SLOVENSKI STANDARD
SIST EN 13001-1:2015

01-julij-2015

Nadomešča:
SIST EN 13001-1:2005+A1:2009
SIST EN 13001-1:2005+A1:2009/AC:2010

Žerjavi - Konstruiranje, splošno - 1. del: Splošna načela in zahteve

Cranes - General design - Part 1: General principles and requirements

Krane - Konstruktion allgemein - Teil 1: Allgemeine Prinzipien und Anforderungen

Appareils de levage à charge suspendue - Conception générale - Partie 1: Principes généraux et prescriptions

Ta slovenski standard je istoveten z: **EN 13001-1:2015**

ICS:

53.020.20	Dvigala	Cranes

SIST EN 13001-1:2015 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13001-1

April 2015

ICS 53.020.20

Supersedes EN 13001-1:2004+A1:2009

English Version

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This European Standard was approved by CEN on 16 February 2015.

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

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Ref. No. EN 13001-1:2015 E

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Foreword

This document (EN 13001-1:2015) 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of an identical text or by endorsement, at the latest by October 2015, and conflicting national standards shall be withdrawn at the latest by October 2015.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 13001-1:2004+A1:2009.

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.

The major changes in this revision are in 4.2.7.2, 4.3.3 and 4.4.4. Annex B has been added.

This European Standard is one part of EN 13001. The parts are the following ones:

— *Part 1: General principles and requirements*;

— *Part 2: Load actions*;

— *Part 3-1: Limit States and proof competence of steel structure*;

— *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* [currently at Enquiry stage];

— *Part 3-5: Limit states and proof of competence of forged hooks* [Technical Specification].

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

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 EN ISO 12100.

The crane parts, components or 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 general principles and requirements to be used together with EN 13001-2 and the EN 13001-3 series of standards, and as such they specify conditions and requirements on design to prevent mechanical hazards of cranes, and 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 European 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 European Standard is applicable to cranes which are manufactured after the date of approval by CEN of this standard and serves as reference base for the European Standards for particular crane types.

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

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

ISO 2394, *General principles on reliability for structures*

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 ISO 12100:2010 and, for the definitions of loads, in ISO 4306-1:2007, Clause 6, and the following apply.

3.2 Symbols and abbreviations

The symbols and abbreviations used in this part of EN 13001 are given in Table 1.

Table 1 — Symbols and abbreviations

Symbols, abbreviations	Description
$adm\sigma$	Allowable (admissible) stress
C	Total number of working cycles
C_i	Number of working cycles where a load *i* is handled
C_r	Number of working cycles of task *r*
$Dh0$ to $Dh9$	Classes of average linear displacement $\overline{X}_{lin}$ for hoisting
$Dt0$ to $Dt9$	Classes of average linear displacement $\overline{X}_{lin}$ for traversing (trolley)
$Dc0$ to $Dc9$	Classes of average linear displacement $\overline{X}_{lin}$ for travelling (crane)
$Da0$ to $Da5$	Classes of average angular displacement $\overline{X}_{ang}$
f_i	Characteristic loads including dynamic factors
F_j	Combined loads from load combination *j* (limit state method)
$\overline{F}_j$	Combined loads from load combination *j* (allowable stress method)
k_m	Stress spectrum factor, based on m of detail under consideration
kQ	Load spectrum factor
kQ_r	Load spectrum factor for task *r*
$\lim D$	Limit in damage calculation
$\lim\sigma$	Limit design stress
m	Inverse slope of the log σ_a/log N curve
$\hat{n}$	Total number of stress cycles
n_{ij}	Number of stress cycles of class *ij*
$n_{ij}^{(r)}$	Number of stress cycles of class *ij* occurring each time task r is carried out
n_{ri}, n_{rj}	Service frequency of position *i* or *j*
$n(R$ or $\sigma_m)$	Number of stress cycles with stress amplitude σ_a (R or σ_m)
$n_i(R$ or $\sigma_m)$	Number of stress cycles with amplitude $\sigma_{a,i}$ (R or σ_m)
N	Number of stress cycles to failure by fatigue
N_D	Number of cycles at reference point

