GUIDANCE NOTES
GD 11-2012

**CHINA CLASSIFICATION SOCIETY**

# GUIDELINES FOR SURVEY OF SAILING CRAFT

# 2012

**Beijing**

# CONTENTS

# CHAPTER 1 GENERAL

## Section 1 General Provisions

### 1.1.1 Application

1.1.1.1 The Guidelines applies to new constructed sailing craft intended for leisure and pleasure of less than 24 m in length ($L_H$), excluding those for sports.

1.1.1.2 The design categories of sailing craft are as follows:

(1) Category I means the craft designed for navigating exceeding 200 n miles off the shore and with the minimum design significant wave height① ($H_S$) of 6 m.

(2) Category II means the craft designed for navigating within 200 n miles off the shore and with the minimum design significant wave height ($H_S$) of 4 m.

(3) Category III means the craft designed for navigating within 20 n miles off the shore and with the minimum design significant wave height ($H_S$) of 2 m.

(4) Category IV means the craft designed for navigating within 10 n miles off the shore and with the minimum design significant wave height ($H_S$) of 1 m.

(5) Category V means the craft designed for navigating within 5 n miles off the shore and with the minimum design significant wave height ($H_S$) of 0.5 m.

1.1.1.3 Unless expressly provided otherwise in the Guidelines, the machinery and electrical installations (other than main propulsion) and outfitting onboard the sailing craft are to meet the relevant requirements of PART ONE of CCS Rules for Construction and Classification of Yachts, of which the design of steering gears is to meet the relevant provisions of ISO standards②.

1.1.1.4 Unless expressly provided otherwise in the Guidelines, the statutory requirements for fire safety, life-saving, cabin arrangement, watertight integrity, communication and navigation, signal, environment protection, etc., are to meet the relevant provisions of the Administration. For sailing craft entitled to fly the flag of China, the relevant requirements of Part One of MSA Interim Provisions for Statutory Survey of Yachts are to be complied with.

1.1.1.5 The material and construction technology of sailing craft are to comply with the relevant requirements of CCS Rules for Materials and Welding or other recognized standards.

### 1.1.2 Equivalent and exemption

1.1.2.1 Any craft which embodies structure and features of a novel kind may be exempted from any requirement of the Guidelines if the application of which might seriously impede the incorporation of its features or its service, subject to agreement of CCS.

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① The significant wave height of sailing craft navigating within the actual water areas is not to exceed its design significant wave height.

② Refer to ISO 12215-8 for details.

1.1.2.2 Any fitting, material, appliance or apparatus, other than that required in the Guidelines, may be allowed to be fitted in a craft, if it is satisfied by trail thereof or otherwise that such fitting, material, appliance or apparatus is at least as effective as that required in the Guidelines.

1.1.2.3 Equivalent or substitution to those methods of calculation, criteria of evaluation, manufacturing procedures, materials, survey and test requirements specified by the Guidelines may be accepted subject to agreement of CCS, when relevant tests, theoretical basis or service experience are provided. ISO standards or other recognized standards may also be accepted by CCS as the equivalent requirements.

### 1.1.3 Definitions

1.1.3.1 Unless expressly provided otherwise, the definitions in the Guidelines are as follows:

(1) Sailing craft are the yachts for which the primary means of propulsion is by wind power.

(2) Length of craft $L_H$ (m) is the length of hull for craft, which is the horizontal distance from foremost end to the aftermost end of craft. This length includes all structural and integral parts of the craft, such as stem or stern posts, bulwarks and hull/deck joints. This length excludes removable parts without affecting the structural integrity of the craft, e.g. spars, bowsprits, pulpits at either end of the craft, stemhead fittings, rudders, outdrives, outboard motors and their mounting brackets and plates, diving platforms, boarding platforms, rubbing strakes and fenders. For catamaran, the length of each hull is to be measured individually. The length of the hull, $L_H$, is to be taken as the longest of the individual measurement.

(3) Full load waterline length $L_{WL}$ (m) is the length of watertight envelope of the rigid hull at the waterline at full load displacement in rest floatation, excluding appendages at or below the waterline.

(4) Full load displacement $\Delta$ (t) is the weight of water displaced by a craft under a full load service condition with the required equipment, cargoes, stores, accessories, rigging, etc., 100% of fuel oil, lubricating oil, fresh water, food, supplies and rated passengers onboard and the craft is in a state readily for sailing.

(5) Maximum waterline breadth $B_{WL}$ (m) is the maximum breadth of watertight envelope of the rigid hull at the waterline at full load displacement in rest floatation for monohull craft; and the sum of maximum moulded breadths of each hull for watertight envelope of the rigid hull at the waterline at full load displacement in rest floatation for catamaran.

(6) Beam between centers of buoyancy $B_{CB}$ (m) is the transverse distance between centers of buoyancy of two hulls for the catamaran at full load displacement.

(7) Moulded baseline is a longitudinal line through the lower surface of bottom plate of the cross section in half-length of full load waterline $L_{WL}$.

(8) Moulded depth $D$ (m) is the vertical distance measured at the cross section in half-length of full load waterline $L_{WL}$ from the moulded baseline to the top of main deck beam at side.

(9) Maximum moulded depth $D_{\max}$ (m) is the vertical distance measured at the cross section in half-length of full load waterline $L_{WL}$ from the lowest point of keel (including the ballast keel) to the top of main deck beam at side.

(10) Draught $T$ (m) is the vertical distance measured at the cross section in half-length of full load waterline $L_{WL}$ from the moulded baseline to the full load waterline, excluding the ballast keel below the moulded baseline.

(11) Maximum draught $T_{\max}$ (m) is the vertical distance measured at the cross section in half-length of full load waterline $L_{WL}$ from the lowest point of keel (including the ballast keel) to the lowest point of keel (including the ballast keel) to the full load waterline.

