SLOVENSKI STANDARD
oSIST prEN 14439:2014

01-december-2014

Dvigala (žerjavi) - Varnost - Stolpna dvigala

Cranes - Safety - Tower cranes

Krane - Sicherheit - Turmdrehkrane

Appareils de levage à charge suspendue - Sécurité - Grues à tour

Ta slovenski standard je istoveten z: **prEN 14439 rev**

ICS:

53.020.20	Dvigala	Cranes

oSIST prEN 14439:2014 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 14439 rev

September 2014

ICS 53.020.20

Will supersede EN 14439:2006+A2:2009

English Version

Cranes - Safety - Tower cranes

Appareils de levage à charge suspendue - Sécurité - Grues à tour

Krane - Sicherheit - Turmdrehkrane

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 147.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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Foreword

This document (prEN 14439:2014) 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 will supersede EN 14439:2006+A2:2009.

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.

CEN/TC 147/WG 12 "Cranes – Tower Cranes" has developed a revision of this document, which differs from EN 14439:2006+A2:2009 as follows:

— Integration of mobile self-erecting tower cranes, including introduction of a new dedicated Annex H

— integration and rules for application of EN 13001 series of standards

— modification of clause 5.2

— integration and rules for application of EN ISO 13849-1

— modification of Annex E – Climbing system

— addition of a new annex concerning calculation of the maximum load effect at the load case wind coming from all directions

— addition of a new annex concerning calculation of standards values of the limit design stress range

— addition of a new annex concerning the requirements on a tower crane for installation of a powered access system

To select a suitable set of crane standards for a given application see Annex J.

NOTE Some of the standards listed are in preparation.

Introduction

This is a harmonised European Standard to provide one means for tower cranes to conform with the relevant Essential Health and Safety Requirements of the Machinery Directive 2006/42/EC modified.

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 hazardous events are covered are indicated in the scope of this European 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 cranes that have been designed and built according to the provisions of this type C standard.

1 Scope

This European Standard specifies safety requirements:

— for tower cranes and

— for climbing systems used with the masts of tower cranes for which they have been designed. They are classified as external or internal systems.

This European Standard applies to tower cranes for construction work, which are either erected by parts or self-erecting cranes, including mobile self-erecting tower cranes. Tower cranes for construction work are exclusively equipped with a hook as load-handling device.

This European Standard is not applicable to mobile cranes, mobile harbour cranes, crawler cranes, slewing jib cranes, bridge and gantry cranes, offshore cranes, floating cranes, loader cranes, hand operated cranes or railway cranes.

This European Standard deals with all significant hazards, hazardous situations and events relevant to tower cranes, when used as intended and under conditions foreseen by the manufacturer. This European Standard specifies the appropriate technical measures to eliminate or reduce risks arising from the significant hazards (see Clause 4).

The significant hazards covered by this European Standard are identified in Clause 4.

This European Standard does not cover hazards related to:

— the lifting of persons by the tower crane itself.

The requirements related to Electromagnetic compatibility (EMC), the specific hazards due to external influence on electrical equipment, potentially explosive atmospheres and ionising radiation are not covered by this European Standard.

This European Standard covers hazards related to the lifting of persons using a climbing system.

This European Standard is not applicable to tower cranes and climbing systems which are manufactured before the date of publication by CEN of this European Standard.

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 1050:1996, *Safety of machinery — Principles for risk assessment*

EN 12077-2:1998+A1:2008, *Cranes safety — Requirements for health and safety — Part 2: Limiting and indicating devices*

EN 12644-1:2001+A1:2008, *Cranes — Information for use and testing — Part 1: Instructions*

EN 13001-1:2008+A1:2009, *Cranes — General design — Part 1: General principles and requirement*

EN 13001-2:2011, *Cranes — General design — Part 2: Load effects*

EN 13001-3-1:2013, *Cranes — General design — Part 3-1: Limit states and proof of competence of steel structures*

EN 13135-1:2003+A1:2010, *Cranes — Safety — Design — Requirements for equipment — Part 1: Electrotechnical equipment*

EN 13135-2:2004+A1:2010, *Cranes — Equipment — Part 2: Non-electrotechnical equipment*

EN 13135:2011, *Cranes — Safety — Design — Requirements for equipment*

EN 13557:2003+A2:2008, *Cranes — Controls and control stations*

EN 13586:2004+A1:2008, *Cranes — Access*

EN 60204-32:2008, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines* (IEC 60204-32)

