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ISO/TC **188**

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Small craft — Hull construction and scantlings —

Part 7:
Scantling determination of multihulls

Petits navires — Construction de coques et échantillons —

Partie 7: Détermination de l'échantillonnage pour les multicoques

ICS 47.080

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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.

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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.

ISO 12215-7 was prepared by Technical Committee ISO/TC 188, *Small craft*, Subcommittee SC , .

ISO 12215 consists of the following parts, under the general title *Hull construction — Scantlings*:

— *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 monohull, design stress, scantlings determination*

— *Part 6: Structural arrangements and details*

— *Part 7: Multihulls*

— *Part 8: Rudders*

— *Part 9: Appendages and rig attachments*

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 reason underlying the preparation of this International Standard is that standards and recommended practices for loads on the hull and the dimensioning of small craft differ considerably, thus limiting the general world wide acceptability of boats.

The objective of this standard is to achieve an overall structural strength that ensures the watertight and weathertight integrity of the craft.

The working group considers this standard to have been developed applying present practice and sound engineering principles. The design pressures of this standard shall be used only with the equations of this standard.

Considering future development in technology and boat types, and small craft presently outside the scope of this standard, provided methods supported by appropriate technology exist, consideration may be given to their use provided equivalent strength to this standard is achieved.

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

Small craft — Hull construction and scantlings —

Part 7:
Scantling determination of multihulls

1 Scope

This part of ISO 12215 applies to the determination of design loads, pressures, stresses, and to the determination of the scantlings, including internal structural members of multihull small craft with a length of the hull (L_H) of up to 24 m according to ISO 8666. The construction material is planned to be fibre reinforced plastics, aluminium or steel alloys, wood or other suitable boat building material. It only applies to boats in intact condition.

The assessment shall generally include all parts of the craft that are assumed watertight or weathertight when assessing stability, freeboard and buoyancy according to ISO 12217, all structural integral parts, and in addition any highly loaded areas like attachment areas of ballast keels, centreboards, rudders, chain plates, etc.

Hydrofoils are not covered in this part of 12215.

NOTE 1 Scantlings derived from this International Standard are primarily intended to apply to recreational craft including charter vessels.

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 8666, *Small craft — Principal data*

ISO 12215-5, *Small craft — Scantlings — Part 5: Design pressures for monohull, design stress, scantlings determination*

ISO 12215-6, *Small craft — Scantlings — Part 6: Structural arrangements and details*

ISO 12215-8, *Small craft — Scantlings — Part 8: Rudders*

ISO 12215-9, *Small craft — Scantlings — Part 9: Appendages and rig attachments*

3 Terms and definitions

For the purposes of this International Standard, 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 m², 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-masts is included in As

In the rest of this International Standard, non-sailing craft are considered as motor craft.

3.4
design category factor for multihulls
k_{DC}
factor lowering requirements according to design category, its values are according to Table 1

Table 1 — Values of design category factor for multihulls k_{DC}

Design Category	A	B	C	D
Value of k_{DC}	1	0,8	0,6	0,4

NOTE k_{DC} is the same as in ISO 12215-5.

3.5
wet deck
underside area of the structure connecting hulls

NOTE Some multihulls have not wet deck but just crossbeams.

4 Symbols

Unless specifically otherwise defined, the symbols shown in Table 2 are used in this International Standard.

NOTE The symbols are shown in alphabetic order, not order of appearance.