(12) Block coefficient $C_B$ is the value calculated according to the following formula:

$$C_B = \frac{\Delta}{1.025 L_{WL} B_{WL} T}$$

## Section 2 Compliance Survey

### 1.2.1 General requirements

1.2.1.1 The requirements of survey type, manufacturer's assessment, fabrication survey and type survey certificates, compliance certificate, etc., are to comply with the relevant provisions of PART ONE of CCS Rules for Construction and Classification of Yachts.

### 1.2.2 Examination of plans and technical documents

1.2.2.1 The contents of examination of plans and technical documents for craft are to be in accordance with the relevant provisions of PART ONE of CCS Rules for Construction and Classification of Yachts, of which the following contents of relevant hull structures and stability information are to be submitted for approval:

(1) general arrangement;

(2) arrangement of sails, rigging and masts;

(3) hull structure (including deck, top of cabin, superstructure, bulkhead structure, etc.);

(4) design of laminates for hull structure (if applicable);

(5) ballast keel (including shape, material, structure, connection with hull, etc.);

(6) arrangement of chainplates (including specifications and breaking loads of all rigging associated with the chainplates);

(7) connection between mast and hull structure;

(8) general specifications (for information);

(9) lines (for information);

(10) calculations of weight and center of gravity (for information);

(11) calculations of intact stability (including full sail hoisted condition, half sail hoisted condition and sail lowered condition);

(12) strength calculations of hull structure (for information).

**1.2.3 Items of prototype survey and test**

1.2.3.1 The items of prototype survey and test for craft are to be in accordance with the relevant provisions of PART ONE of CCS Rules for Construction and Classification of Yachts, in addition to, the following items are to be added:

(1) to inspect the connection between chainplates and hull structure;

(2) to inspect the connection between ballast keel and bottom structure;

(3) to inspect the connection between masts and the bulkhead or deck or bottom;

(4) to perform the operation test of sail hoisting and sail lowering.

## CHAPTER 2 HULL STRUCTURE

### Section 1 General Provisions

#### 2.1.1 General requirements

2.1.1.1 The provisions of this Chapter apply to monohull craft and catamaran craft with the hull structure made of fabric reinforced plastics (FRP) or aluminium alloy. Special consideration will be given by CCS for craft made of other materials provided with the relevant information.

2.1.1.2 Other recognized standards, such as ISO standards, are to be accepted by CCS as the equivalent requirements of this Chapter.

#### 2.1.2 Definitions and symbols

2.1.2.1 *b* (mm) means the shorter dimension of the panel. For the panel fitted with FRP top-hat stiffener, the width of stiffener bottom is to be deduced for the calculation.

2.1.2.2 *l* (mm) means the longer dimension of the panel. For the panel fitted with FRP top-hat stiffener, the width of stiffener bottom is to be deduced for the calculation.

2.1.2.3 *s* (mm) means the spacing between centerlines of adjacent stiffeners (hereinafter referred to as spacing of stiffeners).

2.1.2.4 $l_u$ (mm) means the span of unsupported length of stiffener, see Figure 2.1.4a (hereinafter referred to as span of stiffener). For FRP top-hat stiffener, the spacing of centerline of adjacent top-hat stiffeners is to be taken, see Figure 2.1.2.4b.

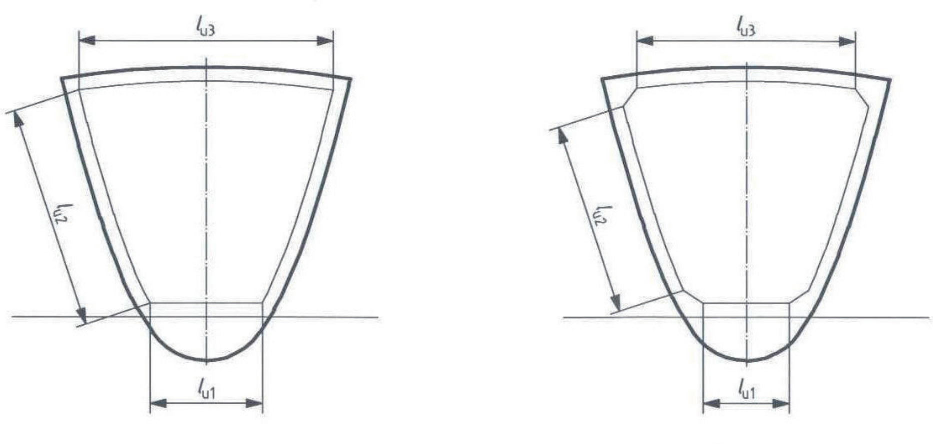


**Figure 2.1.2.4a**

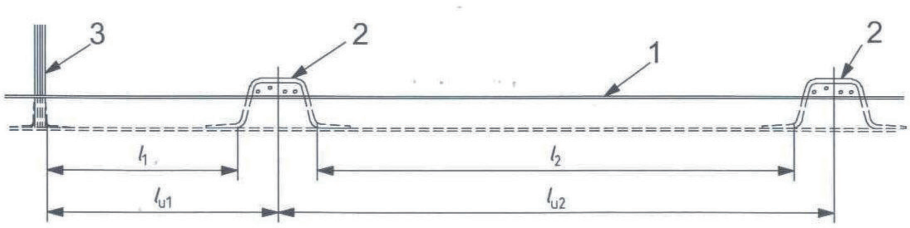


**Figure 2.1.2.4b**

2.1.2.5 $b_e$ (mm) means the effective breadth of attached plate for stiffener, to be calculated according to the following, but not more than the spacing of stiffeners:

$b_e = 60t$ for attached plate made of aluminium alloy stiffener, where $t$ is the thickness of plating;

$b_e = 20t + w$ for single skin attached plate made of FRP top-hat stiffener, where $t$ is the thickness of attached plate, $w$ is the bottom width of top-hat stiffener, see Figure 2.1.2.5;

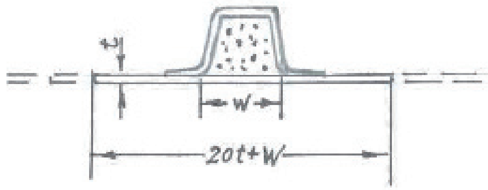


**Figure 2.1.2.5**

$b_e = 20\ (t_o + t_i)$ for sandwich laminate attached plate made of FRP top-hat stiffener, where $t_o$ and $t_i$ are the thicknesses of outer skin and inner skin① of sandwich laminate, respectively.

