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Small craft — Hull construction and scantlings —

Part 9: Sailing boats — Appendages and rig attachment

Petits navires — Construction de coques et échantillons —

Partie 9: Bateaux à voiles — Appendices et points d'attache du gréement

ICS 47.080

ISO/CEN PARALLEL ENQUIRY

The CEN Secretary-General has advised the ISO Secretary-General that this ISO/DIS covers a subject of interest to European standardization. **In accordance with the ISO-lead mode of collaboration as defined in the Vienna Agreement, consultation on this ISO/DIS has the same effect for CEN members as would a CEN enquiry on a draft European Standard.** Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month FDIS vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

Contents

Page

Foreword v
Introduction vi
1 Scope 1
2 Normative references 1
3 Terms and definitions 2
4 Symbols 3
5 Design criteria 5
5.1 Design stresses 5
5.2 Design stresses for typical bolts 5
5.2.1 Stainless steel ISO bolts 6
5.2.2 Steel ISO bolts 6
6 Load on appendages 7
6.1 General 7
6.2 Gravity and dynamic loads from ballast keel 7
6.2.1 Bending moment due to heel (see Figure 1) 7
6.2.2 Maximum longitudinal allowable offset (see Figure 2) 8
6.2.3 Vertical docking or grounding load 9
6.2.4 Longitudinal grounding 9
6.3 Calculation of centreboards or daggerboards 10
6.3.1 General 10
6.3.2 Calculation speed for centre-boards 10
6.3.3 Design loads for boards fitted on capsize recoverable boats 10
7 Ballast keels 10
7.1 Ballast keel material design strength 10
7.2 Strength of ballast keels 10
7.2.1 General case 10
7.2.2 Ballast with a top flange (see Figure 4b) 11
7.2.3 Lead ballast 11
7.2.4 Solid and hollowed foil sections 12
8 Structural arrangement and strength in way of ballast keel 12
8.1 General 12
8.2 Floors of equivalent stiffness 12
8.3 Floors of non equivalent stiffness 12
8.4 Resistance to keel heeling load 13
8.5 Resistance to vertical docking or grounding load 13
8.6 Resistance to longitudinal grounding 14
9 Analysis of bolted ballast keels 15
9.1 Bolt diameter determination 15
9.1.1 Constant bolt diameter 15
9.1.2 Different bolt diameter 16
9.1.3 Validity of the calculations 16
9.1.4 Bolt final evaluation 16
9.2 Bearing pressure topics 17
9.3 Shell plating reinforcement close to ballast keel 18
9.3.1 Shell plating around ballast keel 18
9.3.2 Shell plating in way of ballast keel bolts 18
9.4 Minimum washer dimensions and hull thickness in way of washers 19

10 Strength of sailing boats rig attachments 19
10.1 Preliminary 19
10.2 General 20
10.3 Dimensioning righting/heeling moment 20
10.3.1 Design heeling / righting moment for sailing monohulls 20
10.3.2 Design heeling/righting moment for sailing multihulls 21
10.4 Calculation for single mast 23
10.4.1 Mast compression / Shroud traction due to heeling moment 23
10.4.2 Design and ultimate loads on rig element and chainplates 24
10.5 Distribution of heeling moment between several masts 28

11 Transmission of rig loads to the structure 28

12 Mast step 29
12.1 Deck stepped masts 29
12.1.1 Unstiffened plywood or cored bulkheads (see Figure 10a) 29
12.1.2 Mast pillars (see Figure 10b) 30
12.1.3 Mast bulkheads with a well-bracketed vertical stiffener in way of the mast 30
12.2 Keel stepped masts (see Figure 10c) 31
12.3 Analysis by finite element method: 31
12.4 Simplified mast step scantling method: 31

Annex A (normative) Information on metal and bolts 33
A.1 Typical metal properties 33
A.2 Bolt material choice 34
A.2.1 Bolt material resistant to chemical corrosion 34
A.2.2 Prevention of electrolytic and galvanic corrosion 34
A.3 Bolt screwing and pre-stressing 34

Annex B (informative) Example of calculation of a chainplate and its connection 36
B.1 Formulas 36
B.2 Pre-calculated values for typical chainplates 37
B.2.1 General 37
B.2.2 Lightened chainplates 37
B.2.3 AISI 304 or 316 Stainless steel chainplates 37
B.2.4 Pre-calculated values for typical 5083 Aluminium 38
B.3 Example of calculation of the junction between the chainplate and the structure 39
B.3.1 Example of bolted junction 39
B.3.2 Example of connection of a bracket with the hull 39

Annex C (informative) Section modulus of some typical shapes 40
C.1 Dimensions 40

Annex D (informative) Worked examples 42
D.1 Keel bolts and floors 42

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.

