SLOVENSKI STANDARD
oSIST prEN 13001-3-7:2019

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Žerjavi - Konstrukcija, splošno - 3-7. del: Mejna stanja in dokaz varnosti mehanizma - Zobniki in menjalniki

Cranes - General design - Part 3-7: Limit states and proof of competence of machinery - Gears and gear boxes

Appareils de levage à charge suspendue - Conception générale - Partie 3-7 : États limites et vérification d'aptitude des éléments de mécanismes - Engrenages et réducteurs

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21.200	Gonila	Gears
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Cranes - General design - Part 3-7: Limit states and proof of competence of machinery - Gears and gear boxes

Appareils de levage à charge suspendue - Conception générale - Partie 3-7 : États limites et vérification d'aptitude des éléments de mécanismes - Engrenages et réducteurs

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (prEN 13001-3-7:2019) has been prepared by Technical Committee CEN/TC 147 “Cranes – Safety”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

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 document is one part of the EN 13001 series. The other parts are as follows:

— *Cranes — General design — Part 1: General principles and requirements*;

— *Crane safety — General design — Part 2: Load actions*;

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

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

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

— *Cranes — General design — Part 3-4: Limit states and proof of competence of machinery — Bearings*;

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

— *Cranes — General design — Part 3-6: Limit states and proof of competence of machinery — Hydraulic cylinders*;

— *Cranes — General design — Part 3-8: Limit states and proof competence of machinery — Shafts* [Enquiry stage].

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

Introduction

This European Standard has been prepared to provide a means for the mechanical design and theoretical verification of cranes to conform to essential health and safety requirements. This European 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 ISO 12100.

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

1 Scope

This document is due to be used together with EN 13001-1 and EN 13001-2 and as such they specify general conditions, requirements and methods to prevent by design and theoretical verification, mechanical hazards in gear components of cranes.

This document covers the following types of gears and adjoining components, used in mechanisms for any principal movement of a crane:

— cylindrical helical and spur gears and bevel gears, with involute profile geometry;

— gears arranged in enclosed housings or as open gears;

— gears made from steel or iron and gear boxes made from steel, iron or aluminium;

— gears and pinions with lubrication;

— gear boxes and single gear arrangements with bearings and shafts supporting the gears.

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 7 of this document are necessary to reduce or eliminate the risks associated with the following hazards:

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

— exceeding temperature limits of material.

This document is applicable to cranes, which are manufactured after the date of approval of this document by CEN, and serves as a reference base for product standards of particular crane types.

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 1561:2011, *Founding — Grey cast irons*

EN 1563:2018, *Founding — Spheroidal graphite cast irons*

EN 1564:2011, *Founding — Ausferritic spheroidal graphite cast irons*

EN 1706:2010, *Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties*

EN 10025-2:2004, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3:2004, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-6:2004+A1:2009, *Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

EN 10083-2:2006, *Steels for quenching and tempering — Part 2: Technical delivery conditions for non alloy steels*

EN 10083-3:2006, *Steels for quenching and tempering — Part 3: Technical delivery conditions for alloy steels*

EN 10084:2008, *Case hardening steels — Technical delivery conditions*

EN 10085:2001, *Nitriding steels — Technical delivery conditions*

EN 10293:2015, *Steel castings - Steel castings for general engineering uses*

EN 13001-1:2015, *Cranes — General design — Part 1: General principles and requirements*

EN 13001-2:2014, *Crane safety — General design — Part 2: Load actions*

EN 13001-3-1:2012+A2:2018, *Crane safety — General design — Part 3-1: Limit States and proof competence of steel structure*

EN 13001-3-2:2014, *Crane safety — General design — Part 3-2: Limit states and proof of competence of wire ropes in reeving systems*

EN 13001-3-3:2014, *Crane safety — General design — Part 3-3: Limit states and proof of competence of wheel/rail contacts*

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

EN 13001-3-5:2016, *Crane safety — General design — Part 3-5: Limit states and proof of competence of forged hooks*

EN 13001-3-6:2018, *Crane safety — General design — Limit states and proof of competence of machinery — Hydraulic cylinders*

prEN 13001-3-8:2018, *Cranes — General design — Part 3-8: Limit states and proof competence of machinery — Shafts*

EN 13135:2013+A1:2018, *Cranes — Safety — Design — Requirements for equipment*

prEN 14492-2:2016, *Cranes — Power driven winches and hoists — Part 2: Power driven hoists*

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

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

ISO 1122-1:1998, *Vocabulary of gear terms — Part 1: Definitions related to geometry*

ISO 1328-1:2013, *Cylindrical gears — ISO system of flank tolerance classification — Part 1: Definitions and allowable values of deviations relevant to flanks of gear teeth*

ISO 1328-2:1997, *Cylindrical gears — ISO system of accuracy — Part 2: Definitions and allowable values of deviations relevant to radial composite deviations and runout information*

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

ISO 6336-1:2006, *Calculation of load capacity of spur and helical gears — Part 1: Basic principles, introduction and general influence factors*

ISO 6336-2:2006, *Calculation of load capacity of spur and helical gears — Part 2: Calculation of surface durability (pitting)*

ISO 6336-3:2006, *Calculation of load capacity of spur and helical gears — Part 3: Calculation of tooth bending strength*

ISO 6336-5:2016, *Calculation of load capacity of spur and helical gears — Part 5: Strength and quality of materials*

ISO 6336-6:2006, *Calculation of load capacity of spur and helical gears — Part 6: Calculation of service life under variable load*

ISO 10300-1:2014, *Calculation of load capacity of bevel gears — Part 1: Introduction and general influence factors*

