SLOVENSKI STANDARD
SIST EN 13001-3-8:2026

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Žerjavi - Splošno konstruiranje - Mejna stanja in dokaz varnosti mehanizma - 3-8. del: Gredi

Cranes - General design - Limit states and proof competence of machinery - Part 3-8: Shafts

Krane - Konstruktion allgemein - Teil 3-8: Grenzzustände und Sicherheitsnachweise für Maschinenbauteile - Wellen

Appareils de levage à charge suspendue - Conception générale - Partie 3-8 : États limites et vérification d’aptitude des éléments de mécanismes - Arbres

Ta slovenski standard je istoveten z: **EN 13001-3-8:2026**

ICS:

21.120.10	Gredi	Shafts
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Cranes - General design - Part 3-8: Limit states and proof competence of machinery - Shafts

Appareils de levage à charge suspendue - Conception générale - Partie 3-8 : États limites et vérification d'aptitude des éléments de mécanismes - Arbres

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 13001-3-8:2026) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by SFS.

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of an identical text or by endorsement, at the latest by November 2026, and conflicting national standards shall be withdrawn at the latest by November 2026.

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

This document is one part of the EN 13001 series, *Cranes — General design*. 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 — Bearings*;

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

— *Part 3-6: Limit states and proof of competence of machinery — Hydraulic cylinders*.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

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 in the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous 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.

1 Scope

This document specifies limit states and methods to prevent mechanical hazards in shafts and rotating or non-rotating axles of cranes by design and theoretical proof of competence.

This document is intended to be used together with the other generic parts of the EN 13001 series of standards (see Annex D).

This document covers specific shafts and rotating or non-rotating axles as an integrated part of cranes, that are not dealt with by other EN 13001 standards (e.g. pinned connections in EN 13001-3-1:2025). It is not intended to shafts or axles being part of standardized component (e.g. gearboxes, motors).

The significant hazardous situations and hazardous events that could result in risks to persons during intended use and reasonably foreseeable misuse are identified in Annex E. Clauses 4 to 7 of this document provide requirements and methods to reduce or eliminate these risks:

— exceeding the limits of strength (yield, ultimate, fatigue);

— exceeding temperature limits of material or components.

This document does not deal with the proofs of strength of welded and cast shafts, and dynamic instabilities such as shaft whirling.

This document does not apply to cranes that are manufactured before the date of its publication as EN and serves as a reference base for the European Standards for particular crane types (see Annex D).

This document deals only with limit state method in accordance with EN 13001-1:2015 [34].

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 10025-2:2019, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3:2019, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-4:2019+A1:2022, *Hot rolled products of structural steels — Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

EN 10088-3:2023, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resistant steels for general purposes*

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

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

EN ISO 148-1:2016, *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1:2016)*

EN ISO 683-1:2018, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering (ISO 683-1:2016)*

EN ISO 683-2:2018, *Heat-treatable steels, alloy steels and free-cutting steels — Part 2: Alloy steels for quenching and tempering (ISO 683-2:2016)*

EN ISO 683-3:2022, *Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels (ISO 683-3:2022)*

EN ISO 683-5:2021, *Heat treatable steels, alloy steels and free-cutting steels — Part 5: Nitriding steels (ISO 683-5:2017)*

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

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

3 Terms and 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 the following apply. For terms and definitions of loads, ISO 4306-1:2007, Clause 6 applies.

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

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp/

3.1.1
shaft
cylindrical rotating rod for the transmission of movement, forces and torques

3.1.2
axle
spindle on which a component (e.g. wheel, sheave) revolves or which rotates with a component (or components) attached to it, with transmission of movement and forces, but without transmission of torque

3.2 Symbols and abbreviations

The symbols and abbreviations used in this document are given in Table 1.