Table 2 — Symbols, coefficients, parameters

Symbol	Unit	Designation/Meaning of symbol	Reference/Article concerned
Principal dimensions and data			
B_{CB}	m	Beam between centres of buoyancy	6.1
B_{CP}	m	Beam between upper shrouds chainplates	9.3.3
B_{WL}	m	Beam of waterline according to ISO 8666	6.1
D	m	Depth of hull at mid length	9.4.2
L_{WL}	m	Length of waterline according to ISO 8666	6.1
m_{LDC}	kg	Mass of loaded displacement	3.2, 7.8
V	Knots	Boat maximum speed if fully loaded condition	6.2, 7.2
W_{AWK}	Knots	Apparent wind speed in knots	6.3
Z_{WD}	m	Wet deck freeboard above waterline	7.8
Calculation data, coefficients, pressures used for local loads (Articles 6 to 8)			
k_{AR}		Area pressure distribution factor f	7.1
k_{DC}		Design category factor for multihulls	3.4
K_{DR}		Deadrise pressure reduction factor	7.2
K_L		Longitudinal pressure distribution factor	7.3
k_{LWD}		Wet deck longitudinal pressure distribution factor	7.4
k_{SUP}		Superstructure and deckhouse pressure distribution factor	7.6
k_{VS}		Speed correction factor	7.5
K_Z		Vertical pressure reduction factor	7.7
k_{ZWD}		Wet deck vertical pressure correction factor	7.8
n_{CGMH}	g	Dynamic load factor for multihulls	7.9
P_{BMH}	kN/m^2	Bottom pressure for multihulls	8.2
$P_{BMH\ BASE}$	kN/m^2	Base bottom pressure for multihulls	8.2
$P_{BMH\ MIN}$	kN/m^2	Minimal bottom pressure for multihulls	8.2
P_{DMH}	kN/m^2	Deck pressure for multihulls	8.4
$P_{DMH\ MIN}$	kN/m^2	Minimal deck pressure for multihulls	8.4
$P_{DMH\ BASE}$	kN/m^2	Base deck pressure for multihulls	8.4
P_{SMH}	kN/m^2	Side pressure for multihulls	8.3
$P_{SMH\ MIN}$	kN/m^2	Minimal superstructure pressure for multihulls	8.3
$P_{SUP\ MH}$	kN/m^2	Superstructure pressure for multihulls	8.5

Symbol	Unit	Designation/Meaning of symbol	Reference/Article concerned
$P_{SUPMH\ MIN}$	kN/m^2	Minimal superstructure pressure for multihulls	8.5
P_{WDMH}	kN/m^2	Wet deck pressure for multihulls	8.6
$P_{WDMH\ min}$	kN/m^2	Minimal wet deck pressure for multihulls	8.6
$P_{WDMH\ base}$	kN/m^2	Base wet deck pressure for multihulls	8.6
$\beta_{0,4L}$	Degrees	Deadrise at 0,4 L_{WL}	6.1
β_X	Degrees	Deadrise at section x	6.1
Calculation data, coefficients, pressures used for global loads (Articles 9 to 12)			
A_S	m^2	Sail area	3.3, C.2.1
c	mm	Core thickness of sandwich web	12.4.1
C_M	N	Compression in the mast	9.3.3
F_{CPW}	N	Vertical load on windward chainplate	9.3.3
F_{CP}	N	Vertical load on leeward chainplate	9.3.3
G_C	N/mm^2	Core shear modulus	12.4.1
E_t	N/mm^2	Tensile elastic modulus of the web material	12.4.1
H_{CE}	m	Height of centre of effort of A_S above waterline	9.3.1, C.2.2
H_W	mm	height of the web on a beam	12.4
k_{HD}	*	Min ratio between $M_{DH\,3}$ and $M_{DH\,1}$	9.3.1
k_{SB}	*	Shear bending coefficient	12.4.1
H_{LP}	m	Height of centre of lateral underwater pressure	9.3.1, C.2.2
M_{BH}	Nm	Longitudinal bending moment on each hull	9.4.2
M_{HD}	Nm	Design righting moment for multihull	9.3.1
M_{HD1}	Nm	Righting moment corresponding to maximum stability	9.3.1
M_{HD2}	Nm	Design heeling/righting moment due to wind	9.3.1
M_{HD3}	Nm	Design righting moment corresponding to shroud strength	9.3.1
R_{US}	N	Ultimate strength of the upper shroud	9.3.1
t	mm	Single skin or sandwich thickness of the web	12.4.1
T	Nm	Twisting moment due to sea	9.4.3
T_{JH}	N	Tension in the jib halyard	9.3.3,C.2.2
T_{HS}	N	Tension in the headstay	9.3.3, C.2.2
T_{MS}	N	Tension in the mainsail sheet and halyard	9.3.3, C.2.2
T_{US}	N	Tension in the upper shroud	9.3.3, C.2.2
t_w	mm	Thickness of the web	12.4
σ_d	N/mm^2	Design direct stress in stiffener	10.2
τ	N/mm^2	Effective shear stress for stiffening member	12.4
τ_d	N/mm^2	Design shear stress for stiffening member	12.4
τ_{crit}	N/mm^2	Critical buckling shear stress in the web	12.4.1
The units used in Annexes are defined in these annexe			

