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SLOVENSKI STANDARD
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Dvigala (ġerjavi) - Konstruiranje, sploġno - 1. del: Sploġna naļ ela 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

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English Version

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This European Standard was approved by CEN on 2 March 2004 and includes Corrigendum 1 issued by CEN on 12 November 2008 and Amendment 1 approved by CEN on 7 March 2009.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Foreword

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of an identical text or by endorsement, at the latest by October 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This European Standard was approved by CEN on 2 March 2004 and includes Corrigendum 1 issued by CEN on 12 November 2008 and Amendment 1 approved by CEN on 7 March 2009.

This document supersedes EN 13001-1:2004.

The start and finish of text introduced or altered by amendment is indicated in the text by tags !A1) (A1".

The modifications of the related CEN Corrigendum have been implemented at the appropriate places in the text and are indicated by the tags !AC) (AC".

!A1) 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 Annexes ZA and ZB, which are integral parts of this document. (A1"

Annex A is informative.

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 rope reeving components

Part 3.3: Limit states and proof of competence of wheel/rail contacts

Part 3.4: Limit states and proof of competence of machinery

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and 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 with the essential health and safety requirements of the Machinery Directive, as amended. This standard also establishes interfaces between the user (purchaser) 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 1070.

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 is to be used together with Part 2 and Part 3, and as such, they specify general conditions, requirements and methods to prevent mechanical hazards of cranes by design and theoretical verification. Part 3 is only at pre-drafting stage; the use of Parts 1 and 2 is not conditional to the publication of Part 3.

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) rigid body instability of the crane or its parts (tilting, shifting);

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

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003).*

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications(ISO 12100-2:2003).*

EN 1070:1998, *Safety of machinery — Terminology.*

[AC) EN 1990:2002, *Eurocode - Basis of structural design* (AC]

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

ISO 4306-1:1990, *Cranes — Vocabulary — Part 1: General.*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1070:1998, EN 1990-1:2002 and clause 6 of ISO 4306-1:1990 apply.

3.2 Symbols and abbreviations

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

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*
D	Classes of average displacements $\overline{X}$
D_{lin0} to D_{lin9}	Classes of average linear displacement $\overline{X}_{lin}$
D_{ang0} to D_{ang5}	Classes of average angular displacement $\overline{X}_{ang}$
f_i	Characteristic loads
F_j	Combined loads from load combination *j* (limit state method)
$\overline{F}_j$	Combined loads from load combination *j* (allowable stress method)
k	Stress spectrum factor

Table 1 *(continued)*

Symbols, abbreviations	Description
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 σ_m)	Number of stress cycles with stress amplitude σ_a (R or σ_m)
n_i (R or σ_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
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 , S_0 , to S_9	Classes of stress history parameters s
S_k	Load effect in section *k* of a member (limit state method)
$\bar{S}_k$	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*

Table 1 *(concluded)*

Symbols, abbreviations	Description
$\overline{x}_r$	Average displacement during task *r*
$\overline{X}$	Average displacement
$\overline{X}_{lin}, \overline{X}_{ang}$	Average linear or angular displacement
α_1, α_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
μ, μ_1, μ_2	Rises of lines of constant N in the σ_a-σ_m-plane
ν	Relative total number of stress cycles
σ_a	Stress amplitude
σ_a(*R* or σ_m)	Stress amplitude for constant stress ratio *R* or constant mean stress σ_m
$\hat{\sigma}_a$ (*R* or σ_m)	Maximum stress amplitude for constant stress ratio R or constant mean stress σ_m
$\sigma_{\mathrm{a,i}}$	Stress amplitude of range i
$\sigma_{\mathrm{a,i}}$ (*R* or σ_m)	Stress amplitude of range i for constant stress ratio or constant mean stress
σ_b	Lower extreme value of stress cycle
σ_ℓ	Design stress in element *l* (limit state method)
$\overline{\sigma}_\ell$	Design stress in element *l* (allowable stress method)
$\sigma_{1\ell}$	Stresses in element *l* resulting from S_k (limit state method)
$\overline{\sigma}_{1\ell}$	Stresses in element *l* resulting from $\overline{S}_k$ (allowable stress method)
$\sigma_{2\ell}$	Stresses in element *l* arising from local effects (limit state method)
$\overline{\sigma}_{2\ell}$	Stresses in element *l* arising from local effects (allowable stress method)
σ_m	Mean stress
$\sigma_{\mathrm{m,j}}$	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

Machinery shall conform to the safety requirements and/or measures of this clause. Hazards not covered in EN 13001 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 EN standards listed in annex A. In addition, the machine shall be designed according to the principles of [AC⟩ EN ISO ⟨AC] 12100-1 and [AC⟩ EN ISO ⟨AC] 12100-2 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.