International Standard ISO 12215 was prepared by Technical Committee ISO/TC 188, Small craft.

Beside this ninth part, ISO 12215 consists of

— *Part 1: Materials - Thermosetting resins, glass fibre reinforcement, reference laminate*

— *Part 2: Materials - Core materials for sandwich construction, embedded materials*

— *Part 3: Materials - Steel, aluminium, wood, other materials*

— *Part 4: Workshop and manufacturing*

— *Part 5: Design pressures for monohulls, designs stresses, scantlings determination*

— *Part 6: Structural arrangements and details*

— *Part 7: Multihulls*

— *Part 8: Rudders*

The development of ISO 12215 parts 1 to 9 owes a considerable debt to the energy and work of Mr Fritz HARTZ who was involved at the start of the project and was the convener of TC 188 WG 18 until his death on the 16th of November 2002. All the members of WG 18 and TC 188 wish to express their gratitude for his major contribution to the production of this International Standard

Introduction

The dimensioning according to this International Standard is regarded as reflecting current practice, provided the craft is correctly handled in the sense of good seamanship and operated at a speed appropriate to the prevailing sea state.

Small craft — Hull construction and scantlings —

Part 9:
Sailing boats — Appendages and rig attachment

1 Scope

This part of ISO 12215 applies to the determination of the loads and scantlings of sailing craft appendages and rig attachments on craft with a length of the hull (L_H), according to ISO 8666, of up to 24 m.

It applies to

— Loads / scantlings of appendages, such as ballast keels, centre-boards, etc (Articles 6 to 9);

— Loads / scantlings of rig attachment such as chainplates, tie rods, mast pillars and mast step (Articles 10 to 12).

This part of ISO 12215 only covers the most common arrangements, other arrangements, including transversally canting keels, are outside the scope of this part of ISO 12215, but the loads and safety factors given in the present document may be used as a basis for engineering calculation.

NOTE 1 Canting keels may need higher safety factors since they are effectively operating in a "near knockdown" condition for longer periods than is envisaged in 6.1.

In many cases this part of ISO 12215 shall be used in conjunction with Part 5 for pressure and scantlings determination, Part 6 for details and Part 8 for rudders.

NOTE 2 Scantlings derived from this International Standard are primarily intended to apply to recreational craft, including charter vessels.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12215. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12215 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8666, *Small craft — Principal data.*

ISO 3506-1, *Mechanical properties of corrosion resistant stainless steel fasteners — Part 1 Bolts, screws and studs.*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*

ISO 12215-3, *Small craft —Part 3: Materials — Steel, aluminum, wood, other materials.*

ISO 12217-2, *Small craft —Stability and floatability — Assessment methods and categorization — Part 2 sailing craft with a hull length greater than 6 m.*

3 Terms and definitions

For the purposes of this part of ISO 12215, the following terms and definitions apply.

3.1
design categories
sea and wind conditions for which a boat is assessed by this International Standard to be suitable, provided the craft is correctly handled in the sense of good seamanship and operated at a speed appropriate to the prevailing sea state

3.1.1
design category A ("ocean")
category of boats considered suitable to operate in seas with significant wave heights above 4 m and wind speeds in excess of Beaufort Force 8, but excluding abnormal conditions, e.g. hurricanes

3.1.2
design category B ("offshore")
category of boats considered suitable to operate in seas with significant wave heights up to 4 m and winds of Beaufort Force 8 or less

3.1.3
design category C ("inshore")
category of boats considered suitable to operate in seas with significant wave heights up to 2 m and a typical steady wind force of Beaufort Force 6 or less

3.1.4
design category D ("sheltered waters")
category of boats considered suitable to operate in waters with significant wave heights up to and including 0,30 m with occasional waves of 0,5 m height, for example from passing vessels, and a typical steady wind force of Beaufort 4 or less

3.2
loaded displacement mass
m_{LDC}
mass of the craft, including all appendages, when in the fully loaded ready for use condition as defined in ISO 8666

NOTE This displacement includes all possible options like generator, air conditioning, etc.

3.3
sailing craft
boat for which the primary means of propulsion is by wind power, having a total profile area As, defined in ISO 8666, expressed in m^2, of all sails that may be set at one time when sailing closed hauled (for the headsails it is the area of the fore triangle) of As > $0,07(m_{LDC})^{2/3}$

The area of wing-mast its area is included in As.

3.4
design category factor for appendages and rig
k_{DCA}
factor correcting requirements according to design category, its values are according to Table 1

Table 1 — Values of design category factor for appendages and rig

Design Category	A &B	C & D
Value of k_{DCA}	1	0,75

4 Symbols

Unless specifically otherwise defined, the symbols shown in Table 2 are used in this part of ISO 1215.

