SLOVENSKI STANDARD
SIST EN 13001-2:2014

01-oktober-2014

Nadomešča:
SIST EN 13001-2:2011
SIST EN 13001-2:2011/AC:2012

Varnost žerjava - Konstrukcija, splošno - 2. del: Učinki obremenitev

Crane safety - General design - Part 2: Load actions

Kransicherheit - Konstruktion allgemein - Teil 2: Lasteinwirkungen

Sécurité des appareils de levage à charge suspendue - Conception générale - Partie 2: Effets de charge

Ta slovenski standard je istoveten z: EN 13001-2:2014

ICS:

53.020.20	Dvigala	Cranes

SIST EN 13001-2:2014 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13001-2

August 2014

ICS 53.020.20

Supersedes EN 13001-2:2011

English Version

Crane safety - General design - Part 2: Load actions

Sécurité des appareils de levage à charge suspendue - Conception générale - Partie 2: Charges

Kransicherheit - Konstruktion allgemein - Teil 2: Lasteinwirkungen

This European Standard was approved by CEN on 14 June 2014.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists 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.

CEN members are the national standards bodies of 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 13001-2:2014 E

Contents

Page

Foreword

This document (EN 13001-2:2014) has been prepared by Technical Committee CEN/TC 147 "Crane — 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 February 2015 and conflicting national standards shall be withdrawn at the latest by February 2015.

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

This document supersedes EN 13001-2:2011.

The major changes in this revision are in 4.2.2.2, 4.2.3.4, 4.2.4.10, 4.3.2, 4.3.4 and 4.3.7. There are new issues in 4.2.4.7, 4.2.4.8, Annex B, Annex C and Annex D.

This document has been prepared under a mandate 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 Annex ZA, which is an integral part of this document.

This European Standard is one Part of EN 13001. The other parts are as follows:

— *Part 1: General principles and requirements*

— *Part 2: Load actions*

— *Part 3-1: Limit states and proof of competence of steel structures*

— *Part 3-2: Limit states and proof of competence of wire ropes in reeving systems*

— *Part 3-3: Limit states and proof of competence of wheel/rail contacts*

— *Part 3-4: Limit states and proof of competence of machinery*

— *Part 3-5: Limit states and proof of competence of forged hooks*

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

According to the CEN-CENELEC Internal Regulations, the national standards organizations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard has been prepared to be a harmonized standard to provide one means for the mechanical design and theoretical verification of cranes to conform to the essential health and safety requirements of the Machinery Directive, as amended. This standard also establishes interfaces between the user (purchaser) of the crane and the designer, as well as between the designer and the component manufacturer, in order to form a basis for selecting cranes and components.

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

The machinery concerned and the extent to which hazards are covered are indicated in the scope of this standard.

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

1 Scope

This European Standard specifies load actions to be used together with the standard EN 13001-1 and EN 13001-3, and as such they specify conditions and requirements on design to prevent mechanical hazards of cranes, and provides a method of verification of those requirements.

NOTE Specific requirements for particular types of crane are given in the appropriate European Standard for the particular crane type.

The following is a list of significant hazardous situations and hazardous events that could result in risks to persons during normal use and foreseeable misuse. Clause 4 of this standard is necessary to reduce or eliminate the risks associated with the following hazards:

a) Instability of the crane or its parts (tilting).

b) Exceeding the limits of strength (yield, ultimate, fatigue).

c) Elastic instability of the crane or its parts (buckling, bulging).

d) Exceeding temperature limits of material or components.

e) Exceeding the deformation limits.

This document is not applicable to cranes that are manufactured before the date of its publication as EN.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1990, *Eurocode - Basis of structural design*

EN 13001-1, *Cranes — General Design — Part 1: General principles and requirements*

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

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1990, Clause 6 of ISO 4306-1:2007 and the following apply.

3.1.1
hoist load
sum of the masses lifted by the crane, taken as the maximum that the crane is designed to lift in the configuration and operational conditions being considered

3.1.2
single failure proof system
force carrying arrangement of several components, arranged so that in case of a failure of any single component in the arrangement, the capability to carry the force is not lost