ISO 10300-2:2014, *Calculation of load capacity of bevel gears — Part 2: Calculation of surface durability (pitting)*

ISO 10300-3:2014, *Calculation of load capacity of bevel gears — Part 3: Calculation of tooth root strength*

ISO 17485:2006, *Bevel gears — ISO system of accuracy*

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, ISO 1122-1 and ISO 4306-1:2007 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
gear box
power transmission component with gears, shafts and bearings placed in and supported by an enclosed housing with input and output shafts

3.1.2
open gear
gear transmission where the gear parts are not supported by a compact, integrated housing structure

3.1.3
case hardening
hardening method applicable to steels, changing the chemical composition and microstructure of the surface layer by adsorption of carbon, nitrogen or a mixture of the two and by diffusion, create a chemical composition gradient

3.1.4
carburize hardening depth
depth of the gear surface zone with hardness greater than 550 HV for core hardness less than 450 HV, or greater than 650 HV for core hardness greater than or equal to 450 HV

3.1.5
induction and flame hardening depth
depth of the gear surface zone with hardness greater than or equal to 80 % of the specified surface hardness

3.1.6
nitrided and nitrocarburized hardening depth
depth of the gear surface zone with hardness greater than or equal to 400 HV, or where the core hardness is greater than 380 HV, depth of the gear surface zone with hardness greater than the core hardness plus 50 HV

3.1.7
coupon
sized test piece made from a representative grade of material

3.1.8
vertical movement
movement of hoist load or of a crane part, where the slope of the path of the moved masses is 5 % or steeper in relation to horizontal level

[SOURCE: EN 13135:2013+A1:2018, 3.29, modified — "Mass" was replaced with "masses" in the present definition.]

3.1.9
horizontal movement
movement of hoist load or of a crane part, where the slope of the path of the moved masses is less than 5 % in relation to horizontal level

Note 1 to entry: The definition is taken from EN 13135:2013+A1:2018, 5.2.8.5.1.

3.2 Symbols and abbreviations

Table 1 — Symbols and abbreviations

Symbols, abbreviations	Description
C	Total number of working cycles during the design life of a crane/hoist
C_{GVL}, C_{GVU}	Design numbers of working cycles for gears, vertical movements, laden (L) and unladen (U) parts of working cycles
C_{GH}	Design number of working cycles for gears, horizontal movements
h	Height of tooth
K_A	Application factor, ISO 6336-6
m	Slope of Wöhler curve, EN 13001-1
m_{RC}	Rated capacity (rated load) of a crane or hoist
m_{DW}	Mass of the crane or hoist, relevant for a horizontal movement
N	Number of stress cycles
p	Fatigue exponent in ISO 6336-6
R_a	Surface roughness
s_{AL}, s_{DL}, s_{AU}, s_{DU}	Acceleration and deceleration distances of movement
S_{Fmin}	Safety factor for tooth bending, ISO 6336-3
S_{Hmin}	Safety factor for surface durability, ISO 6336-3
T	Operating temperature of gear or gear box
T_n	Nominal torque
X_{lin}	Average displacement of movement
Y_{NT}, Z_{NT}	Life factors
ϕ_1, ϕ_2, ϕ_5, ϕ_L etc.	Dynamic load factors, EN 13001-2
γ_p	Partial safety factor, EN 13001-2
γ_n	Risk coefficient as defined in EN 13001-2
γ_{sB}	Specific safety factor for brakes

4 General requirements

4.1 Gear materials and associated heat treatment

4.1.1 General requirements on materials

Commonly used materials for gears and their associated heat treatments are listed in Table 2. See Annex A for more guidance on heat treatment recommendations.

Table 2 — Typical materials for gears

Type of material	Material standard	Selected qualities	
Quenched and tempered	EN 10083-3	25CrMo4+QT	42CrMo4+QT
		36NiCrMo16+QT	34CrNiMo6+QT
		35NiCr6+QT	30CrNiMo8+QT
		36CrNiMo4+QT	
Case hardened	EN 10084	17NiCrMo6–4	16MnCr5
		18CrNiMo7–6	20MnCr5
Induction or flame hardened	EN 10083-2	C45E	C45R
	EN 10083-3	37Cr4	42CrMo4
		41Cr4	
Nitrited	EN 10085	41CrMoV9	
	EN 10083-3	34CrMo4+QT	30CrNiMo8+QT
		36NiCrMo16+QT	
Cast iron	EN 1563	EN-GJS 600-3	EN-GJS 700-2
	EN 10293	GE 300	
Structural steels	EN 10025-3	S420	S460
	EN 10025-6	S500	S690

Other materials than those mentioned in Table 2 may be used, provided that the material properties and characteristics are specified in a manner corresponding to referenced European Standards and fulfil the requirements specified to the listed material qualities, especially regarding:

— chemical composition;

— mechanical strength;

— surface hardness;

— elongation at fracture;

— hardenability and the Jominy probe test results.

Verification of material properties shall be in accordance with the standards given in Table 2.

Grey cast irons, bronzes and alloys containing aluminium or zinc are not permitted for gears in mechanisms for vertical movements.

Classification of material quality grades related to the heat treatment procedure, in accordance with ISO 6336-5, shall be applied. Three classes ML, MQ and ME are defined. Generally, the class MQ is recommended. Where the class ME is applied, the provisions shall be specified and the compliance with the requirements of ISO 6336-5 be documented in detail. The class ML should not be applied for high risk applications.

4.1.2 Impact toughness of gears

Steel qualities listed in Table 2 and delivered in accordance with the relevant standard may be used as such for gears in operating temperatures −10 °C and higher.