2.1.2.6 Relative coordinate system OXYZ: taking the intersect between after perpendicular of full load waterline at longitudinal middle plane and moulded baseline as the origin, the $x$ coordinate along the forward direction being positive, the $y$ coordinate along the left direction being positive and the $z$ coordinate along the upper direction being positive.

### 2.1.3 Selection of load points

2.1.3.1 For plate panel, the center of plate panel is to be taken as the calculated load point. For vertical plate panel, the load point is to be taken at the one-third height of the plate panel above its lower edge.

2.1.3.2 For stiffener, the middle of stiffener span is to be taken as the load point. For vertical stiffener, the load point it to be taken at the one-third span of stiffener $l_u$ above its lower edge.

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① Outer skin means the side of sandwich laminate which is subject to the effects of static and dynamic loads of liquid or impact loads constantly.
Inner skin means the other side of sandwich laminate which is not subject to the effects of loads.

**2.1.4 Division of bottom area and side shell area**

2.1.4.1 The bottom area is the part of the shell located below the full load waterline.

2.1.4.2 The side shell area is the part of the shell located above the full load waterline, other than the deck. The side shell area for catamaran also includes the cross-deck bottom.

**2.1.5 Determination of plate panel dimension for large side shell without stiffener**

2.1.5.1 Where the side shell plate is not fitted with stiffeners, natural stiffeners are normally the ones where the angle between two adjacent panels at hull cross section is < 130° with a hard angle (e.g. angled bottom centerline, deck/hull angles, knuckles at sides) and sufficient strength and rigidity, and in way of the intersections between the double bottom structures, fixed tanks, isolating plates, continuous small platforms, etc., and the shell plate of hull. Where a curved plate thickness in way is calculated, the shorter dimension *b* is to be taken as the chord length of curvature.

## Section 2 Local Strength

**2.2.1 Local design loads**

2.2.1.1 The design pressure load $P_b$ of monohull craft bottom is determined by the following formula:

$$P_b = 10C_n\left(\frac{C_W}{C_{L1}} + T\right) + 27C_nT\left(\frac{50-\beta_x}{50-\beta}\right)\left(1 + C_K\frac{x - x_K}{L_{WL} - x_K}\right) \quad \text{kN/m}^2$$

where: $C_n$ — coefficient of design category, to be obtained according to the design category:

$C_n$ = 1.0 for craft with design category I and II;
$C_n$ = 0.85 for craft with design category III;
$C_n$ = 0.76 for craft with design category IV;
$C_n$ = 0.70 for craft with design category V;

$C_W$ — wave coefficient, $C_W = 10\lg\left(\frac{L_{WL} + L_H}{2}\right) - 10$, but not to be less than 3.0;

$C_{L1}$ — longitudinal distribution coefficient of monohull craft bottom pressure, to be obtained according to the longitudinal coordinate *x* of load point:

$C_{L1}$ = 1.4 for $5/6 \le x/L_{WL} \le 1$;
$C_{L1}$ = 1.7 for $2/3 \le x/L_{WL} < 5/6$;
$C_{L1}$ = 1.9 for $1/3 \le x/L_{WL} < 2/3$;
$C_{L1}$ = 2.2 for $0 \le x/L_{WL} < 1/3$;

$\beta$, $\beta_x$ — deadrise angle in way of LCG of craft and deadrise angle of load point at the cross section of coordinate *x*, respectively, in (°), $\beta_x$ is not to be taken greater than 50°.
The deadrise angle $\beta_x$ is to be so measured to draw a reference line connecting the intersection of bottom line at *x* cross section and half-height of draught (*T*/2) with the origin of coordinate, then to take the angle between the reference line and horizontal axis (see Figure 2.2.1.1);

$C_K$ — coefficient of ballast keel, to be obtained according to the type of keel:

$C_K$ = 1.0 for lifting ballast keel;
$C_K$ = 1.5 for bar ballast keel;
$C_K$ = 2.1 for bulb ballast keel;

$x_K$ — longitudinal coordinate of centroid for ballast keel, in m;
$x$ — longitudinal coordinate of load point, in m.
where: $x - x_K = 0$ for $x - x_K < 0$.

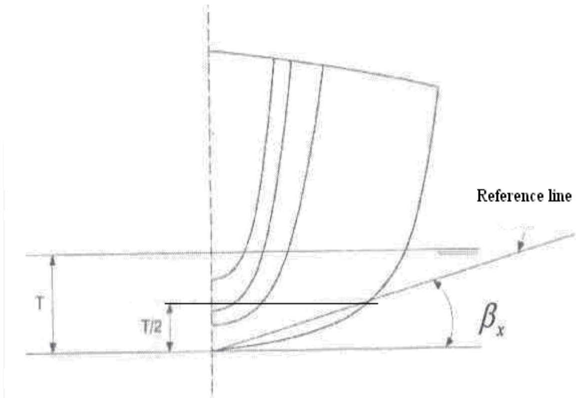


**Figure 2.2.1.1**

2.2.1.2 The design pressure of catamaran craft bottom $P_b$ is to be determined by the following formula:

$$P_b = 10C_n\left(\frac{C_W}{C_{L2}} + h\right) \quad \text{kN/m}^2$$

where: $C_{L2}$ — longitudinal distribution coefficient of catamaran craft bottom pressure, to be obtained according to the longitudinal coordinate x of load point:

$C_{L2}$ = 1.1 for $5/6 \le x/L_{WL} \le 1.0$;
$C_{L2}$ = 1.7 for $2/3 \le x/L_{WL} < 5/6$;
$C_{L2}$ = 2.2 for $1/3 \le x/L_{WL} < 2/3$;
$C_{L2}$ = 2.5 for $0 \le x/L_{WL} < 1/3$;

$h$ — vertical distance of bottom load point below the full load waterline, in m;

$C_n$ and $C_W$ — the same as 2.2.1.1.