5 General

The scantling determination shall be accomplished as follows:

— for local loads, the parameters given in article, 8, and paragraph 10.1 shall be used;

— for global loads, the method given in articles, 9, 10,11 and 12 shall be used;

All parameters, coefficients, mechanical properties, etc. not given in this part of ISO 12215 shall be derived from ISO 12215-5.

This part of ISO 12215 shall also be used in conjunction with:

— ISO 12215-6 for details;

— ISO 12215-8 for rudders;

— ISO 12215-9 for appendages and rig attachment.

6 Dimensions, areas, and data

6.1 Dimensions

Same dimensions as in 12215-5, and, in particular:

— L_{WL} is the length on the fully loaded waterline, the craft being at rest (m)

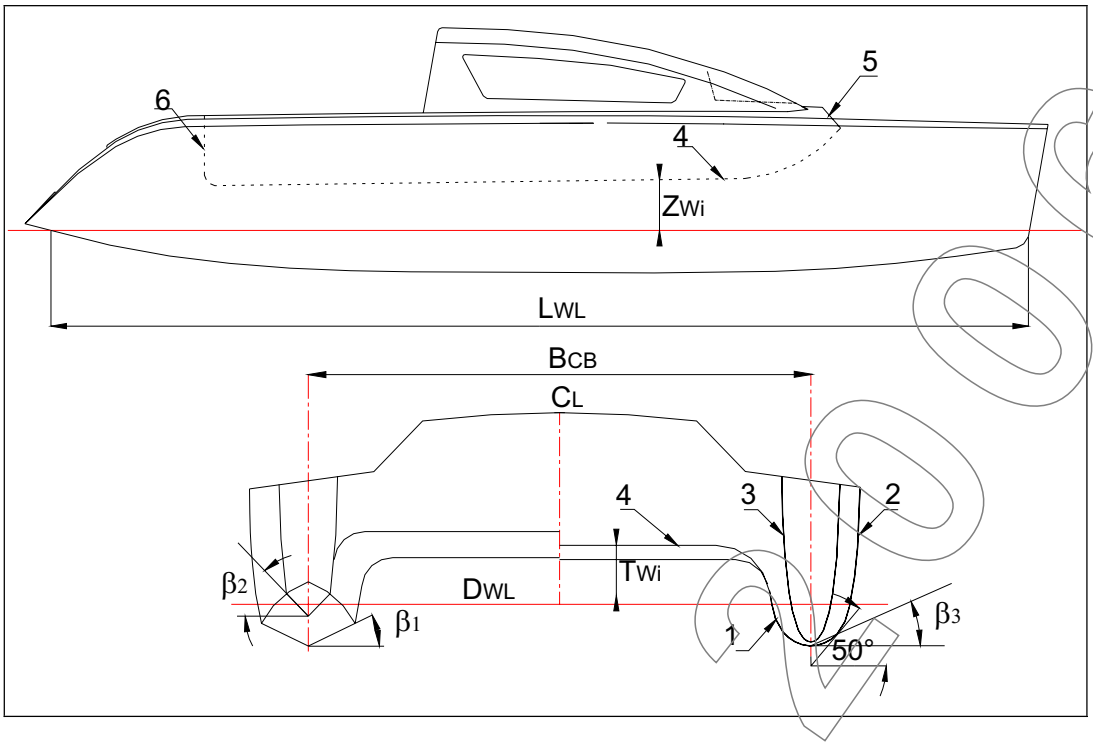
— B_{WL} is the sum of the maximum waterline beams of the two hulls for catamarans or the maximum waterline beam of the main hull for trimarans (m)

