SLOVENSKI STANDARD
SIST-TS CEN/TS 13001-3-1:2005

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Dvigala (žerjavi) - Konstrukcija, splošno – 3-1. del: Mejna stanja in dokaz varnosti jeklene nosilne konstrukcije

Cranes - General design - Part 3-1: Limit states and proof of competence of steel structures

Krane - Konstruktion allgemein - Teil 3-1: Grenzzustände und Sicherheitsnachweis von Stahltragwerken

Appareils de levage a charge suspendue - Conception générale - Partie 3-1: Etats limites et vérification d'aptitude des structures en acier

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English version

Cranes - General design - Part 3-1: Limit states and proof of competence of steel structures

Appareils de levage à charge suspendue - Conception générale - Partie 3-1: Etats limites et vérification d'aptitude des structures métalliques

Krane - Konstruktion allgemein - Teil 3-1: Grenzzustände und Sicherheitsnachweis von Stahltragwerken

This Technical Specification (CEN/TS) was approved by CEN on 25 November 2003 for provisional application.

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Foreword

This document (CEN/TS 13000-3.1:2004) has been prepared by Technical Committee CEN/TC 147 “Cranes — Safety”, the secretariat of which is held by BSI.

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 98/37/EC, amended by 98/79/EC.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary Iceland, Ireland, Italy, Latavia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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

The annexes A, C and D are normative. The annexes B, E and F are informative.

Introduction

This European Standard has been prepared to be a harmonised 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, hazardous situations and events are covered are indicated in the scope of this document.

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.

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

1 Scope

This European Standard is to be used together with Part 1 and Part 2 and as such they specify general conditions, requirements and methods to prevent mechanical hazards of cranes by design and theoretical verification.

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. Clauses 4 to 8 of this standard are necessary to reduce or eliminate the risks associated with the following hazards:

a) Exceeding the limits of strength (yield, ultimate, fatigue);

b) Exceeding temperature limits of material or components;

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

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.

NOTE prCEN/TS 13001-3-1 deals only with limit state method according to EN 13001-1.

As an alternative to the herein presented limit state method using partial safety factors, the allowable stress method using a global safety factor according to Part 1 and Part 2 may also be applied for special crane systems with linear behaviour.

As crane structures are basically dynamically loaded only the linear theory of elasticity is applicable and only limited local plasticity is allowed. The use of the theory of plasticity for calculation of ultimate load bearing capacity is not allowed.

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

EN 1990-1:2002, *Eurocode – Basic of structural design*

EN 1993-1-1:1992: *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings.*

EN 10025:1990/A1:1993, *Hot rolled products of non-alloy structural steels — Technical delivery conditions (includes amendment A1:1993).*

EN 10045-1:1989, *Charpy impact test on metallic material — Part 1: Test method.*

EN 10113-1:1993, *Hot-rolled products in weldable fine grain structural steels — Part 1: General delivery conditions.*

EN 10113-2:1993, *Hot-rolled products in weldable fine grain structural steels — Part 2: Delivery conditions for normalized/normalized rolled steels.*

EN 10113-3:1993, *Hot-rolled products in weldable fine grain structural steels — Part 3: Delivery conditions for thermomechanical rolled steels.*

EN 10137-2:1995, *Plates and wide flats made of high yield strength structural steels in the quenched and tempered or precipitation hardened conditions — Part 2: Delivery conditions for quenched and tempered steels.*

EN 10149-1:1995, *Hot-rolled flat products made of high yield strength steels for cold forming — Part 1: General delivery conditions.*

EN 10149-2:1995, *Hot-rolled flat products made of high yield strength steels for cold forming — Part 2: Delivery conditions for thermomechanically rolled steels.*

EN 10149-3:1995, *Hot-rolled flat products made of high yield strength steels for cold forming — Part 3: Delivery conditions for normalized or normalized rolled steels.*

EN 10164:1993, *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions.*

EN 12345:1996, *Welding — Multilingual terms for welding joints with illustrations (trilingual version).*

EN 13001-1:2004, *Cranes — General Design — Part 1:General principles and requirements.*