2.2.1.3 The design pressure of side shell for monohull craft $P_S$ is to be taken as follows, whichever is the greater:

$$P_1 = 10\,C_n\left(\frac{C_W}{C_{L1}} + T - h\right) \quad \text{kN/m}^2$$

$$P_2 = 40C_n \quad \text{kN/m}^2$$

where: $C_n$, $C_W$ and $C_{L1}$ — the same as 2.2.1.1;
$h$ — vertical distance of side shell load point above the full load waterline, in m.

2.2.1.4 The design pressure of side shell for catamaran craft $P_S$ is to be taken as follows, whichever is the greater:

$$P_1 = C_n\left[\left(1+0.3C_B\right)\frac{C_W}{C_{L2}}+0.3C_BT-h\right] \quad \text{kN/m}^2$$

$$P_2 = 40C_nC_S \quad \text{kN/m}^2$$

where: $C_S$ — position coefficient of side shell, to be determined according to where the load point is located:

within the external side shell area of catamaran: $C_S = 1.0$ for $2/3 \le x/L_{WL} \le 1.0$;

$C_S = 0.65$ for $0 \le x/L_{WL} < 2/3$;

cross-deck bottom and internal side shell within forward 1/3 length of cross-deck: $C_S = 1.5$;

other areas of cross-deck bottom and internal side shell: $C_S = 1.0$;

$C_n$, $C_W$ and $h$ — the same as 2.2.1.3;

$C_{L2}$ — the same as 2.2.1.2.

2.2.1.5 The design pressure of deck $P_D$ is to be determined by the following:

(1) Weather deck: $P_{D0} = C_nC_{L3}[0.5(\Delta\times10^3)^{0.33} + 12]$ kN/m², and not to be less than 5 kN/m².

where: $C_n$ — the same as 2.2.1.3;

$C_{L3}$ — longitudinal distribution coefficient of weather deck pressure, to be obtained according to the longitudinal coordinate $x$ of load point:

$C_{L3}=0.5$ for $x/L_{WL} = 0$;

$C_{L3}=1.0$ for $x/L_{WL} = 0.6 \sim 1.0$;

$C_{L3}$ is to be obtained by linear interpolation for $x/L_{WL} = 0 \sim 0.6$.

(2) For deck in walking areas less than 0.8 m above weather deck: $P_{D1} = 0.5P_{D0}$ kN/m².

(3) For deck in walking areas more than 0.8 m above weather deck: $P_{D2} = 0.35P_{D0}$ kN/m².

(4) For cabin deck located in common spaces: $P_{D3} = 5$ kN/m².

(5) For cabin deck located in machinery spaces: $P_{D4} = 10$ kN/m².

2.2.1.6 The design pressures of end and side bulkheads for superstructure/deck houses $P_{SUP}$ are to be determined by the following formula:

$$P_{SUP} = C_nC_{SUP}[0.5(\Delta\times10^3)^{0.33} + 12] \quad \text{kN/m}^2$$

where: $C_n$ — coefficient of design category, see 2.2.1.1;

$C_{SUP}$ — coefficient, $C_{SUP} = 1.0$ for fore end bulkhead and $C_{SUP} = 0.5$ for side and after end bulkheads.

The minimum design pressures of fore end and after end bulkheads and side bulkhead of the first tier superstructure/deck houses are to be of 20 kN/m², 10 kN/m² and 14 kN/m², respectively.

2.2.1.7 The design pressure of bulkheads $P_{BUL}$ is to be determined by the following:

(1) For the design pressure of watertight bulkhead: $P_{BUL} = 7\ h_B$ kN/m$^2$, where $h_B$ is the height measured from the load point calculated to the top of bulkhead, in m.

(2) For the design pressure of bulkhead in tank: $P_{BUL} = 10\ h_B$ kN/m$^2$, where $h_B$ is the height of the load point calculated to the top of vent pipe, in m.

### 2.2.2 Scantling of FRP hull structure

2.2.2.1 The minimum thickness of plating for single skin hull structure $t_{\min}$ and the minimum content of fiber per unit $w_{\min}$ are to be determined by the following formulae according to where the plating is located:

$$w_{\min} = 0.43k_5\left(A + 2.36k_7\sqrt{L_{WL}} + A\Delta^{0.33}\right) \text{ kg/m}^2 \quad \text{for bottom plate, side plate and transom plate;}$$
$$t_{\min} = k_5\left(0.14L_{WL} + 1.45\right) \text{ mm} \quad \text{for weather deck.}$$

The factors $A$, $k_5$ and $k_7$ may be obtained from Table 2.2.2.1.

**Table 2.2.2.1**

| | Position | $A$ | $k_5$ | $k_7$ |
|---|---|---|---|---|
| FRP hull structure | Bottom | 1.5 | 1.0* | 0.03 |
| | Side/transom | 1.5 | | 0 |

*Note: $k_5$ = 1.0 for E-glass reinforcement containing up to 50% of chopped strand mat by mass; $k_5$ = 0.9 for bidirectional glass fiber cloth reinforced plastic.

2.2.2.2 The minimum mass $w_{\min}$ of fiber of inner and outer skins for sandwich hull structure plating per unit area is to be determined by the following formulae:

Outer skin $\quad w_{1\min} = C_n k_4 k_5\left(0.1L_{WL} + 0.15\right) \quad$ kg/m$^2$

Inner skin $\quad w_{2\min} = 0.7w_{1\min} \quad$ kg/m$^2$

where: $C_n$ — coefficient of design category, see 2.2.1.1;
$k_4$ — factor of position, to be obtained according to where the sandwich laminate is located:
$k_4$ = 1.0 for sandwich laminate located at bottom area of craft;
$k_4$ = 0.9 for sandwich laminate located at side shell area of craft;
$k_4$ = 0.7 for sandwich laminate located at deck area of craft;
$k_5$ — to be obtained from Table 2.2.2.1.

