friction or the braking torque of the driven wheels cannot prevent the crane or trolley from drifting away in the specified out-of-service wind conditions in accordance with EN 13001-2:2021, 4.2.4.2, the crane or trolley shall be equipped with the following:

- rail clamps that can operate at any position of the track; or
- anchor pins or other means of same function that can hold the crane in certain anchoring positions.

¹¹ As impacted by ISO 2631-1:1997/Amd1:2010A