

ISO/TC 96/SC 10

Secretariat: DIN

Voting begins on:
2008-09-05

Voting terminates on:
2008-11-05

Cranes — Proof of competence of steel structures —

Part 1: General

Appareils de levage à charge suspendue — Vérification d'aptitude des structures en acier —

Partie 1: Généralités

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 20332-1

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.



Reference number
ISO/FDIS 20332-1:2008(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

**iTeh STANDARD PREVIEW
(standards.iteh.ai)**

[ISO/FDIS 20332-1](https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1)

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

Copyright notice

This ISO document is a Draft International Standard and is copyright-protected by ISO. Except as permitted under the applicable laws of the user's country, neither this ISO draft nor any extract from it may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, photocopying, recording or otherwise, without prior written permission being secured.

Requests for permission to reproduce should be addressed to either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Reproduction may be subject to royalty payments or a licensing agreement.

Violators may be prosecuted.

Contents

Page

Foreword.....	v
1 Scope	1
2 Normative references	1
3 Terms, definitions, symbols and abbreviations	2
4 General.....	7
4.1 General principles.....	7
4.2 Documentation	7
4.3 Alternative methods	7
4.4 Materials of structural members	7
4.5 Bolted connections.....	9
4.5.1 Bolt materials	9
4.5.2 General.....	9
4.5.3 Shear and bearing connections	9
4.5.4 Friction grip type (slip resistant) connections	10
4.5.5 Connections loaded in tension	10
4.6 Pinned connections.....	10
4.7 Welded connections.....	10
4.8 Proof of competence for structural members and connections.....	11
5 Proof of static strength	11
5.1 General.....	11
5.2 Limit design stresses and forces.....	12
5.2.1 General.....	12
5.2.2 Limit design stress in structural members.....	12
5.2.3 Limit design forces in bolted connections	13
5.2.4 Limit design forces in pinned connections	22
5.2.5 Limit design stresses in welded connections	25
5.3 Execution of the proof.....	26
5.3.1 Proof for structural members	26
5.3.2 Proof for bolted connections.....	27
5.3.3 Proof for pinned connections.....	27
5.3.4 Proof for welded connections	28
6 Proof of fatigue strength.....	28
6.1 General.....	28
6.2 Limit design stresses	29
6.2.1 Characteristic fatigue strength.....	29
6.2.2 Weld quality.....	30
6.2.3 Requirements for fatigue testing	31
6.3 Stress histories	32
6.3.1 Determination of stress histories.....	32
6.3.2 Frequency of occurrence of stress cycles.....	32
6.3.3 Stress history parameter	34
6.3.4 Determination of stress history class, S	36
6.4 Execution of the proof.....	37
6.5 Determination of the limit design stress range	37
6.5.1 Applicable methods.....	37
6.5.2 Direct use of stress history parameter	37
6.5.3 Use of S classes.....	38
6.5.4 Independent concurrent normal and/or shear stresses	39

Annex A (informative) **Limit design shear force, $F_{v,Rd}$, in shank per bolt and per shear plane for multiple shear plane connections** 40

Annex B (informative) **Preloaded bolts** 41

Annex C (normative) **Design weld stress, $\sigma_{w,Sd}$ and $\tau_{w,Sd}$** 43

Annex D (normative) **Values of slope constant, m , and characteristic fatigue strength, $\Delta\sigma_c$, $\Delta\tau_c$** 47

Annex E (normative) **Calculated values of limit design stress range, $\Delta\sigma_{Rd}$** 64

Annex F (informative) **Evaluation of stress cycles — Example** 66

Annex G (informative) **Calculation of stiffnesses for connections loaded in tension**..... 68

Bibliography 71

iTeh STANDARD PREVIEW
(standards.iteh.ai)

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 20332-1 was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 10, *Design principles and requirements*.

ISO 20332 consists of the following parts, under the general title *Cranes — Proof of competence of steel structures*:

— *Part 1: General*

iTeh STANDARD PREVIEW
(standards.iteh.ai)
[ISO/FDIS 20332-1](https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1)
<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 20332-1

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

Cranes — Proof of competence of steel structures —

Part 1: General

1 Scope

This part of ISO 20332 sets forth general conditions, requirements, methods and parameter values for performing proof-of-competence determinations of the steel structures of cranes based upon the limit state method. It is intended to be used together with the loads and load combinations of the applicable parts of ISO 8686.

This part of ISO 20332 is general and covers cranes of all types. Other International Standards may give specific proof-of-competence requirements for particular crane types.