2.2.2.3 The thickness $t$ of single skin laminate is not to be less than:

$$t = k_C b\sqrt{\frac{k_2 P}{500\sigma_{fnu}}} \quad \text{mm}$$

where: $k_C$ — reduction factor for curved plates, to be determined by the following Table according to camber $c$ of curved plates:

**Table 2.2.2.3**

| $c/b$ | $k_C$ |
|---|---|
| 0 ~ 0.03 | 1.0 |
| 0.03 ~ 0.18. | 1.1−3.33 $c/b$ |
| > 0.18 | 0.5 |

*$c$ in the Table is the camber of arc line for lath beam measured by taking the breadth of panel $b$ as the span.

$k_2$— correction factor for aspect ration of panel ($l/b$); if $l/b> 2$, $k_2= 0.5$; if $l/b \le 2$, to be taken as:

$$k_2 = \frac{0.271(l/b)^2 + 0.91(l/b) - 0.554}{(l/b)^2 - 0.313(l/b) + 1.351}$$

$P$ — design load determined according to 2.2.1, in kN/m²;

$\sigma_{fun}$ — ultimate bending strength of laminate, in N/mm², may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor.

2.2.2.4 The total effective thickness of FRP sandwich laminate $t_S$ is not to be less than the value calculated by the following formula:

$$t_S = \sqrt{k_C b \frac{k_{2S} P}{1000\tau_d}} \quad \text{mm}$$

where: $t_S$— effective total thickness of sandwich laminate, i.e. distance between mid-thickness of outer and inner skins, in mm, $t_S = t_C + 0.5(t_1 + t_2)$;

where: $t_C$— thickness of sandwich core, in mm;
$t_1$— thickness of outer skin of sandwich laminate (excluding gel coat), in mm;
$t_2$— thickness of inner skin of sandwich laminate, in mm;

$k_C$ and $P$ — the same as 2.2.2.3;

$k_{2S}$— correction factor for aspect ration of panel ($l/b$) of sandwich laminate panel, to be obtained from the following Table:

**Table 2.2.2.4(1)**

| $l/b$ | ≥4 | 3.0 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | 1.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $k_{2S}$ | 0.5 | 0.493 | 0.463 | 0.459 | 0.453 | 0.445 | 0.435 | 0.424 | 0.410 | 0.395 | 0.378 | 0.360 | 0.339 |

$\tau_d$ — allowable shear strength of sandwich core, in N/mm², to be obtained according to the type of cores:
$\tau_d = 0.5\tau_u$ for balsa wood or honeycomb core;
$\tau_d = 0.55\tau_u$ for cross-linked PVC core;
$\tau_d = 0.65\tau_u$ for linear PVC or SAN core;
where: $\tau_u$ — ultimate shear strength of core, in N/mm², may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor. The minimum value of ultimate shear strength is not to be less than that specified in the following Table:

**Table 2.2.2.4(2)**

| $L_H$ (m) | $L_H < 10$ | $10 \le L_H \le 15$ | $15 < L_H < 24$ |
|---|---|---|---|
| $\tau_{u\min}$ (N/mm²) | 0.25 | $0.25 + 0.03(L_H - 10)$ | 0.40 |

2.2.2.5 Due to the different laminates of three parts of top-hat stiffener made of FRP single skin panel (top plate, web plate and attached plate with effective width), the mechanical performance of them are also different. In general, the difference of performances is not to exceed 25%. The section modulus $W$, moment of inertia $I$ and web plate area $A$ of the top-hat stiffener are not to be less than the values calculated by the following formulae respectively. However, additional consideration is to be taken for such top-hat stiffener if the difference of mechanical performance for these three parts exceeds 25%.

$$W = 167\frac{k_{CS}Psl_u^2}{\sigma_{ut}}\times10^{-9} \qquad \text{cm}^3;$$

$$I = 52\frac{k_{CS}^{1.5}Psl_u^3}{E}\times10^{-10} \qquad \text{cm}^4;$$

$$A = 10\frac{Psl_u}{\tau_u}\times10^{-6} \qquad \text{cm}^2.$$

where: $P$ — design load as determined by 2.2.1, in kN/m²;

$l_u$ — span of stiffener, in mm, see 2.1.2.4. For bending stiffener, chord length of the arc is to be taken;

$k_{CS}$— reduction factor of bending stiffener, to be determined by the following Table according to the ratio of camber $c$ and span $l_u$:

**Table 2.2.2.5**

| $c/l_u$ | $k_{CS}$ |
|---|---|
| 0 ~ 0.03 | 1.0 |
| 0.03 ~ 0.18. | 1.1 ~ 3.33 $c/l_u$ |
| > 0.18 | 0.5 |

Note: $c$ in the Table means the camber value measured by taking the span of bending stiffener $l_u$ as the chord, in mm.

$\sigma_{ut}$ — multimate tensile strength of top plate of top-hat stiffener made of FRP single skin panel, in N/mm², may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor;

$\tau_u$ — ultimate shear strength of web plate of top-hat stiffener made of FRP single skin panel, in N/mm², may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor;

$E$ — elastic modulus of top-hat stiffener made of FRP single skin panel or that of its attached plate, whichever is the less, in N/mm².

2.2.2.6 The main transverse bulkhead of FRP hull is generally made of unstiffened plywood. The thickness of such plywood bulkhead $t_b$ is not to be less than the value calculated according to the following formula:

$$t_b = 7D \quad \text{mm}$$

where: $D$ — moulded depth, in m, see 1.1.3.1(8).

2.2.2.7 Where the unstiffened FRP sandwich laminate structure is used for main transverse bulkheads of hull, the following three conditions are also to be met:

(1) The ultimate shear strength $\tau_u$ of sandwich laminate core, in N/mm², is not to be less than the values list in Table 2.2.2.4 (2).