EN ISO 3744:2010, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane* (ISO 3744)

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment* (ISO 4871)

EN ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane* (ISO 11201)

EN ISO 11203:2009, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level* (ISO 11203)

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

EN ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design* (ISO 13849-1)

EN ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs* (ISO 13857)

ISO 3864 (all parts), *Graphical symbols — Safety colours and safety signs*

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

ISO 4306-3:2003, *Cranes — Vocabulary — Part 3: Tower cranes*

ISO 4306-3:2003/A1:2011), *Cranes — Vocabulary — Part 3: Tower cranes*

ISO 4309, *Cranes — Wire ropes — Care, maintenance, installation, examination and discard*

FEM 1.001 — Booklet 2:1998, *Rules for the design of hoisting appliances — Classification and loading on structures and mechanisms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in in EN ISO 12100, ISO 4306-1 and ISO 4306-3 and the following apply.

Note 1 to entry: Additional definitions for climbing systems and powered access systems are given in Annex G and Annex I.

3.1
rated capacity
load, having mass m_{NL}, which is lifted by the crane and suspended from the fixed load-lifting attachment(s). Mass m_{NL} is the sum of the pay load m_{PL} and the non-fixed load-lifting attachment(s) m_{NA}:

$m_{NL} = m_{PL} + m_{NA}$.

The maximum net load that the crane is designed to lift for a given crane configuration and load location during normal operation.

3.2
tower crane
power-driven slewing jib type crane with the jib located at the top of a tower which stays approximately vertical in the working position

Note 1 to entry: A tower crane is equipped with means for raising and lowering suspended loads and for the movement of such loads by changing the load-lifting radius, travelling of the load, slewing or travelling of the complete appliance. Some tower cranes perform several, but not necessarily all of these movements.

3.2.1
tower crane erected from parts

tower crane assembled from component parts where the design of the crane allows the crane to remain in the erected position in out-of-service conditions and to be dismantled for movement to another site

3.2.2
self-erecting tower crane
tower crane which is transported to site and mostly assembled without use of a separate lifting appliance, where the design of the crane allows the crane to remain in the erected position in out-of-service conditions and to be lowered for movement to another site

3.2.3
mobile self-erecting tower crane
self-erecting tower crane mounted on a self-propelled chassis and designed for a significantly lower load spectrum compared to tower cranes according to 3.2.1 and 3.2.2

4 List of significant hazards

Table 1 contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

Table 1 — List of significant hazards and associated requirements

NOTE Numbering in first column is in accordance with EN 1050:1996.

No.	Hazards	Relevant clause(s) in this European Standard
Hazards, hazardous situations and hazardous events		
1	**Mechanical hazards** due to machine parts or work pieces, e.g.:	
	– Shape	5.4.1
	– Inadequacy of mechanical strength	5.2, 5.3.2, E.2.2
1.1	Crushing hazard	5.4.3, 5.4.4, 5.4.4.2
1.2	Shearing hazard	5.4.3, E.2.4.1, E.2.4.5
1.3	Cutting or severing hazard	5.4.3
1.4	Entanglement hazard	5.4.3, 5.4.3.1
1.5	Drawing-in or trapping hazard	5.4.3
1.6	Impact hazard	5.4.2, 5.4.1.7, 5.4.2.9, 5.4.3, E.2.4.3
1.9	High pressure fluid injection or ejection hazard (on cranes with hydraulic)	5.3.2, E.3.2
2	**Electrical hazards** due to:	
2.1	Contact of persons with live parts (direct contact)	5.3.1, E.2.3
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	5.3.1, E.2.3
2.3	Approach to live parts under high voltage	5.3.1
3	**Thermal hazards,** resulting in:	
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources	5.4.1
3.2	Damage to health by hot or cold working environment	5.4.1, 5.4.1.8
4	**Hazards generated by noise**	5.5, 7.2.5, Annex F
4.1	Hearing loss	5.5, 7.2.5, Annex F
4.2	Interference with speech communication	5.5, 7.2.5, Annex F
7	**Hazards generated by materials and substances** (and their constituent elements) processed or used by the machinery	
7.2	Fire or explosion hazard	5.4.1
8	**Hazards generated by neglecting ergonomic principles in machinery design** as, e.g. hazards from:	
8.1	Unhealthy postures or excessive effort	5.4.4.3, E.2.4.4
8.2	Inadequate consideration of hand-arm foot-leg anatomy	5.4.1, 5.4.1.3
8.3	Neglected use of personal protection equipment	5.4.4, 5.4.4.5.1, E.2.4.4
8.4	Inadequate local lighting	5.4.1, 5.4.5
8.6	Human error, human behaviour	5.4.1, 5.4.1.1, 5.4.1.2, 5.4.2, 5.4.6,