Table 1 — Symbols and abbreviations

Symbols, abbreviations	Description
A_{v}	Minimum impact toughness
$A_{0,95}$	Equivalent section area of 'non-rotational' component
b	Fatigue strength exponent, for a material (ε-N procedure)
b_p	Fatigue strength exponent, for a component (ε-N procedure)
c	Fatigue ductility exponent, for a material (ε-N procedure)
C	Total number of working cycles
c_p	Fatigue ductility exponent, for a component (ε-N procedure)
D_{Sd}	Design fatigue damage
D_{Rd}	Limit design fatigue damage
d	Diameter
d_{equ}	Equivalent diameter
E	Modulus of elasticity
$f_{\mathrm{Rd},\sigma}$	Limit design normal stress
$f_{\mathrm{Rd},\tau}$	Limit design shear stress
f_{u}	Ultimate strength of material
f_{y}	Yield strength of material
f_1	Notch factor
f_2	Size factor
f_3	Surface roughness factor
f_4	Surface treatment factor
f_{prob}	Survival probability factor
K'	Factor of cyclic resistance (ε-N procedure)
K_{t}	Stress concentration factor
k_{m}	Stress spectrum factor
kQ	Load spectrum factor
k_{s}	Shaft stress spectrum factor
l_{s}	Design number of shaft sets
m_σ	Inverse slope of σ/N-curve (or S-N curve) for normal stresses
m_τ	Inverse slope of σ/N-curve (or S-N curve) for shear stresses
m'	Second inverse slope of σ/N-curve
n_{i}	Number of stress cycles, of range i

Symbols, abbreviations	Description
n'	Cyclic strain-hardening exponent (ε-N procedure)
$\hat{n}$	Total number of stress cycles
N_{fi}	Number of stress cycles to failure, for stress of range *i*
N; N_{f}	Number of stress cycles to failure
N_{Ref}	Reference number of stress cycles
r	Notch radius
R	Stress ratio
R_{d}	Design resistance
R_{a}	Average depth of surface profile according to EN ISO 21920-2:2022
S_{d}	Design stress or design force
s_{s}	Shaft stress history parameter
t	Thickness
T	Operation temperature
z	Adaptation factor
$\varepsilon_{\mathrm{f}}^{'}$	Fatigue ductility factor (ε-N procedure)
ε_{a}	Total strain amplitude (ε-N procedure)
$\varepsilon_{\mathrm{ae}}$	Elastic strain amplitude (ε-N procedure)
$\varepsilon_{\mathrm{ap}}$	Plastic strain amplitude (ε-N procedure)
$\varepsilon_{\mathrm{e,a}}$	Amplitude of elastic strain (ε-N procedure)
$\varepsilon_{\mathrm{e,loc}}$	Elastic local strain value (ε-N procedure)
ε_{r}	Real strain value (ε-N procedure)
$\varepsilon_{\mathrm{r,a}}$	Amplitude of strain value (ε-N procedure)
$\varepsilon_{\mathrm{r,i}}$	Amplitude of strain value, of range *i* (ε-N procedure)
$\varepsilon_{\mathrm{r,loc}}$	Real local strain value (ε-N procedure)
γ_{ff}	Safety factor for fatigue
γ_{m}	General resistance factor
γ_{mf}	Fatigue strength specific resistance factor
γ_{p}	Partial safety factor (see EN 13001-2:2021)
γ_{Rm}	Resulting resistance factor
γ_{sm}	Specific resistance factor
υ_{s}	Relative total number of stress cycles
$\sigma_{\mathrm{a,i}}$	Design stress amplitude

Symbols, abbreviations	Description
$\hat{\sigma}_{a,i}$	Maximal design stress amplitude
$\sigma_{d,ref}$	Material fatigue strength (normal stress)
$\sigma_{d,s}$	Intermediate alternating fatigue strength (normal stress)
σ_{d}	Component fatigue strength (normal stress)
σ_{dtr}	Alternating fatigue strength (normal stress)
$\sigma_{e,loc}$	Elastic local stress (ε-N procedure)
$\sigma_{e,nom}$	Nominal elastic stress (ε-N procedure)
$\sigma_{eq,e,loc,m}$	Mean equivalent elastic local stress (ε-N procedure)
$\sigma_{eq,e,loc,a}$	Amplitude of equivalent elastic local stress (ε-N procedure)
$\sigma_{eq,e,loc,max}$	Maximal equivalent elastic local stress (ε-N procedure)
$\sigma_{eq,e,loc,min}$	Minimal equivalent elastic local stress (ε-N procedure)
σ_{eq}	Equivalent normal stress
$\sigma_{eq,a}$	Amplitude of equivalent normal stress
σ'_{f}	Fatigue resistance factor (ε-N procedure)
σ_{m}	Mean stress
$\sigma_{r,a}$	Amplitude of real local stress (ε-N procedure)
$\sigma_{r,loc}$	Real local stress (ε-N procedure)
$\sigma_{r,m}$	Mean real local stress (ε-N procedure)
$\sigma_{Rd,f}$	Limit design normal stress for fatigue
σ_{Sd}	Design normal stress
$\sigma_{Sd,f}$	Design normal stress for fatigue
$\sigma_{Sd,eq}$	Equivalent design normal stress
$\tau_{Rd,f}$	Limit design shear stress for fatigue
τ_{Sd}	Design shear stress