3.2 Symbols and abbreviations

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

Table 1 — Symbols and abbreviations

Symbols, abbreviations	Description
A1 to A4	Load combinations including regular loads
A	Characteristic area of a crane member
A_g	Projection of the hoist load on a plane normal to the direction of the wind velocity
A_c	Area enclosed by the boundary of a lattice work member in the plane of its characteristic height d
A_j	Area of an individual crane member projected to the plane of the characteristic height d
b_h	Width of the rail head
b	Characteristic width of a crane member
B1 to B5	Load combinations including regular and occasional loads
c	Spring constant
c_o, c_a, c_{oy}, c_{oz}	Aerodynamic coefficients
C1 to C11	Load combinations including regular, occasional and exceptional loads
CFF, CFM	Coupled wheel pairs of system F/F or F/M
d	Characteristic dimension of a crane member
d_i, d_n	Distance between wheel pair i or n and the guide means
e_G	Width of the gap of a rail
f	Friction coefficient
f_i	Loads
f_q	natural frequency
f_{rec}	Term used in calculating $v(z)$
F	Force in general
F, F_y, F_z	Wind loads
$\hat{F}$	Maximum buffer force
F_i, F_f	Initial and final drive force
ΔF	Change of drive force
F_{x1i}, F_{x2i}, F_{y1i}, F_{y2i}	Tangential wheel forces
F_y	Guide force
F_{z1i}, F_{z2i}	Vertical wheel forces

Symbols, abbreviations	Description
F/F, F/M	Abbreviations for Fixed/Fixed and Fixed/Moveable, characterizing the possibility of lateral movements of the crane wheels
g	Acceleration due to gravity
h	Distance between instantaneous slide pole and guide means of a skewing crane
$h(t)$	Time dependent unevenness function
h_s	Height of the step of a rail
H_1, H_2	Lateral wheel forces induced by drive forces acting on a crane or trolley with asymmetrical mass distribution
HC1 to HC4	Stiffness classes
HD1 to HD5	Classes of the type of hoist drive and its operation method
i	Serial number
IFF, IFM	Independent wheel pairs of system F/F or F/M
j	Serial number
k	Serial number
K	Drag coefficient of terrain
K_1, K_2	Roughness factors
l	Span of a crane
l_a	Aerodynamic length of a crane member
l_o	Geometric length of a crane member
m_H	Mass of the hoist load
m	Mass of the crane and the hoist load
Δm_H	Released or dropped part of the hoist load
n	Number of wheels at each side of the crane runway
n_m	Exponent used in calculating the shielding factor η
p	Number of pairs of coupled wheels
q	Equivalent static wind pressure
$\bar{q}$	Mean wind pressure
$q(z)$	Equivalent static storm wind pressure
$q(3)$	Wind pressure at $v(3)$
r	Wheel radius
R	Out-of-service wind recurrence interval
Re	Reynold number
s_g	Slack of the guide
s_y	Lateral slip at the guide means

Symbols, abbreviations	Description
s_{yi}	Lateral slip at wheel pair i
S	Load effect
$\hat{S}$	Maximum load effect
S_i, S_f	Initial and final load effects
ΔS	Change of load effect
t	Time
u	Buffer stroke
$\hat{u}$	Maximum buffer stroke
v	Travelling speed of the crane
$\bar{v}$	Constant mean wind velocity
$\bar{v}$ *	Constant mean wind velocity if the wind direction is not normal to the longitudinal axis of the crane member under consideration
v(z)	Equivalent static storm wind velocity
v(z)*	Equivalent static storm wind velocity if the wind direction is not normal to the longitudinal axis of the crane member under consideration
v(3)	Gust wind velocity averaged of a period of 3 seconds
v_g	Three seconds gust amplitude
v_h	Hoisting speed
$v_{h,max}$	Maximum steady hoisting speed
$v_{h,CS}$	Steady hoisting creep speed
$v_m(z)$	Ten minutes mean storm wind velocity in the height z
v_{ref}	Reference storm wind velocity
w_b	Distance between the guide means
z	Height above ground level
$z(t)$	Time-dependent coordinate of the mass centre
α_r	Relative aerodynamic length
α_w	Angle between the direction of the wind velocity $\bar{v}$ or $v(z)$ and the longitudinal axis of the crane member under consideration
α	Skewing angle
α_g	Part of the skewing angle α due to the slack of the guide
α_G, α_s	Terms used in calculating ϕ_4
α_t	Part of the skewing angle α due to tolerances
α_w	Part of the skewing angle α due to wear
β	Angle between horizontal plane and non-horizontal wind direction