Table 2 — Symbols, coefficients, parameters

NOTE Symbols, coefficient, parameters, are classed alphabetic order.

Symbol	Unit	Designation/Meaning of symbol	Reference/Article concerned
a	m	vertical distance from CG of keel to keel junction	6.2.1
A_S	m^2	Sail area (mainsail + fore triangle) as defined in ISO 8666	10.3.2
b_c	m	Horizontal distance from centerline to chainplate	10.4.1
B_{CB}	m	Beam between centers of buoyancy of catamarans	10.3.2
B_H	mm	Beam of hull, as defined in ISO 8666	10.3.1
b_i	mm	Distance between hinge gearing line and opposed bolt axis	9.1.1
$b_{i\ MAX}$	mm	Maximal value of b_i	9.1.1
$b_{Q\ max}$	mm	Maximal value of b_Q	9.2
c	m	Vertical distance between top of keel and mid floor	6.2.1
d, d_i	mm	N nominal diameter of bolt or of bolt n°i	8.1.4
d_{ineck}	mm	Neck diameter of bolt N° i	8.1.2
d_{neck}	mm	Required neck diameter of bolts	8.1.1
F_{IJ}	N	Load on rig, chainplate, mast step, hull connection	10.4.2.2
F_{QVd}	N	Vertical force at ballast keel CG	6.2.3
F	N	Force or shear load	8.4, 8.5, 8.6
F_{QLd}	N	Longitudinal force at bottom of ballast keel	6.2.4
F_{TIP}	N	Design capsize recovery force at tip of the board	6.3.3
F_{VH}	N	Nominal mast compression/ chainplate traction due to heel	9.3.1
h_{CE}	m	Height of centroid of AS above loaded waterline	10.3.2
h_{LP}	m	Height of centroid of underwater surface below waterline	10.3.2
h_{TIP}	m	Vertical distance between centbrd tip and hull connection	6.3.3
k_{DCA}	*	Design category factor for appendages and rig attachment	3.4
k_{IJ}	*	Coefficient on rig, chainplate, mast step, hull connection	10.4.2.2
k_{VS}	*	Speed correction factor for sailing craft	10.3.2
ℓ_F	m	Long. distance between furthermost and aftermost bolts	8.4
L_{Bolts}	m	Hull length of the craft according to ISO 8666	6.2.2
L_H	m	Hull length of the craft according to ISO 8666	6.2.4
L_Q	mm	Length of the top chord of the keel of top of flange	8.2

L_{WL}	m	Length of waterline in loaded condition	9.2.2
m_{LDC}	kg	Loaded displacement mass (with all options)	3.2, 6.1.3
M_{CB}	Nm	Lifting board design moment	6.3.1
M_{CRB}	Nm	Capsize recoverable boat centerboard design bending Mt	6.3.3
M_{Hd}	Nm	Design heeling/righting moment	9.2.1
M_{HQd}	Nm	Ballast keel design bending moment at keel junction	6.2.1
n_F	*	Number of floors connected to the keel	8.6.1
n_P	*	Min number of persons for boat recovery acc. to ISO 12217	6.3.3
p	mm	Bolt screw pitch	8.1.4
Q	kg	Mass of the ballast keel	6.2.1
R_{M30}	Nm	Righting moment at 30° heel	9.2.1
R_{Mcrew}	NM	Righting moment from the crew	9.2.1
S_{MQ}	cm3	Section modulus of ballast keel	7.2.1
T	m	Maximum draft of the craft according to ISO 8666	6.2.4
V_{CBMONO}	knots	Monohull centerboard design speed	6.2.21
$V_{CBMULTI}$	knots	Multihull centerboard design speed	6.2.21
V_{AWK}	knots	Apparent wind speed for calculation of multihulls	9.2.2
x_1	mm	Width of protruding flange	7.2.2
y_1	mm	Thickness of protruding flange	7.2.2
σ	N/mm^2	Tensile stress (ultimate, yield, design, bearing)	5.1.1
τ	N/mm^2	Shear stress (ultimate, design)	5.1.1

5 Design criteria

5.1 Design stresses

For direct stresses and combined stresses the values given in Table 3 shall be used.