— B_{CB} is , for a catamaran, horizontal distance between centres of buoyancy (m)

Where the bottom of the hull is made of approximately flat surfaces the deadrise is the actual deadrise (see β_1 and β_2 in Figure 1), and where the bottom has round bilges, the deadrise shall be measured as the angle between hull bottom lowest point (hull centreline) and the point where the bottom is tangent to a line angled 50° from horizontal (see β_3 in Figure 1).

— $\beta_{0,4L}$ is the deadrise angle at $0{,}4 \cdot L_{WL}$ forward of its the aft end, not to be taken less than 10°, nor more than 30°. (degrees)

— β_x is the deadrise angle at a distance x forward of its the aft end, not to be taken less than 10°. (degrees)



Key

1 Bottom area
2 Outer side outer
3 Inner side inner
4 Wet deck
5 Front face of wet deck
6 Aft facing cross-beam

Figure 1 — General dimensions of a catamaran

In Figure 1, Z_{Wi} (m) is the wet deck height above waterline, the index i explains that this height is usually variable and is shown at section i.

6.2 Boat speed

For motor craft V is, the maximum speed in calm water declared by the manufacturer, with the craft in m_{LDC} conditions, this speed shall not be taken less than $4 \times \sqrt{L_{wl}}$ (knots)

For sailing craft, speed does not need to be declared.

6.3 Wind speed

V_{AWK} is the apparent wind speed for multihulls given in Table 3 (knots)

NOTE V_{AWK} is considered as the apparent wind speed just before a reef is taken. It is a theoretical value derived from industry practice, that may differ from actual wind speed, according to sail shape, sail tension, fabric, etc.

Table 3 — Values of V_{AWK} according to design category

Design category	A & B	C & D
V_{AWK} (knots)	36 for $12 \le L_{WL} < 15$ 32 for $15 \le L_{WL} < 18$ 30 for $18 \le L_{WL} < 20$ 25 for $L_{WL} > 20$	25

6.4 Areas

The limit between bottom and side is the waterline for boats where $V / \sqrt{L_{WL}} \le 5$.

The limit between bottom and side is the chine where $V / \sqrt{L_{WL}} > 5$. If the chine is not clearly defined, it shall be taken at a point where a tangent at 50° from the horizontal touches the hull (see Figure 1 in Part 5).

The wet deck area is the bottom and front area of any platform connecting the hulls or outriggers, including the their connection (hard chined or curved) to the hull or outrigger. For local loads, the front and bottom of crossbeams are considered as part of the wet deck.

The sides are divided into outer side and inner side where the latter is less exposed to local loads.

7 Pressure adjusting coefficients

7.1 Area pressure distribution factor k_{AR}

Same as in ISO 12215-5, except that for all multihulls (sail and motor) $k_{AR\ MIN}$ is the one for motor craft.

NOTE The reason for this difference is that sailing multihulls do not slam heavily on front topsides like sailing monohulls do because they do not heel significantly.

7.2 Dead rise pressure reduction factor k_{DR}

$$k_{DR} = \frac{90 - \beta_x}{60} \text{ but shall not be taken smaller that 0,5 nor greater than 1} \quad (1)$$

k_{DR} is applied at any section x and is a function of the bottom deadrise angle β_X, measured according ISO 12215-5. It lowers the bottom pressure if $\beta_X > 30°$ and is equal to 0,5, its lower limit for $\beta_X = 60°$.

7.3 Longitudinal pressure distribution factor k_L

Same as in 12215-5 except that n_{CGMH} shall be used instead of n_{CG}.

7.4 Wet deck longitudinal pressure reduction factor k_{LWD}

— k_{LWD} is the wet deck longitudinal pressure distribution, as defined in Figure 4 and equations.

Linear interpolation shall be used between the points.