Symbols, abbreviations	Description
β_2	Term used in calculating ϕ_2
β_3	Term used in calculating ϕ_3
γ_f	Overall safety factor
γ_m	Resistance coefficient
γ_n	Risk coefficient
γ_p	Partial safety factor
γ_s	Additional safety factor for stability
δ	Term used in calculating ϕ_1
ε_S	Conventional start force factor
ε_M	Conventional mean drive force factor
η	Shielding factor
η_W	Factor for remaining hoist load in out of service condition
λ	Aerodynamic slenderness ratio
μ, μ'	Parts of the span l
F	Term used in calculating the guide force F_y
F_{1i}, F_{2i}	Terms used in calculating F_{y1i} and F_{y2i}
ξ	Term used in calculating ϕ_7
ξ_{1i}, ξ_{2i}	Term used in calculating F_{x1i} and F_{x2i}
$\xi_G(\alpha_G)$, $\xi_s(\alpha_s)$	Curve factors
ρ	Density of the air
φ	Solidity ratio
ϕ_i	Dynamic factors
ϕ_1	Dynamic factor acting on the mass of the crane
ϕ_2	Dynamic factor on hoist load when hoisting an unrestrained grounded load in regular operation
ϕ_{2C}	Dynamic factor on hoist load when hoisting an unrestrained grounded load under exceptional conditions
$\phi_{2,min}$	Term used in calculating ϕ_2
ϕ_3	Dynamic factor for inertial and gravity effects by sudden release of a part of the hoist load
ϕ_4	Dynamic factor for loads caused by travelling on uneven surface
ϕ_5	Dynamic factor for loads caused by acceleration of all crane drives
ϕ_6	Dynamic factor for test loads

Symbols, abbreviations	Description
ϕ_7	Dynamic factor for loads due to buffer forces
ϕ_8	Gust response factor
ϕ_L, ϕ_{ML}	Factors for calculation of force in case the load or moment limiter is activated
ψ	Reduction factor used in calculating aerodynamic coefficients

4 Safety requirements and/or measures

4.1 General

Loads and load combinations, as given in 4.2 and 4.3, shall only be applied as relevant for specified configurations and operational conditions of the crane.

The load actions shall be taken into account in proofs against failure by uncontrolled movement, yielding, elastic instability and, where applicable, against fatigue.

4.2 Loads

4.2.1 General

4.2.1.1 Introduction

The loads acting on a crane are divided into the categories of regular, occasional and exceptional as given in 4.2.1.2, 4.2.1.3 and 4.2.1.4. For the proof calculation of means of access, loads only acting locally are given in 4.2.4.13. Combinations of regular, occasional and exceptional loads into load combinations A, B and C are given in 4.3.

4.2.1.2 Regular loads

Regular loads are those loads that occur frequently under normal operation.

a) Hoisting and gravity effects acting on the mass of the crane;

b) inertial and gravity effects acting vertically on the hoist load;

c) loads caused by travelling on uneven surface;

d) loads caused by acceleration of all crane drives;

e) loads induced by displacements.

4.2.1.3 Occasional loads

a) Loads due to in-service wind;

b) snow and ice loads;

c) loads due to temperature variation;

d) loads caused by skewing.

Occasional loads occur infrequently. They are usually neglected in fatigue assessment.

4.2.1.4 Exceptional loads

a) Loads caused by hoisting a grounded load under exceptional circumstances;

b) loads due to out-of-service wind;

c) test loads;

d) loads due to buffer forces;

e) loads due to tilting forces;

f) loads caused by emergency cut-out;

g) loads due to dynamic cut-off by lifting force limiting device;

h) loads due to dynamic cut-off by lifting moment limiting device;

i) loads due to unintentional loss of hoist load;

j) loads caused by failure of mechanism or components;

k) loads due to external excitation of crane support;

l) loads caused by erection and dismantling.

Exceptional loads are also infrequent and are likewise usually excluded from fatigue assessment.

4.2.2 Regular loads

4.2.2.1 Hoisting and gravity effects acting on the mass of the crane

When lifting the load off the ground or when releasing the load or parts of the load, the crane structure is under effect of vibration excitation, which shall be taken into account as a load effect. The gravitational force induced by the mass of the crane or crane part shall be multiplied by the factor ϕ_1. Dependent upon the gravitational load effect of the mass and load combination in question, the factor ϕ_1 is calculated in accordance with either Formula (1) or (2). For definitions of unfavourable and favourable load effects see 4.3.3.

The gravitational load effect of the mass is unfavourable, Formula (1) applies:

$$\phi_1 = 1 + \delta \qquad \text{with } 0 \le \delta \le 0{,}1 \tag{1}$$

The gravitational load effect of the mass is favourable, Formula (2) applies:

$$\phi_1 = 1 - \delta \qquad \text{with } 0 \le \delta \le 0{,}05 \tag{2}$$

The maximum values of δ from the Formulae (1) and (2) shall be used unless other values are justified by measurements, calculations or obtained from the appropriate European Standard for the particular type of crane.

The mass of the crane includes those components which are always in place during operation except for the net load itself. For some cranes or applications, it may be necessary to add mass to account for accumulation of debris.

4.2.2.2 Hoisting an unrestrained grounded load

When hoisting an unrestrained grounded load, the crane is subject to dynamic effects of transferring the load off the ground onto the crane. These dynamic effects shall be taken into account by multiplying the gravitational force due to the mass of the hoist load m_H by a factor ϕ_2, see Figure 1.