Symbols, abbreviations	Description
p	Average number of accelerations
P, P_0 to P_3	Classes of average numbers of accelerations p
Q_0 to Q_5	Classes of load spectrum factors kQ
Q	Maximum value of Q_r for all tasks r
Q_i	Magnitude of load *i*
Q_r	Maximum load for task *r*
R_d	Characteristic resistance of material, connection or component
R	Stress ratio
s	Stress history parameter
S_{02} to S_9	Classes of stress history parameters s
S_k	Load effect in section *k* of a member (limit state method)
$\overline{S}_k$	Load effect in section *k* of a member (allowable stress method)
U, U_0 to U_9	Classes of total numbers of working cycles C
x_{ri}, x_{rj}	Displacement of the drive under consideration to serve position *i* or *j*
$\overline{x}_r$	Average displacement during task *r*
$\overline{X}_{lin}, \overline{X}_{ang}$	Average linear or angular displacement
$\alpha, \alpha_1, \alpha_2$	Angles between horizontal line and lines of constant N in the $\sigma_a - \sigma_m$ plane
α_r	Relative number of working cycles for task *r*
γ_f	Overall safety factor
γ_m	Resistance coefficient
γ_n	Risk coefficient
γ_p	Partial safety factor
$\overline{\gamma}_p$	Reduced partial safety factor
v	Relative total number of stress cycles
σ_a	Stress amplitude
$\sigma_a(R)$, $\hat{\sigma}_a(R)$	Stress amplitude, maximum stress amplitude for constant stress ratio R
$\sigma_a(\sigma_m)$, $\hat{\sigma}_a(\sigma_m)$	Stress amplitude, maximum stress amplitude for constant mean stress σ_m
$\sigma_{a,i}$	Stress amplitude of range *i*

Symbols, abbreviations	Description
σ_b	Lower extreme value of stress cycle
σ_l	Design stress in element *l* (limit state method)
$\bar{\sigma}_l$	Design stress in element *l* (allowable stress method)
σ_{1l}	Stresses in element *l* resulting from S_k (limit state method)
$\bar{\sigma}_{1l}$	Stresses in element *l* resulting from $\bar{S}_k$ (allowable stress method)
σ_{2l}	Stresses in element *l* arising from local effects (limit state method)
$\bar{\sigma}_{2l}$	Stresses in element *l* arising from local effects (allowable stress method)
σ_m	Mean stress
$\sigma_{m,j}$	Mean stress of range *j*
σ_u	Upper extreme value of stress cycle
ϕ_i	Dynamic factors

4 Safety requirements and/or measures

4.1 General

Cranes shall conform to the safety requirements and/or measures of this clause. Hazards not covered in EN 13001 (all parts) may be covered by other general requirements for all types of cranes and/or by specific requirements for particular types of cranes, as given in the standards listed in Annex A. In addition, the machine shall be designed according to the principles of EN ISO 12100 for hazards relevant but not significant which are not dealt with by the above mentioned standards.

4.2 Proof calculation

4.2.1 General principles

The objective of this calculation is to prove theoretically that a crane, taking into account the service conditions agreed between the user, designer and/or manufacturer, as well as the states during erection, dismantling and transport, has been designed in conformance to the safety requirements to prevent mechanical hazards.

The proof of competence according to the EN 13001 series shall be carried out by using the general principles and methods appropriate for this purpose and corresponding with the recognized state of the art in crane design.

Alternatively, advanced and recognized theoretical or experimental methods may be used in general, provided that they conform to the principles of this standard.

Hazards can occur if extreme values of load effects or their histories exceed the corresponding limit states. To prevent these hazards with a margin of safety, it shall be shown that the calculated extreme values of load effects from all loads acting simultaneously on a crane and multiplied with an adequate partial safety coefficient, as well as the estimated histories of load effects, do not exceed their corresponding limit states at any critical point of the crane. For this purpose the limit state method, and where applicable the allowable stress method, is used in accordance with international and European design codes.

The analysis of load actions from individual events or representative use of a crane (representative load histories) is required to reflect realistic unfavourable operational conditions and sequences of actions of the crane.

Figure 1 illustrates the general layout of a proof calculation for cranes.