(2) The thickness of sandwich laminate core $t_C$ is not to be less than five times the thickness of the thinner skin.

(3) The total effective thickness of sandwich laminate $t_S$ and thickness of core $t_C$ are also to meet the following two conditions:

$$t_S \times t_C \geq \frac{t_b^2}{6}\left(\frac{50}{\sigma_{fnu}}\right)$$

$$t_S \times \frac{t_C^2}{2} \geq \frac{t_b^3}{12}\left(\frac{4000}{E}\right)$$

where: $t_S$ — effective total thickness of sandwich laminate, in mm, see 2.2.2.4;

$t_C$ — thickness of sandwich laminate core, in mm;

$t_b$ — thickness of bulkhead as required by 2.2.2.6, in mm;

$\sigma_{fun}$— ultimate bending strength of sandwich laminate skin, in N/mm², may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor;

$E$ — elastic modulus of sandwich laminate skin, in N/mm².

### 2.2.3 Scantling of aluminium alloy hull structure

2.2.3.1 The minimum thickness of aluminium alloy hull structure $t_{\min}$ is to be determined by the following formulae:

$t_{\min} = k_5(A + 2.36k_7\sqrt{L_{WL}} + A\Delta^{0.33})$ mm, for bottom plate, side plate and transom plate;

$t_{\min} = 0.06L_{WL} + 1.35$ mm, for weather deck.

The factors $A$, $k_5$ and $k_7$ may be obtained from Table 2.2.3.1.

**Table 2.2.3.1**

| | Position | $A$ | $k_5$ | $k_7$ |
|---|---|---|---|---|
| Aluminium alloy | Bottom | 1.0 | $\sqrt{125/R_{P0.2W}}$ | 0.02 |
| | Side/transom | 1.0 | | 0 |

where: $R_{P0.2W}$— the specified non-proportionality tensile strength of aluminium alloy section under annealing condition, in N/mm², see the relevant provisions of CCS Rules for Materials and Welding.

2.2.3.2 The thickness of plating for aluminium alloy hull $t$ is not to be less than the following calculated value:

$$t = k_C b \sqrt{\frac{k_2 P}{900 R_{P0.2W}}} \quad \text{mm}$$

where: $k_C$— reduction factor for curved plates, to be determined by the following Table according to camber c of curved plates, see Table 2.2.2.3;;

$k_2$— correction factor for aspect ration of panel ($l/b$), if $l/b > 2$, $k_2 = 0.5$; if $l/b \le 2$, to be taken as:

$$k_2 = \frac{0.271(l/b)^2 + 0.91(l/b) - 0.554}{(l/b)^2 - 0.313(l/b) + 1.351}$$

$P$ — design load to be determined according to 2.2.1, in kN/m$^2$;

$R_{P0.2W}$ — the specified non-proportionality tensile strength of aluminium alloy section under annealing condition, in N/mm$^2$, see the relevant provisions of CCS Rules for Materials and Welding.

2.2.3.3 The section modulus $W$ of aluminium alloy stiffener (including attached plate with effective breadth) and its web plate area $A$ are to be not less than the value calculated by the following formulae:

$$W = 119 \frac{k_{CS} P s l_u^2}{R_{P0.2W}} \times 10^{-9} \quad \text{cm}^3;$$

$$A = 12.5 \frac{P s l_u}{R_{P0.2W}} \times 10^{-6} \quad \text{cm}^2;$$

where: $P$ — design load to be determined according to 2.2.1, in kN/m$^2$;

$k_{CS}$— reduction factor of bending stiffener, to be determined by camber c of stiffener, see Table 2.2.2.5;

$R_{P0.2W}$ — the specified non-proportionality tensile strength of aluminium alloy section under annealing condition, in N/mm$^2$, see the relevant provisions of CCS Rules for Materials and Welding.

## Section 3 Longitudinal Strength of Monohull Craft

### 2.3.1 General requirements

2.3.1.1 For monohull craft with any one of the following conditions, in addition to compliance with the requirements of Section 2 in this Chapter, longitudinal strength and stability are to be required to check for its scantling in accordance with the provisions of this Section:

(1) transversely framed hull;

(2) large opening on strength deck;

(3) $L_H / D_{max} > 12$.

2.3.1.2 Where longitudinal strength of hull girder for monohull craft is checked, the check may only be done to ensure that the weather deck at amidcraft section will keep stability under the maximum design bending moment of sagging specified in 2.3.2.1.

**2.3.2 Check of longitudinal strength**

2.3.2.1 The maximum design bending moment of sagging $M_V$ is to be calculated as follows:

$$M_V = 2.7 C_n L_H \Delta \times 10^3 \quad \text{N·m}$$

2.3.2.2 The weather deck compressive stress $\sigma$ at amidcraft section under the maximum design bending moment of sagging $M_V$ is to be determined as the following formula:

$$\sigma = \frac{M_V}{W_d} \quad \text{N/mm}^2$$

where: $W_d$— amidcraft section modulus at weather deck, in $cm^3$.

2.3.2.3 Where the weather deck of FRP hull is made of sandwich laminate, and the core material is cellular plastic (with very less compressive elastic modulus), the core materials of all sandwich laminate members at amidcraft section may be negligible when the amidcraft section modulus $W_d$ at weather deck is calculated.

**2.3.3 Deck stability**

2.3.3.1 It is to ensure that each longitudinal member of weather deck at amidcraft section which is used for calculation of longitudinal bending strength for hull girder will keep stability under the compressive stress $\sigma$ specified in 2.3.2.2.

2.3.3.2 The stability of the structural members at amidcraft section may be checked in accordance with the relevant requirements of CCS Rules for Construction and Classification of Sea-going High Speed Craft. However, when the critical yield stress $\sigma_{cr}$ of aluminium alloy deck panel is determined, the specified non-proportionality tensile strength of aluminium panel under annealing condition $R_{P0.2W}$ is to be used for yield strength of deck material, in $N/mm^2$, see the relevant provisions of CCS Rules for Materials and Welding.