EN 13001-2:2004, *Cranes — General Design — Part 2: Load actions.*

EN 22553:1994, *Welded, brazed and soldered joints — Symbolic representation on drawings (ISO 2553:1992).*

EN 25817:1992, *Arc-welded joints in steel — Guidance on quality levels for imperfections (ISO 5817:1992).*

EN ISO 898-1:1999, *Mechanical properties of fasteners — Part 1: Bolts, screws and studs (ISO 898-1:1999).*

EN ISO 9013:2002, *Thermal cutting — Classification of thermal cuts — Geometrical specification and quality tolerances (ISO 9013:2002).*

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).

ISO 286-2:1990, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

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

3 Terms and definitions

3.1
Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 292-1, EN 292-2 and EN 1070 and the basic list of definitions as provided in EN 1990-1 apply. For the definitions of loads, clause 6 of ISO 4306-1:1990 applies.

3.2
Symbols and abbreviations

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

Table 1 — Symbols and abbrevations

Symbols, abbreviations	Description
A	cross section
A_S	stress area of a bolt
a_r	relevant weld thickness
D_o, D_i	outer, inner diameter of hollow pin
d	diameter (shank of bolt, pin)
d_o	diameter of hole
e_1, e_2	distances
F_b	tensile force in bolt
F_d	limit force
F_K	characteristic value (force)
F_p	preloading force in bolt
F_{Rd}	limit design force
F_t	external force (on bolted connection)
$F_{b,\,Rd}$	limit design bearing force
$F_{b,\,Sd}$; $F_{bi,\,Sd}$	design bearing force
$F_{p,\,d}$	design preloading force
$F_{s,\,Rd}$	limit design slip force per bolt and friction interface
$F_{t,\,Rd}$	limit design tensile force in bolt
$F_{v,\,Rd}$	limit design shear force per bolt/pin and shear plane
$F_{v,\,Sd}$	design shear force per bolt/pin and shear plane
$F_{s,t}$	acting normal/shear force
f_d	limit stress
f_K	characteristic value (stress)
f_{Rd}	limit design stress

Table 1 (*continued*)

Symbols, abbreviations	Description
f_u	ultimate strength of material
f_{ub}	ultimate strength of bolts
$f_{w,\,Rd}$	limit design weld stress
f_y	yield point of material
f_{yb}	yield point of bolts
f_{yk}	yield point (nominal value) of material or member
f_{yp}	yield point of pins
G_t	mass of the moving crane parts during a representative working cycle
h	distance between weld and contact area of acting load
K_b	stiffness (slope) of bolt
K_c	stiffness (slope) of flanges
k^*	specific spectrum ratio factor
$k_{(m)}$	stress spectrum factor based on m of the detail under consideration
$k_{(m=3)}$	stress spectrum factor based on m = 3
l_r	relevant weld length
l_W	weld length
M_{Rd}	limit design bending moment
M_{Sd}	design bending moment
m	inverse slope of /N-curve
NC	notch class
$min\ s$, $max\ s$	extreme values of stresses
P_S	probability of survival
p_1, p_2	distances
Q	mass of the maximum hoist load
q	impact toughness parameter
R_d	design resistance
r	radius of wheel
S_d	design strain
$s(m)$	stress history parameter
T	temperature
t	thickness
W_{el}	elastic section modulus
a	characteristic factor for bearing connection
a_w	characteristic factor for limit weld stress
g_m	general resistance coefficient
g_{Mf}	fatigue strength specific resistance factor

Table 1 (*concluded*)