Proofs of competence, by theoretical calculations and/or testing, are intended to prevent hazards related to the performance of the structure by establishing the limits of strength, e.g. yield, ultimate, fatigue, brittle fracture.

According to ISO 8686-1, there are two general approaches to proof-of-competence calculations: the limit state method employing partial safety factors, and the allowable stress method employing a global safety factor. The allowable stress method is a permitted alternative to the limit state method as set forth in this part of ISO 20332.

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

Proof-of-competence calculations for components of accessories (e.g. hand rails, stairs, walkways, cabins) are not covered by this part of ISO 20332. However, the influence of such attachments on the main structure needs to be considered.

NOTE Proof of competence for elastic stability is to be covered by another International Standard.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 148-1:2006, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 273:1979, *Fasteners — Clearance holes for bolts and screws*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*, corrected by ISO 286-2:1988/Cor 1:2006

ISO 404:1992, *Steel and steel products — General technical delivery requirements*

ISO 898-1:—¹⁾, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

1) To be published. (Revision of ISO 898-1:1999)

ISO 4301-1:1986, *Cranes and lifting appliances — Classification — Part 1: General*

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

ISO 5817:2003, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*, corrected by ISO 5817:2003/Cor 1:2006

ISO 8686 (all parts), *Cranes — Design principles for loads and load combinations — Part 1: General*

ISO 9013:2002, *Thermal cutting — Classification of thermal cuts — Geometrical product specification and quality tolerances*

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

ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 17659:2002, *Welding — Multilingual terms for welded joints with illustrations*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the terms and definitions given in ISO 12100-1, ISO 12100-2, ISO 17659 and ISO 4306-1:2007, Clause 6, and the following terms, definitions, symbols and abbreviations (see Table 1) apply.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.1 grade of steel

marking that defines the strength of steel, usually defining yield stress, f_y , sometimes also ultimate strength, f_u

[ISO/FDIS 20332-1](#)

3.2 quality of steel

marking that defines the impact toughness and test temperature of steel

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

Table 1 — Main symbols and abbreviations used in this part of ISO 20332

Symbols	Description
A	Cross-section
A_{eq}	Equivalent area for calculation
A_n	Net cross-sectional area at bolt or pin holes
A_r	Minor area of the bolt
A_S	Stress area of the bolt
a	Geometric dimension
a_{hi}	Geometric dimension for weld penetration
a_r	Effective weld thickness
b	Geometric dimension
b_c	Geometric dimension
b_{eff}	Effective dimension for calculation
b_l	Geometric dimension
C	Total number of working cycles

Table 1 (continued)

Symbols	Description
c	Geometric dimension
D_A	Diameter of the sheet
D_1	Inner diameter of hollow pin
D_o	Outer diameter of hollow pin
d	Diameter (shank of bolt, pin)
d_h	Diameter of the hole
d_w	Diameter of the contact area of the bolt head
d_o	Diameter of the hole
E	Modulus of elasticity
e_1, e_2	Edge distances
F	Force
F_b	Tensile force in bolt
$F_{b, Rd}$	Limit design bearing force
$F_{b, Sd}; F_{bi, Sd}$	Design bearing force
ΔF_b	Additional force
F_{cr}	Reduction in the compression force due to external tension
$F_{cs, Rd}$	Limit design tensile force
F_d	Limit force
$F_{e,t}$	External force (on bolted connection)
F_k	Characteristic value (force)
F_p	Preloading force in bolt
$F_{p, d}$	Design preloading force
F_{Rd}	Limit design force
F_{Sd}	Design force of the element
$F_{s, Rd}$	Limit design slip force per bolt and friction interface
$F_{t, Rd}$	Limit design tensile force per bolt
$F_{t, Sd}$	External tensile force per 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
$F_{\sigma, \tau}$	Acting normal/shear force
f_d	Limit stress
f_k	Characteristic value (stress)
f_{Rd}	Limit design stress

Table 1 (continued)