4 Safety requirements

4.1 General

Machinery shall comply with the safety requirements and/or protective/risk reduction measures of this clause. In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

4.2 Materials

4.2.1 Grades and qualities for shafts

For shafts, steel in accordance with the following European Standards shall be used; alternatively, grades and qualities other than those mentioned in the below standards may be used if the mechanical properties and the chemical composition are equivalent:

a) steels for quenching and tempering (see Table 2):

  1) non alloy steels: EN ISO 683-1:2018;

  2) alloy steels: EN ISO 683-2:2018;

b) structural steels (see Table 2):

  1) non-alloy structural steels: EN 10025-2:2019;

  2) weldable fine grain structural steels in conditions:

    i) normalized (N): EN 10025-3:2019;

    ii) thermomechanical (M): EN 10025-4:2019+A1:2022;

c) stainless steels (see Table 2):

  1) semi-finished (bars, rods ...): EN 10088-3:2023;

d) steels with heat treatment:

  1) case hardening: EN ISO 683-3:2022;

  2) nitriding (see Table 2): EN ISO 683-5:2021.

Table 2 shows specific values for the nominal value of strength f_u, f_y for raw material. For more information, see the specific European Standards listed above.

Table 2 — Specific values of a selection of steels

Steel	Standard	Diameter d/Thickness t (raw material) mm	Nominal strength f_y Yield N/mm^2	Nominal strength f_u Ultimate N/mm^2
Steels for quenching and tempering, in the quenched and tempered condition (+QT)				
C25E C25R C25	EN ISO 683-1:2018	$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$	370 320	550 500
C30E C30R C30		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	400 350 300	600 550 500
C35E C35R C35		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	430 380 320	630 600 550
C40E C40R C40		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	460 400 350	650 630 600
C45E C45R C45		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	490 430 370	700 650 630
C50E C50R C50		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	520 460 400	750 700 650
C55E C55R C55		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	550 490 420	800 750 700
C60E C60R C60		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	580 520 450	850 800 750
23Mn6		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	550 440 400	700 650 600
28Mn6		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	590 490 440	800 700 650
36Mn6		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$	640 540 460 410	850 750 700 650
42Mn6		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$	690 590 480 460	900 800 750 700

Steel	Standard	Diameter d/Thickness t (raw material)	Nominal strength	
			f_y Yield	f_u Ultimate
		mm	N/mm^2	N/mm^2
34Cr4 34CrS4	EN ISO 683-2:2018	$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	700 590 460	900 800 700
37Cr4 37CrS4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	750 630 510	950 850 750
41Cr4 41CrS4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$	800 660 560	1 000 900 800
25CrMo4 25CrMoS4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$	700 600 450 400	900 800 700 650
34CrMo4 34CrMoS4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$ $160 < d \le 250$ or $100 < t \le 160$	800 650 550 500 450	1 000 900 800 750 700
42CrMo4 42CrMoS4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$ $160 < d \le 250$ or $100 < t \le 160$	900 750 650 550 500	1 100 1 000 900 800 750
50CrMo4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$ $160 < d \le 250$ or $100 < t \le 160$	900 780 700 650 550	1 100 1 000 900 850 800
41CrNiMo2 41CrNiMoS2		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$	840 740 640 540	1000 900 800 750
36CrNiMo4		$d \le 16$ or $t \le 8$ $16 < d \le 40$ or $8 < t \le 20$ $40 < d \le 100$ or $20 < t \le 60$ $100 < d \le 160$ or $60 < t \le 100$ $160 < d \le 250$ or $100 < t \le 160$	900 800 700 600 550	1100 1000 900 800 750