Symbols, abbreviations	Description
g_p	partial safety factor
g_R	resulting resistance coefficient
g_S	specific resistance factor
g_{Rb}	resulting resistance coefficient of bolt
g_{sb}	specific resistance factor of bolt
g_{Rm}	resulting resistance coefficient of members
g_{sm}	specific resistance factor of members
g_{Rp}	resulting resistance coefficient of pins
g_{sp}	specific resistance factor of pins
g_{Rs}	resulting resistance coefficient of slip-resistance connection
g_{ss}	specific resistance factor of slip-resistance connection
g_{Rw}	resulting resistance coefficient of welding connection
g_{sw}	specfic resistance factor of welding connection
f_2	dynamic factor
k	spread angle
l	width of contact area in weld direction
d_p	elongation from preloading
DF_b	additional force
Dd	additional elongation
μ	slip factor
Ds_c	characteristic value of stress range (normal stress)
Dt_c	characteristic value of stress range (shear stress)
s_{Sd}	design stress (normal)
t_{Sd}	design stress (shear)
$s_{w,\,Sd}$	design weld stress (normal)
$t_{w,\,Sd}$	design weld stress (shear)
Ds_{Rd}	permissible (limit) stress range (normal)
$Ds_{Rd,1}$	permissible stress range for k* = 1
Dt_{Rd}	permissible (limit) stress range (shear)
Ds_{Sd}	design stress range (normal)
Dt_{Sd}	design stress range (shear)

4 General

4.1 Materials

4.1.1 Structural members

European Standards specify materials and specific values. This standard gives a preferred selection.

For structural members, steel according to following European Standards should be used:

Non-alloy structural steels EN 10025.

Weldable fine grain structural steels in conditions:

normalised (N) EN 10113-2;

thermomechanical (M) EN 10113-3.

High yield strength structural steels in the quenched and tempered condition EN 10137-2.

High yield strength steels for cold forming in conditions:

thermomechanical (M) EN 10149-2;

normalised (N) EN 10149-3.

Table 2 shows specific values for the nominal value of strength f_u, f_y and limit design stress f_{Rd} (see 5.2). For more information see the specific European Standard.

Grades and qualities other than those mentioned in the above standards and in Table 2 can be used if the mechanical properties and the chemical composition are guaranteed by the manufacturer and conform to the relevant European Standard. If necessary, the weldability shall be demonstrated by the steel manufacturer.

When selecting grade and quality of the steel for tensile members, the sum of impact toughness parameters q_i shall be taken into account. Table 3 gives the impact toughness parameters q_i for various influences. Table 4 gives the required steel quality and impact energy/test temperature in dependence of q_i. Grades and qualities of steel other than mentioned in Table 4 may be used, if the steel manufacturer guarantees and certifies an impact energy/test temperature, tested according to EN 10045-1.

Table 2 — Specific values of steels for structural members

Steel	Standard	Thickness t (mm)	Nominal strength		Limit design stress for γ_{Rm}=1,1	
			f_y yield (N/mm^2)	f_u ultimate (N/mm^2)	f_{Rd}, normal (N/mm^2)	f_{Rd}, shear (N/mm^2)
S235	EN 10025	t 16	235	340	214	123
		16<t 40	225		205	118
		40<t 100	215		195	113
		100<t 150	195		177	102
S275		t 16	275	430	250	144
		16<t 40	265		241	139
		40<t 63	255		232	134
		63<t 80	245		223	129
		80<t 100	235		214	123
		100<t 150	225		205	118
S355		t 16	355	490	323	186
		16<t 40	345		314	181
		40<t 63	335		305	176
		63<t 80	325		296	171
		80<t 100	315		287	166
		100<t 150	295		268	155
S355	EN 10113-2 (N) EN 10113-3 (M)	t<16	355	450	323	186
		16<t 40	345		314	181
		40<t 63	335		305	176
		63<t 80 (N)	325		295	171
		80<t 100 (N)	315		286	165
		100<t 150 (N)	295		268	155
S420		t<16	420	500	382	220
		16<t 40	400		364	210
		40<t 63	390		355	205
		63<t 80 (N)	370		336	194
		80<t 100 (N)	360		327	189
		100<t 150 (N)	340		309	178
S460		t<16	460	530	418	241
		16<t 40	440		400	231
		40<t 63	430		391	226
		63<t 80 (N)	410		373	215
		80<t 100 (N)	400		364	210
S460	EN 10137-2	3<t 50	460	550	418	241
		50<t 100	440		400	231
S500		3<t 50	500	590	455	262
		50<t 100	480		436	252
S550		3<t 50	550	640	500	289
		50<t 100	530		482	278
S620		3<t 50	620	700	564	325
		50<t 100	580		527	304
S690		3<t 50	690	770	627	362
		50<t 100	650	760	591	341
S890		3<t 50	890	940	809	467
		50<t 100	830	880	755	436
S960		3<t 50	960	980	873	504