Symbols	Description
f_u	Ultimate strength of material
f_{ub}	Ultimate strength of bolts
f_{uw}	Ultimate strength of the weld
$f_{w, Rd}$	Limit design weld stress
f_y	Yield stress of material or 0,2 % offset yield strength
f_{yb}	Yield stress of bolts
f_{yk}	Yield stress (minimum value) of base material or member
f_{yp}	Yield stress of pins
h	Thickness of workpiece
h_d	Distance between weld and contact area of acting load
K_b	Stiffness (slope) of bolt
K_c	Stiffness (slope) of flanges
k_m	Stress spectrum factor based on m of the detail under consideration
k^*	Specific spectrum ratio factor
l_k	Effective length for tension
l_r	Effective weld length
l_w	Weld length
l_1	Effective length for tension without threat
l_2	Effective length for tension with threat
M_{Rd}	Limit design bending moment
M_{Sd}	Design bending moment
m	(negative inverse) slope constant of log σ /log N curve
N	Number of stress cycles to failure by fatigue for the stress cycle described by $\sigma_{a,i}$ and $\sigma_{m,j}$
N_{ref}	Number of cycles at the reference point
N_t	Total number of occurrences
NC	Notch class
NDT	Non destructive testing
n_i	Number of stress cycles with stress amplitude of range i
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
\hat{n}	Total number of stress cycles
P_s	Probability of survival
p_1, p_2	Distances between bolt centers

Table 1 (continued)

Symbols	Description
Q	Mass of the maximum hoist load
q	Impact toughness parameter
R	Constant stress ratio selected for one-parameter classification of stress cycles
R_d	Design resistance
r	Radius of wheel
S	Class of stress history parameter, s
S_d	Design stresses or forces
s_m	Stress history parameter
T	Temperature
TIG	Tungsten inert gas
t	Thickness
U	Class of working cycles
u	Shape factor
v	Diameter ratio
W_{el}	Elastic section modulus
α	Characteristic factor for bearing connection
α_r	Relative number of working cycles for each task r
α_w	Characteristic factor for limit weld stress
α_1, α_2	Angles between the horizontal line and the line of $N = \text{constant}$ in the $\sigma_a - \sigma_m$ plane
γ_{mf}	Fatigue strength specific resistance factor
γ_m	General resistance factor
γ_p	Partial safety factor
γ_R	Total resistance factor
γ_{Rb}	Total resistance factor of bolt
γ_{Rc}	Total resistance factor for tension on sections with holes
γ_{Rm}	Total resistance factor of members
γ_{Rp}	Total resistance factor of pins
γ_{Rs}	Total resistance factor of slip-resistance connection
γ_{Rw}	Total resistance factor of welding connection
γ_s	Specific resistance factor
γ_{sb}	Specific resistance factor of bolt
γ_{sm}	Specific resistance factor of members
γ_{sp}	Specific resistance factor of pins

Table 1 (continued)

Symbols	Description
γ_{ss}	Specific resistance factor of slip-resistance connection
γ_{st}	Specific resistance factor for tension on sections with holes
γ_{sw}	Specific resistance factor of welding connection
$\Delta\delta$	Additional elongation
δ_p	Elongation from preloading
θ_i	Incline of diagonal members
κ	Dispersion angle
λ	Width of contact area in weld direction
μ	Slip factor
ν	Relative total number of stress cycles (normalized)
ν_D	Ratio of diameters
σ	Indicate the respective stress
$\Delta\sigma$	Stress range
$\Delta\sigma_i$	Stress range i
$\Delta\hat{\sigma}$	Maximum stress range
σ_b	Lower extreme value of stress cycle
$\Delta\sigma_c$	Characteristic fatigue strength (normal stress)
σ_m	Constant mean stress selected for one-parameter classification of stress cycles
$\sigma_{m,j}$	Mean stress of range, j, resulting from rainflow or reservoir method
$\Delta\sigma_{Rd}$	Limit design stress range (normal)
$\Delta\sigma_{Rd,1}$	Limit design stress range for $k^* = 1$
σ_{Sd}	Design stress (normal)
$\Delta\sigma_{Sd}$	Design stress range (normal)
σ_u	Upper extreme value of stress cycle
$\sigma_{w, Sd}$	Design weld stress (normal)
σ_x, σ_y	Normal stress component in direction x, y
$\hat{\sigma}_a$	Maximum stress amplitude
min σ , max σ	Extreme values of stresses
τ	Shear stress
$\Delta\tau_c$	Characteristic fatigue strength (shear stress)
τ_{Sd}	Design stress (shear)
$\Delta\tau_{Sd}$	Design stress range (shear)

Table 1 (continued)

Symbols	Description
$\Delta \tau_{Rd}$	Limit design stress range (shear)
$\tau_{w, Sd}$	Design weld stress (shear)
ϕ_1	Dynamic factor

4 General

4.1 General principles

Proof-of-competence calculations shall be done for components, members and details exposed to loading or repetitive loading cycles that could cause failure, cracking or distortion interfering with crane functions.

NOTE See ISO 8686 for further information applicable to the various types of crane. Not all calculations are applicable for every crane type.

4.2 Documentation

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 ISO 5817, and
- properties of connecting elements.