No.	Hazards	Relevant clause(s) in this European Standard
		E.2.4.1, E.2.4.3
8.7	Inadequate design, location or identification of manual controls	5.4.1, 5.4.1.3, E.2.4.2
8.8	Inadequate design or location of visual display unit	5.4.1, 5.4.1.2
10	**Unexpected start-up, unexpected overrun/overspeed** (or any malfunction) from:	
10.1	Failure/disorder of the control system	5.4.1, 5.4.1.9, 5.4.2, 5.4.2.1, 5.4.2.2, E.2.4.3
10.4	Other external influences (gravity, wind etc.)	5.4.2.6, 7.2.6, E.2.2, E.2.4.3
10.5	Errors in software	5.3.1, E.2.3
10.6	Errors made by the operator (due to mismatch of machinery with human characteristics and abilities)	5.4.1, 5.4.2.4, 5.4.2.5, 5.4.2.6, 5.4.6
13	**Failure of the power supply**	5.3.1, E.2.3
14	**Failure of the control circuit**	5.3.1, E.2.3
16	**Break-up during operation**	5.2, 5.3.2, 5.4.2.8, 5.4.2.9, 5.4.3.2, E.2.2, E.2.4.3
17	**Falling or ejected objects or fluids**	5.4.3.2
18	**Loss of stability/overturning of machinery**	5.2, 5.4.2, 5.4.2.3, 5.4.2.7, 5.4.2.8, 5.4.2.9
19	**Slip, trip and fall of persons** (related to machinery)	5.4.4, 5.4.4.2, 5.4.4.4, E.2.4.4
Additional hazards, hazardous situations and hazardous event due to mobility		
21	**Linked to the work position** (including driving station) on the machine	
21.1	Fall of persons during access to (or at/from) the work position	5.4.4, E.2.4.4
21.3	Fire (flammability of cab, lack of extinguishing means)	5.4.1
21.4	Mechanical hazards at the work position: d) Break-up of parts rotating at high speed	5.4.3.1, 5.4.3.2, 5.4.4.1,
21.5	Insufficient visibility from the work positions	5.4.1, 5.4.1.4
21.6	Inadequate lighting	5.4.1
21.7	Inadequate seating	5.4.1
21.8	Noise at the work position	5.5, 7.1.4
21.10	Insufficient means for evacuation/emergency exit	5.4.1, 5.4.4
22	**Due to the control system**	
22.1	Inadequate location of manual controls	5.3.1, 5.4.1, 5.4.1.2
22.2	Inadequate design of manual controls and their mode of operation	5.3.1, 5.4.1, 5.4.1.2, E.2.4.2
23	**From handling of the machine (lack of stability)**	7.1, 7.1.3
25	**From/to third persons**	
25.2	Drift of part away from its stopping position	5.3.1, 5.3.2, 5.4.2, E.2.3
25.3	Lack or inadequacy of visual or acoustic warning means	5.4.6, 7.3.2, E.4.2.2

No.	Hazards	Relevant clause(s) in this European Standard
Additional hazards, hazardous situations and hazardous event due to lifting		
27	**Mechanical hazard and hazardous events**	
27.1	From load falls, collisions machine tipping caused by:	
27.1.1	Lack of stability	5.2
27.1.2	Uncontrolled loading – overloading – overturning moment exceeded	E.2.4.3.1, E.2.4.3.2
27.1.4	Unexpected/unintended movement of the load	5.3.1, 5.3.2, 5.4.2, E.2.3
27.1.6	Collision of more the one machine	5.4.2.8
27.2	From access of persons to load support	7.2.6
27.3	From derailment	5.3.2
27.4	From insufficient mechanical strength of parts	5.2, 5.3.2, E.2.2
27.5	From inadequate design of pulleys, drums	5.3.2
27.6	From inadequate selection of chains, ropes lifting and accessories and their inadequate integration into the machine	5.3.2.3
27.7	From lowering of load under control of friction brake	5.3.2
27.8	From abnormal conditions of assembly/testing/use/maintenance	6.2, 6.3, E.2.4.1, E.3
28	**Electrical hazards**	
28.1	From lightning	5.3.1
29	**Hazards generated by neglecting ergonomic principles**	
29.1	Insufficient visibility from the driving position	5.4.1, 5.4.1.4
34	**Mechanical hazards and hazardous events** due to:	
34.1	Inadequate mechanical strength – inadequate working coefficients	E.2.2
34.3	Failing of controls in person carrier (function, priority)	E.2.4.2
35	**Falling of person from person carrier**	E.2.4.4