Table 3 — Values of design stresses

Material	Direct stresses			Combined stresses
	σ_d	τ_d	σ_{db}	
Ductile fracture metals[a]	min (0,5 σ_u; 0,9 σ_y)	0,58 σ_d	1,8 σ_d	$\sqrt{\sigma^2 + 3\tau^2} \leq \sigma_d$
Brittle fracture metals[b]	min (0,33 σ_u; 0,6 σ_y)	0,58 σ_d	1,8 σ_d	$\sqrt{\sigma^2 + 3\tau^2} \leq \sigma_d$
Wood and FRP	0,5 σ_u	0,5 τ_u	1,8 σ_d	$\left(\frac{\sigma}{\sigma_u}\right)^2 + \left(\frac{\tau}{\tau_u}\right)^2 < 0{,}25$

[a] Steel, stainless steel, aluminium alloys, titanium alloys, copper alloys, lead antimony alloys, see Annex A

[b] Grey Cast iron, see Annex A

where

σ_d is the design tensile, compressive, and flexural strength (as relevant); (N/mm^2)

σ_u is the ultimate tensile, compressive, and flexural strength (as relevant); (N/mm^2)

σ_y is the yield tensile, compressive, and flexural strength (as relevant); (N/mm^2)

σ_{db} is the design bearing strength; (N/mm^2)

τ_u is the ultimate shear strength; (N/mm^2)

τ_d is the design shear strength. (N/mm^2)

NOTE To be consistent with Parts 5 and 8 of ISO 12215, the design stresses are high. To take this fact into account, the actual loads are raised, where relevant, by an adequate dynamic factor.

For typical stainless steel or carbon steel bolt material, the strength values may shall be taken from Tables 4 to 6 as relevant, unless documented specific bolts are used.

For other metals or custom made steel fasteners, the strength values of Annex A1 shall be taken, as relevant.

For wood and composites, the strength values of the relevant Annexes of ISO 12215-5 shall be used.

5.2 Design stresses for typical bolts

Bolts may be made from any suitable metal, like carbon steel and stainless steel, or non ferrous metals such as Monel 400, etc. Stainless steel or carbon steel bolts are considered in the present article, because they are the most popular material.

Bolt choice information and suggested tightening torque are given in Articles A2 and A3 of Annex A.

5.2.1 Stainless steel ISO bolts

NOTE Stainless steels are classed by ISO 3506 -1:1998 into four main categories, see Table 4.

Table 4 — Classification of ISO Stainless steel screws according to ISO 3506

ISO Material	AISI	Texture
A1	303	Austenitic
A2	304	Austenitic
A4	316	Austenitic
C1 to C4	400 serial	Martensitic

If the steel has a low carbon content, the letter L is added after the ISO material.

Table 5 — Mechanical properties of ISO Stainless steel screws according to ISO 3506

		ISO SS Bolts According to ISO 3506-1		
		Property Class		
		50	70	80
σ_u	N/mm^2	500	700	800
σ_y	N/mm^2	210	450	600
σ_d	N/mm^2	189	350	400

Class 50 is usually made by machining a thread from a solid rod. This is usually how are made threaded rods.

Class 70 and 80 are made by a combination of stamping and cold stretching, this is the most used method for screws and bolts.

Quality SS bolts are usually stamped on their head with, on top, the identification of the manufacturer with 3 letters, and below the ISO material and class quality.

For example A4 L – 80 means ISO Material A4 with low carbon and Class 80.

5.2.2 Steel ISO bolts

Steel (plain or galvanized) are classed by ISO 898-1:1999 into several classes. The first digit multiplies by 100 gives the ultimate strength σ_u (N/mm^2). The yield strength σ_y is obtained by multiplying the first digit by 10 times the second digit.

Table 6 — Mechanical properties of ISO Steel screws

		ISO Class According to ISO 898-1						
		4.8	5.6	5.8	6.8	8.8	10.9	12.9
σ_u	N/mm^2	400	500	500	600	800	1 000	1 200
σ_y	N/mm^2	320	300	400	480	640	900	1 080
σ_d	N/mm^2	200	250	250	300	400	500	600

6 Load on appendages

6.1 General

Section 8 gives requirements and considerations on structural arrangements in way of ballast keels corresponding to the loads given on Section 6. Informative Annex D gives some worked example of ballast keel bolts and structural arrangements.

6.2 Gravity and dynamic loads from ballast keel

6.2.1 Bending moment due to heel (see Figure 1)

$$M_{HQd} = 18\ k_{DCA} \times Q \times a \qquad \text{(Nm)} \qquad (1)$$

is the ballast keel heeling design bending moment at the keel junction at 90° heel.

For calculation of floors, the design keel heeling design moment for floors

$$M_{HFd} = 18\ k_{DCA} \times Q \times (a + c) \qquad \text{(Nm)} \qquad (2)$$

is the ballast keel heeling design bending for floor at 90° heel

NOTE 1 These bending moments includes a factor which reflects dynamic effects

where

- Q is the mass of ballast keel; (kg)
- a is the vertical distance, when upright, from CG of keel to keel junction; (m)
- c is the vertical distance, when upright, from keel junction to floor mid height. (m)