The mass of the hoist load includes the masses of the payload, lifting attachments and a portion of the suspended hoist ropes or chains.

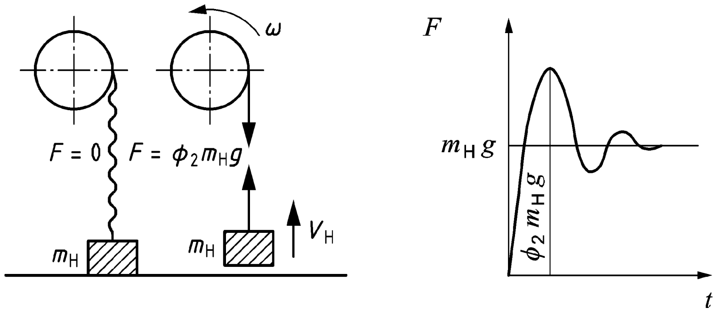

Figure 1 — Dynamic effects when hoisting a grounded load

The values of ϕ_2 and ϕ_{2C} shall be either calculated from the Formula (3) or be determined experimentally or by dynamic analysis. Where the Formula (3) is not used, the true characteristics of the drive system and the elastic properties of the overall load supporting system shall be taken into account.
The dynamic factor ϕ_2 (and respectively ϕ_{2C} for Load combination C1, see 4.2.4.1) is calculated with the Formula (3):

$$\phi_2 = \phi_{2,min} + \beta_2 \times v_h \quad (3)$$

where

β_2 is the factor dependent upon the stiffness class of the crane in accordance with the Table 2,

v_h is the characteristic hoisting speed of the load in [m/s] in accordance with the Table 3, different for calculations of ϕ_2 and ϕ_{2C},

$\phi_{2,min}$ is the minimum value of ϕ_2 and ϕ_{2C} in accordance with Table 4.

For the purposes of this standard, cranes may be assigned to stiffness classes ranging from HC1 to HC4 in accordance with the elastic properties of the crane and its support. The stiffness classes given in the Table 2 shall be selected on the basis of the characteristic vertical load displacement δ.

Table 2 — Stiffness classes

Stiffness class	**Characteristic vertical load displacement δ**	**Factor β_2 [s/m]**
HC1	0,8 m ≤ δ	0,17
HC2	0,3 m ≤ δ < 0,8 m	0,34
HC3	0,15 m ≤ δ < 0,3 m	0,51
HC4	δ < 0,15 m	0,68
The stiffness classes were called hoisting classes in the earlier versions of this standard.		

The characteristic vertical load displacement δ shall be obtained by measurement or calculated from the elasticity of the crane structure, the rope system and the crane support, using the maximum hoist load value and setting the partial safety factors and dynamic factors to 1,0. Product type crane standards may give specific guidance on selection of stiffness classes.

Where the characteristic vertical load displacement δ varies for differing crane configurations, the maximum value of δ may be used for the selection of the stiffness class.

For the purposes of this standard, hoist drives shall be assigned to classes HD1 to HD5 depending on the control characteristics as the weight of the load is transferred from the ground onto the crane. The hoist drive classes are specified as follows:

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 $\phi_{2,min}$.

See Annex B for illustration of the types of hoist drives.

The characteristic hoisting speed v_h to be used in load combinations A, B and C is given in the Table 3.

Table 3 — Characteristic hoisting speeds v_h for calculation of ϕ_2 and ϕ_{2C}

Load combination (see 4.3.6)	Hoist drive class					Factor calculated by Formula (3)
	HD1	HD2	HD3	HD4	HD5	
A1, B1	$v_{h,max}$	$v_{h,CS}$	$v_{h,CS}$	$0,5 \cdot v_{h,max}$	$v_h = 0$	ϕ_2
C1	–	$v_{h,max}$	–	$v_{h,max}$	$0,5 \cdot v_{h,max}$	ϕ_{2C}

Key

$v_{h,max}$ for load combinations A1 and B1: the maximum steady hoisting speed of the load;

$v_{h,max}$ for load combination C1 (see 4.2.4.1): the maximum hoisting speed resulting from all drives (e.g. luffing and hoisting motion) contributing to the hoisting speed of the load;

$v_{h,CS}$ is the steady hoisting creep speed.

The minimum value $\phi_{2,min}$ depends upon the combination of the classes HC and HD and shall be selected in accordance with the Table 4.

Table 4 — Selection of $\phi_{2,min}$

Stiffness class	Hoist drive class				
	HD1	HD2	HD3	HD4	HD5
HC1	1.05	1.05	1.05	1.05	1.05
HC2	1.1	1.1	1.05	1.1	1.05
HC3	1.15	1.15	1.05	1.15	1.05
HC4	1.2	1.2	1.05	1.2	1.05