5 Safety requirements and/or protective measures

5.1 General

Tower cranes shall comply with the safety requirements and/or protective measures of this clause. In addition, the tower crane shall be designed according to the principles of EN ISO 12100 for hazards relevant but not significant, which are not dealt with by this European Standard.

Additional requirements for climbing systems are given in Annex E.

Additional and specific requirements for mobile self-erecting tower cranes are given in Annex H.

5.2 Design requirements on the load bearing structure

5.2.1 General

The proof calculation (proof of strength and proof of stability) shall be done using the standards EN 13001-1, EN 13001-2 and EN 13001-3-1 with requirements and recommendation of following clauses of 5.2 and corresponding to the recognized state of the art in tower crane design.

General principles of calculation shall be done according to EN 13001-1, 4.2.

NOTE Calculations shall base on the assumption of a deformed system in a state of equilibrium (theory second order). Structural deformations can be neglected only if they result in a not significant increase of load effect. An increase greater equal 10% shall be considered as significant.

The documentation of the proof of competence shall include:

- design assumptions including calculation models,
- applicable loads and load combinations,
- material properties,
- weld quality classes, in accordance with EN 13001-3-1,
- properties of connecting elements and
- verification of the relevant limit states (e.g. proof of strength, fatigue proof, proof of stability).

5.2.2 Crane parts classification

Structural crane parts classification for the proof calculation of fatigue shall be done according to EN 13001-1, 4.3 and 4.4.

The classification for a tower crane for construction work shall be at least S2.

Exceptionally the class S1 could be allowed for parts of the jib at which the stress amplitudes are mainly resulting from hoist load actions.

Alternatively, in case of better knowledge of the loading conditions of the design detail under consideration, a specific stress history parameter s_m may be calculated.

5.2.3 Loads

5.2.3.1 General

Loads that are acting during the crane's life shall be considered and shall reflect unfavourable but realistic operating conditions and sequences of actions by the crane driver.

These loads shall be defined and classified as regular loads (for load combinations A), occasional loads (for load combinations B) and exceptional loads (for load combinations C) according to EN 13001-2, 4.2.

5.2.3.2 Loads and values for dynamic factors ϕ_i

Table 2 indicates loads that are generally relevant for tower cranes for construction work, and gives guidance on values for appropriate dynamic factors.

Alternatively other values for dynamic factors may be used when determined by recognized theoretical analysis or experimental method.

In case of a tower crane designed for a special use and/or with dedicated requirements additional loads and relevant values of dynamic factors shall be considered and defined according to EN 13001-2, 4.2 and 4.3.

Table 2 — Loads and guidance on values for dynamic factors ϕ_i for tower cranes for construction work