## Section 4 Overall Strength of Catamaran

**2.4.1 General requirements**

2.4.1.1 It is to check the ability of catamaran structure to resist torque of diagonal swell when the catamaran is navigating in diagonal swell.

2.4.1.2 For catamaran with $L_{WL}/D > 12$, girder strength of its hulls is also to be checked.

### 2.4.2 Design global loads for overall strength

2.4.2.1 The design torque of diagonal swell for catamaran $M_T$ when navigating in diagonal swell is to be determined by the following formula:

$$M_T = 1.5L_{WL}\Delta \times 10^3 \quad \text{N·m}$$

2.4.2.2 For catamaran with $L_{WL}/D > 12$, the vertical design bending moment $M_V$ on each hull is to be determined by the following formula:

$$M_V = 0.5L_{WL}\Delta \times 10^3 \quad \text{N·m}$$

### 2.4.3 Criteria for overall strength check

2.4.3.1 The ability of connection structure between two hulls of catamaran to resist the design torque $M_T$ in diagonal swell specified in 2.4.2.1 is to be checked by direct calculation method, to endure that the shearing stress $\tau$ and normal stress at any point of the connection structure and connection area of each hull are not to exceed the allowable shearing stress $\tau_d$ and allowable normal stress $\sigma_d$ as specified in 2.4.3.3, 2.4.3.4, 2.4.3.5 and 2.4.3.6.

2.4.3.2 Where the girder strength of hulls for catamaran is checked, the tensile/compressive stress $\sigma$ of bottom and deck at amidcraft section under hogging and sagging conditions is not to exceed the allowable stress $\sigma_d$ as specified in 2.4.3.5 and 2.4.3.6.

2.4.3.3 Where the torsional strength of FRP catamaran is checked, the allowable shearing stress of structural members is to be taken as $\tau_d = 0.33\tau_u$, where $\tau_u$ is the ultimate shearing strength of laminate materials.

2.4.3.4 Where the torsional strength of aluminium alloy hull is checked, the allowable shearing stress of structural members is to be taken as $\tau_d = 0.3R_{P0.2W}$, where $R_{P0.2W}$ is the specified non-proportionality tensile strength of aluminium alloy under annealing condition. Where the aluminium alloy member in way of checked position has not been welded, it may be taken as $\tau_d = 0.3R_{P0.2}$, where $R_{P0.2}$ is the specified non-proportionality tensile strength of aluminium alloy.

2.4.3.5 Where the girder strength of each hull of FRP catamaran is checked, the allowable tensile stress of structural member made of FRP laminate is to be taken as $\sigma_d = 0.33\sigma_{ut}$, where $\sigma_{ut}$ is the ultimate tensile strength of laminate material. The allowable compressive stress of structural member made of FRP laminate is to be taken as $\sigma_d = 0.33\sigma_{uc}$, where $\sigma_{uc}$ is the ultimate compressive strength of laminate material.

2.4.3.6 Where the girder strength of each hull of aluminium catamaran is checked, the allowable stress of structural member is to be taken as $\sigma_d = 0.5R_{P0.2W}$, where $R_{P0.2W}$ is the specified non-proportionality tensile strength of aluminium alloy under annealing condition. Where the aluminium alloy member in way of checked position has not been welded, it may be taken as $\sigma_d = 0.5R_{P0.2}$, where $R_{P0.2}$ is the specified non-proportionality tensile strength of aluminium alloy.

# CHAPTER 3 BALLAST KEEL, CHAINPLATES AND MASTS

## Section 1 Ballast Keel

### 3.1.1 General requirements

3.1.1.1 This Section applies to sailing craft fitted with fin-shaped ballast keel at bottom centerplane. The ballast keel is generally to be of fixed-type, and made of lead, cast iron, steel or other heavy materials. Lifting ballast keel may be used for some certain small craft.

3.1.1.2 In addition to ensuring its own strength, the connection strength between ballast keel and hull bottom structure is to be checked.

### 3.1.2 Strength check for ballast keel

3.1.2.1 The ballast keel is to be capable of withstanding the bending moment $M_K$ induced by its weight as it is assumed that the sailing craft heels at 90°. $M_K$ is to be calculated by the following formula:

$$M_K = 18C_{nK}Qa \qquad \text{N·m}$$

where: $C_{nK}$— coefficient of design category for appendage/sail, to be obtained by:

$C_{nK} = 1.0$ for design categories I and II;

$C_{nK} = 0.75$ for design categories III, IV and V;

$Q$ — mass of ballast keel, in kg;

$a$ — distance between cross-section which is the furthest from CG of ballast keel and with least strength (usually being the connection section between ballast keel and craft bottom) and the CG of ballast keel, in m, see Figure 3.1.2.1.

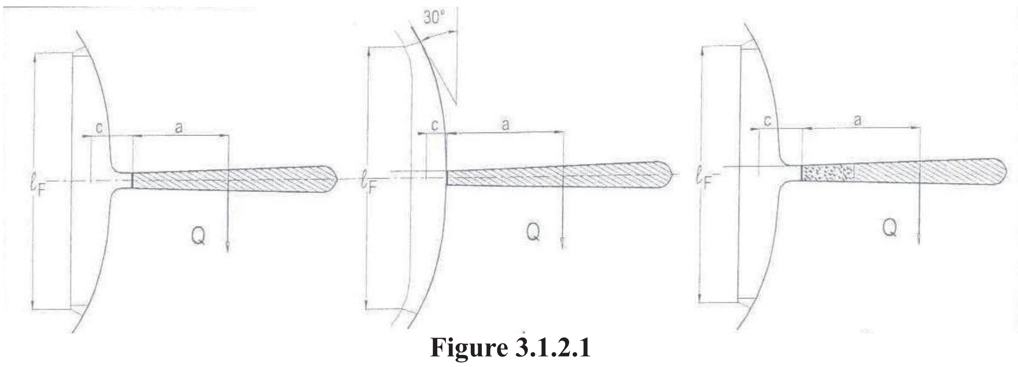


**Figure 3.1.2.1**

3.1.2.2 The strength of ballast keel is to meet the following formula:

$$\frac{M_K}{W_a} \le \sigma_{dk} \qquad \text{N/mm}^2$$

where: $M_K$— design bending moment of ballast keel calculated according to 3.1.2.1, in N·m;