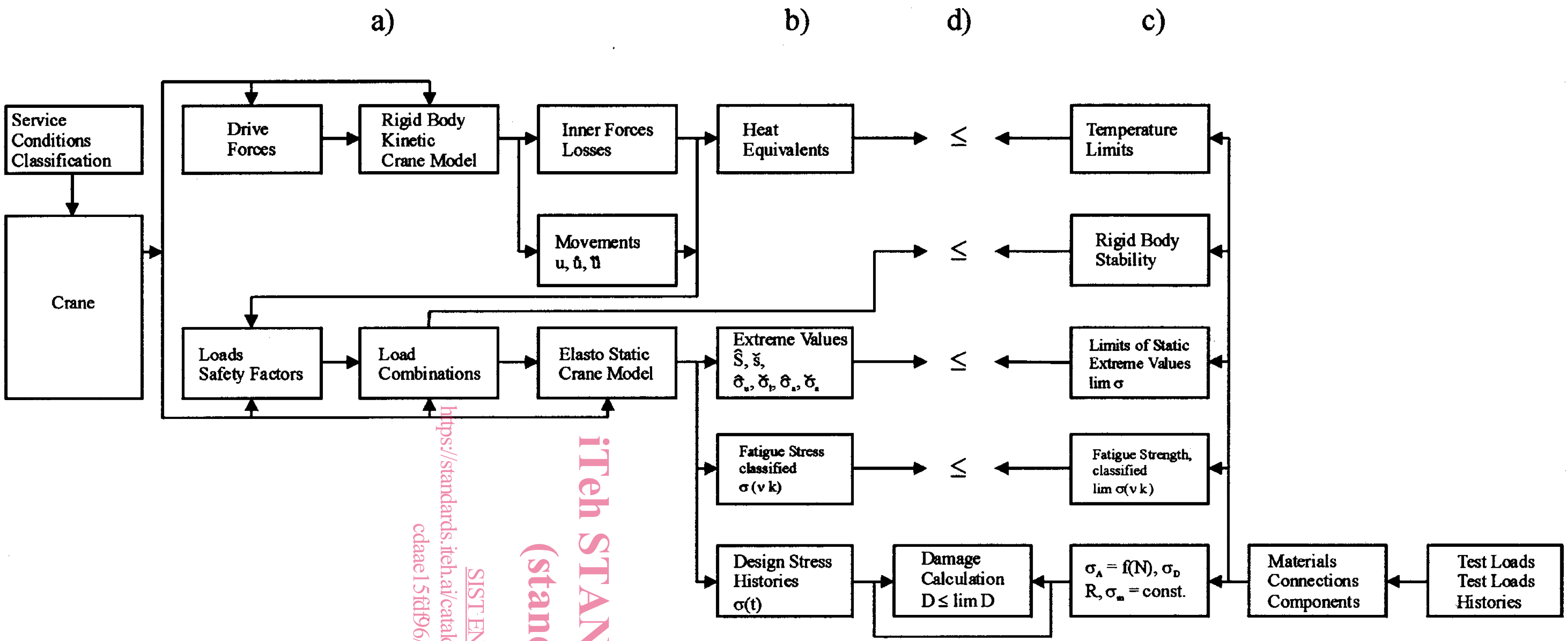
The proof of competence according to EN 13001 shall be carried out by using the general principles and methods appropriate for this purpose and corresponding with the recognised state of the art in crane design.

Alternatively, advanced and recognised 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.



Key

a) Models of crane and loads

b) Load actions

c) Limit states

d) Proof

Figure 1 — Layout of the proof calculation

4.2.2 Models of cranes and loads

For the calculation of the movements, inner forces (torques in gears, rope forces, etc.) and losses of the crane or its parts, rigid body kinetic models are used.

The loads acting on this model are the motor torques and/or brake torques, which have to balance any of the loads acting on the moved parts as losses, mass forces caused by gravity, movement of the crane or parts thereof, and wind forces.

From this rigid body kinetic model of the crane and the load models, any variation of displacement, speed, acceleration and/or inner forces as well as the corresponding instantaneous values of acceleration and/or inner forces can be derived.

These variations, if calculated in conformity with the agreed service conditions, are the base for estimating the histories of load effects (e. g. heat equivalents) and the stress histories. Since the variations and instantaneous values of accelerations and inner forces calculated by using a rigid body kinetic model only represent mean values of the real process, loads caused by sudden alterations of these mean values shall be amplified by dynamic factors ϕ_i to estimate their real values (see EN 13001-2).

For cranes or crane configurations where all the loads from different drives acting simultaneously do not affect each other because they are acting at right angles to each other (i.e. orthogonal), load actions from drives can be considered independently. In cases where the loads from simultaneous actions of different drives affect each other (dependent, non-orthogonal), this shall be taken into account.

The calculation of nominal stresses in any mechanical and/or structural component of a crane or its parts can commonly be based on appropriate elasto-static models, built up by beam or more sophisticated elements, such as plane stress, plate or shell elements.

A nominal stress is a stress calculated in accordance with simple elastic strength of materials theory, excluding local stress concentration effects.

4.2.3 Simulation of load actions

For the simulation of the time varying process of load actions on a crane or its parts, static equivalent loads from independent events occuring during the intended use of a crane shall be applied to elasto-static models, which correspond with the configuration and supporting conditions of the crane or its parts under consideration.

NOTE In this context the term “load” or "load action" means any action or circumstance, which causes load effects in the crane or its parts, for example: forces, intended and non-intended displacements and/or movements, temperature, wind pressure.

Static equivalent loads are given in EN 13001-2. These static equivalent loads are considered as deterministic actions, which have been adjusted in such a way that they represent load actions during the use of the crane from the actions or circumstances under consideration.

The limit state method (see 4.2.7.1) does take into account the probabilistic nature of the loads, whereas the allowable stress method (see 4.2.7.2) does not.

If a different level of safety is required in some instance, a risk factor γ_n may be agreed upon and applied.