Table 2 (*concluded*)

Steel	Standard	Thickness t (mm)	Nominal strength		Limit design stress for γ_{Rm}=1,1	
			f_y yield (N/mm^2)	f_u ultimate (N/mm^2)	f_{Rd}, normal (N/mm^2)	f_{Rd}, shear (N/mm^2)
S315	EN 10149–2 (M) EN 10149-3 (N)	all t	315	390	286	165
S355			355	430	323	186
S420			420	480	382	220
S460 (M)			460	520	418	241
S500 (M)			500	550	455	262
S550 (M)			550	600	500	289
S600 (M)			600	650	545	315
S650 (M)		t 8 t>8	650 630	700	591 573	341 331
S700 (M)		t 8 t>8	700 680	750	636 618	367 357

Table 3 — Impact toughness parameters q_i

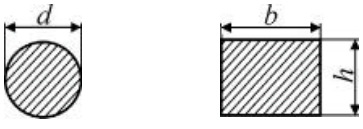
i	Influence		q_i
1	Temperature T (°C)	0 T	0
		-20 T < 0	1
		-40 T < -20	2
		-50 T < -40	4
2	Yield point f_y (N/mm^2)	f_y 300	0
		300 < f_y 460	1
		460 < f_y 700	2
		700<f_y 1 000	3
		1 000<f_y	4
3	Material thickness t (mm)	t 10	0
	Equivalent thickness t for solid bars:	10 < t 20	1
		20 < t 50	2
		50 < t 100	3
	$t = \frac{d}{1{,}8}$ for $\frac{b}{h} < 1{,}8 : t = \frac{b}{1{,}8}$	t > 100	4
4	Stress concentration and notch class $_c$ (N/mm^2) (see annex A and annex E)	$_c$ > 125	0
		80 < $_c$ 125	1
		56< $_c$ 80	2
		$_c$ 56	3

Table 4 — Impact toughness requirement and corresponding steel quality for $\sum q_i$

	$\sum q_i \leq 3$	$4 \leq \sum q_i \leq 6$	$7 \leq \sum q_i \leq 9$	$\sum q_i \geq 10$
Impact energy/ test temperature requirement	27 J / +20°C	27 J / 0°C	27 J / -20°C	27 J / -40°C
EN 10025	JR	J0	J2	a)
EN 10113	N, M	N, M	N, M	NL, ML
EN 10137-2	Q	Q	Q	QL
EN 10149	NC, MC	NC, MC	NC, MC	a)

a) May be used if the steel manufacturer guarantees and certifies an impact energy/test temperature of at least 27 J at –40 °C, tested according to EN 10045-1.

4.1.2 Connecting devices

For bolt connections bolts of the property classes 4.6, 5.6, 8.8, 10.9 or 12.9 according to EN ISO 898-1 shall be used. Nominal values of the strengths:

Table 5 — Property classes

Property class	4.6	5.6	8.8	10.9	12.9
f_{yb} (N/mm^2)	240	300	640	900	1 080
f_{ub} (N/mm^2)	400	500	800	1 000	1 200

4.2 Bolt connections

4.2.1 General

For the purpose of this standard bolt connections are specified as connections, where

bolts are tightened and thus compress the joint surfaces together;

the joint surfaces are secured against rotation (e. g. by using multiple bolts).

4.2.2 Shear and bearing connections

Connections with fitted bolts, where

the loads act perpendicular to the bolt axis and cause shear and bearing stresses in the bolts;

clearance between bolt and hole shall be according to ISO 286-2 tolerances h13 and H11;

at maximum 10 % of the clamping length may be covered by the threaded part of the bolt;

special surface treatment of the contact surfaces is not required.

4.2.3 Slip resistant connections

Connections with high strength bolts of property classes 8.8, 10.9 or 12.9, where