4.3 Alternative methods

The competence may be verified by experimental methods in addition to, or in coordination with, the calculations. The magnitude and distribution of loads during tests shall correspond to the design loads and load combinations for the relevant limit states.

Alternatively, advanced and recognized theoretical or experimental methods generally may be used, provided that they conform to the principles of this part of ISO 20332.

4.4 Materials of structural members

It is recommended that steels in accordance with the following International Standards be used:

- ISO 630 as amended [1];
- ISO 6930-1 [7];
- ISO 4950 [3];
- ISO 4951-1, ISO 4951-2 and ISO 4951-3 [4], [5], [6].

Where other steels are used, the specific values of strengths f_u and f_y have to be known. The mechanical properties and the chemical composition shall be specified according to ISO 404. When used in welded structures, the weldability shall be demonstrated.

When verifying the grade and quality of the steel (see referenced International Standards) used for tensile members, the sum of impact toughness parameters, q_i , shall be taken into account. Table 2 gives q_i for various influences. The required impact energy/test temperatures in dependence of $\sum q_i$ are shown in Table 3 and shall be specified by the steel manufacturer on the basis of ISO 148-1.

Table 2 — Impact toughness parameters, q_i

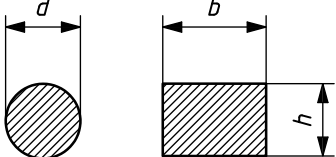
i	Influence	q_i	
1	Temperature T (°C) of operating environment	$0 \leq T$	0
		$-20 \leq T < 0$	1
		$-40 \leq T < -20$	2
		$-50 \leq T < -40$	4
2	Yield stress f_y (N/mm ²)	$f_y \leq 300$	0
		$300 < f_y \leq 460$	1
		$460 < f_y \leq 700$	2
		$700 < f_y \leq 1\ 000$	3
		$1\ 000 < f_y$	4
3	Material thickness t (mm) Equivalent thickness t for solid bars:  $t = \frac{d}{1,8}$ for $\frac{b}{h} < 1,8$; $t = \frac{b}{1,8}$	$t \leq 10$	0
		$10 < t \leq 20$	1
		$20 < t \leq 50$	2
		$50 < t \leq 100$	3
		$t > 100$	4
4	Stress concentration and notch class $\Delta\sigma_c$ (N/mm ²) (see Annex D)	$\Delta\sigma_c > 125$	0
		$80 < \Delta\sigma_c \leq 125$	1
		$56 < \Delta\sigma_c \leq 80$	2
		$\Delta\sigma_c \leq 56$	3
NOTE	For environmental temperatures below -50°C , special measures are required.		

Table 3 — Impact toughness requirement 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

4.5 Bolted connections

4.5.1 Bolt materials

For bolted connections, bolts of the property classes (bolt grades) ISO 898-1:—, 4.6, 5.6, 8.8, 10.9 or 12.9, shall be used. Table 4 shows nominal values of the strengths.

Table 4 — Property classes (bolt grades)

Property class (bolt grade)	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

iTeh STANDARD PREVIEW

Where necessary, the designer should ask the bolt provider to demonstrate compliance with the requirements for protection against hydrogen brittleness relative to the property classes (bolt grades) 10.9 and 12.9. Technical requirements can be found in ISO 15330, ISO 4042 and ISO 9587.

4.5.2 General

<https://standards.iteh.ai/catalog/standards/sist/0018d719-93bd-49b6-8f34-4eab407e2b77/iso-fdis-20332-1>

For the purposes of this part of ISO 20332, bolted connections are connections between members and/or components utilizing bolts where the following applies:

- bolts shall be tightened sufficiently to compress the joint surfaces together, when subjected to vibrations, reversals or fluctuations in loading, or where slippage can cause deleterious changes in geometry;
- other bolted connections can be made wrench tight;
- the joint surfaces shall be secured against rotation (e.g. by using multiple bolts).

4.5.3 Shear and bearing connections

For the purposes of this part of ISO 20332, shear and bearing connections are those connections where the loads act perpendicular to the bolt axis and cause shear and bearing stresses in the bolts and bearing stresses in the connected parts, and where the following applies:

- the clearance between the bolt and the hole shall conform to ISO 286-2:1988, tolerances h13 and H11, or closer, when bolts are exposed to load reversal or where slippage may cause deleterious changes in geometry;
- in other cases, wider clearances according to ISO 273 may be used,
- only the unthreaded part of the shank shall be considered in the bearing calculations;
- special surface treatment of the contact surfaces is not required.