EN 13001-2 Ref. clause	Load line number i	Load	Dyn. factor ϕ_i	Definitions and guidance on values for dynamic factors ϕ_i and load determination
4.2.2.1	1	Hoisting and gravity effects acting on the mass of the crane	ϕ_1	ϕ_1 shall be considered according to EN 13001-2. The value δ defined for tower cranes is: $0 \le \delta \le 0{,}05$
4.2.2.2.1	2	Inertial and gravity effects by hoisting an unrestrained grounded load	ϕ_2	NOTE Hoisting class HC1 is defined for tower cranes. For load combinations A1 and B1: $\phi_{2,max} = 1{,}3$ The use of hoist drive classes HD1 and HD4 is recommended: - HD1: for hoist drives without the possibility of a direct influence on the motor torque, (e.g. pole-changing-drives) - HD4: for hoist drives with the possibility of a direct influence on the motor torque, (e.g. frequency-inverter-drives) For load combination C1: ϕ_2 without limitation For any kind of hoist drive class, ϕ_2 shall be calculated taking into account $V_{h,max}$. NOTE: The use of the hoist drive classes HD2, HD3 and HD5 is not recommended for tower cranes, as the use of the creep speed or the pre-stressing of the cranes structure to achieve low hoisting coefficients is up to the crane driver only.
4.2.2.2.2	3	Inertial and gravity effects by sudden release of a part of the hoist load	ϕ_3	Not applicable for tower crane for construction work
4.2.2.3	4	Loads caused by travelling on uneven surface	ϕ_4	Not applicable for tower crane for construction work NOTE: The railway has to be in conformity with ISO 12488-1 – Class 2.
4.2.2.4	5	Loads caused by acceleration of drives	ϕ_5	ϕ_5 shall be considered according to EN 13001-2. Usual values of the dynamic coefficient ϕ_5 for tower cranes are: $\phi_5 = 1{,}0$ for centrifugal forces; $\phi_5 = 1{,}5$ for drive forces for all typical drives of tower cranes (with no backlash or in case where existing backlash does not affect the dynamic forces and with smooth change of forces);
4.2.2.5	6	Loads induced by displacements	-	Not applicable for tower cranes.
4.2.3.1	7	Loads due to in-service wind	-	The minimum in-service wind level that shall be considered is state 2 (normal winds). The wind pressure to consider is $q_{(3)} = 250$ N/m² (Wind speed $v_{(3)} = 20$ m/s) – see note 1
4.2.3.2	8	Loads due to snow and ice	-	This load has to be considered only on special request from a customer or local regulation.
4.2.3.3	9	Loads due to temperature variation	-	Not applicable for tower cranes.
4.2.3.4	10	Loads caused by skewing	-	Not applicable for tower cranes.

EN 13001-2 Ref. clause	Load line number i	Load	Dyn. factor ϕ_i	Definitions and guidance on values for dynamic factors ϕ_i and load determination
4.2.4.1	11	Loads caused by hoisting a grounded load at maximum hoisting speed	ϕ_2	Refer to load line number 2 of this table.
4.2.4.2	12	Loads due to out-of-service wind	-	Refer to subclause 5.2.3.3.
4.2.4.3	13	Test loads	ϕ_6	According to EN 13001-2 and Annex C of this standard. The minimum wind pressure to consider for test loads is $q_{(3)}$ = 40 N/m² (Wind speed $v_{(3)}$ = 8 m/s) – see note 1
4.2.4.4	14	Loads due to buffer forces	ϕ_7	According to EN 13001-2 and subclause 5.2.2.5 of this standard. In this condition, not applicable for tower cranes.
4.2.4.5	15	Loads due to tilting forces	-	Not applicable for tower cranes.
4.2.4.6	16	Loads caused by emergency cut-out	-	This load can be evaluated by calculation on a dynamic model analysis or by experiment
4.2.4.7	17	Loads caused by anticipated failure of mechanism or components	-	This load can be evaluated by calculation on a dynamic model analysis or by experiment
4.2.4.8	18	Loads due to external excitation of the crane foundation	-	To be considered only on special request from a customer or local regulation.
4.2.4.9	19	Loads caused by erection, dismantling and transport	-	Refer to subclause 5.2.3.4.
4.2.4.10	20	Loads on means provided for access	ϕ_1	According to EN 13001-2
-	21	Loads due to dynamic cut-out by rated capacity limiter	ϕ_L, ϕ_{ML}	Not applicable for tower cranes, as already covered by emergency cut-out situation.
-	22	Loads due to unintentional loss of hoist load	ϕ_9	Refer to subclause 5.2.3.5.

NOTE According to EN 13001-2 the wind velocity $v_{(3)}$ corresponds to the wind speed that can be measured at the highest point of the crane.

5.2.3.3 Loads due to out-of-service wind

Wind loads due to out of service wind for tower cranes are split-up in 3 different wind load assumptions, depending on the wind direction acting on the crane, with the requirement of a free slewing upper works. These loads are converted into 3 different load combinations: C2.1, C2.2 and C2.3 according Table 4.

The static and stability proof shall be made with the following load combinations:

— C2.1 (wind from rear) ,

— C2.2 (wind from front) or C2.3 (wind from all direction).

5.2.3.3.1 Loads due to out-of-service wind from rear

The out-of-service wind loads from rear are assumed to act on a member of a tower crane or on the hoist load remaining suspended at the crane and are calculated using the following formula:

$$F = c_s c_d * q(z) * c * A$$