$W_a$ — modulus of cross-section of ballast keel distanced a from its CG, in $cm^3$;

$\sigma_{dk}$ — allowable stress of ballast keel material, in N/mm$^2$, to be obtained according to material category, to be obtained according to material category:

$\sigma_{dk} = 0.9\sigma_S$ for tough metals, such as steel, stainless steel, etc., $\sigma_S$ is the yield strength of tough metals;

$\sigma_{dk} = 0.6\sigma_S$ for brittle metals, such as cast iron, $\sigma_S$ is the yield strength of brittle metals;

$\sigma_{dk} = 0.5\sigma_u$ for FRP, $\sigma_u$ is the ultimate bending strength of FRP, may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor.

**3.1.3 Strength check for connection between ballast keel and hull bottom structure**

3.1.3.1 The fixed-type ballast keel is usually supported by several frames at craft bottom. Strength check is to be carried out for frames supporting ballast keel, to ensure they are capable of effectively supporting the ballast keel.

3.1.3.2 The design bending moment $M_f$ of $n_f$ frames effectively supporting the ballast keel is to be calculated by the following formula:

$$M_f = 9C_{nK}Q(a + c) \qquad \text{N·m}$$

where: $C_{nK}$, $Q$ and $a$ — the same as 3.1.2.1;

$c$ — distance between CG of frame supporting ballast keel and section connecting ballast keel with craft bottom, in m, see Figure 3.1.2.1.

3.1.3.3 In order to simplify the calculation, it is assumed that the scantlings of these frames supporting ballast keel are similar, the section modulus $W_f$ of each supporting frame is not to be less than the value calculated according to the following formula:

$$W_f = \frac{M_f}{n_f \sigma_{df}} \qquad \text{cm}^3$$

where: $M_f$ — design bending moment of $n_f$ bottom frames effectively supporting ballast keel, in N·m, see 3.1.3.2;

$n_f$ — number of bottom frames effectively supporting ballast keel;

$\sigma_{df}$ — allowable stress of frames, in N/mm$^2$, to be obtained according to material categories of frames:

$\sigma_{df} = 0.5\sigma_u$ for FRP, where σu is the ultimate bending strength of FRP material, it may be obtained by the performance data provided by manufacturer or actually measured value according to recognized standard multiplying rational safety factor;

$\sigma_{df} = 0.9\, R_{P0.2}$ for aluminium alloy, where $R_{P0.2}$ is the yield strength of aluminium alloy.

3.1.3.4 The section of each supporting frame span end is also to be capable of withstanding of the following shearing force $Q_f$:

$$Q_f = \frac{M_f}{n_f \ell_F} \qquad \text{N}$$

where: $M_f$ — design bending moment of $n_f$ bottom frames effectively supporting ballast keel, in N·m, see 3.1.3.2;

$n_f$ — number of bottom frames effectively supporting ballast keel;

$\ell_F$ — span of bottom frame effectively supporting ballast keel, in m, may be measured according to Figure 3.1.2.1. If there are no longitudinal supporting members at the both ends of frame, the frame extends to the both sides in way of a point with an angle of 30° between shell plating tangent and horizontal, which may be regarded as the span point of that frame, see Figure 3.1.2.1.

3.1.3.5 Where a series of bolts with same diameter is used to connect ballast keel with bottom structure at a connecting plane (see Figure 3.1.3.5), the connecting surface is to be flat and sealed. The longitudinal coordinate of centroid of connecting bolt group is to be in consistent with that of ballast keel centroid basically. The diameter *d* of thread root for connecting bolt is not to be less than the value calculated by the following formula:

$$d = 140\sqrt{\frac{C_{nK} Q a b_{\max}}{R_{eH}\sum b_i^2}} \quad \text{mm}$$

where: $C_{nK}$, $Q$ and $a$ — see 3.1.2.1;

$b_i$ — scantling width at each pair of connecting bolts, in mm, to be calculated by:

$b_i = 0.5b_{bi} + 0.4b_{ki}$, where $b_{bi}$ and $b_{ki}$, see Figure 3.1.3.5;

$b_{\max}$ — maximum value of $b_i$, in mm;

$R_{eH}$ — yield stress of connecting bolt, in $N/mm^2$, to be obtained according to material categories of blots.

Where the general low carbon steel is used as material of connecting bolts, $R_{P0.2} = 235\ N/mm^2$, the diameter of thread root of connection bolt is not to be less than 12 mm.

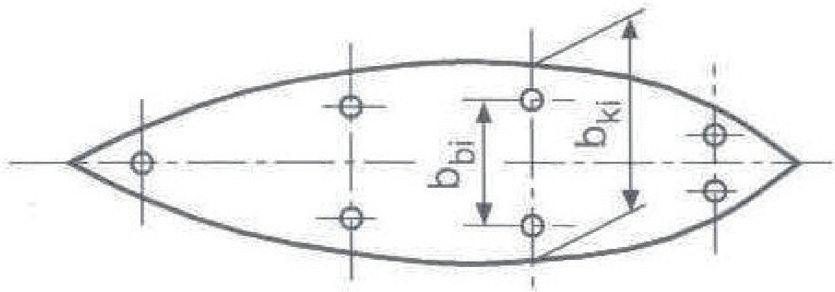


**Figure 3.1.3.5**

3.1.3.6 The thickness of bottom plate within 0.2 maximum draught $T_{\max}$ beyond the root contour line of ballast keel of craft bottom is to be properly increased. The thickness of bottom plate within this range may still be determined according to 2.2.2.3 and 2.2.3.2, however, the design load of the thickness formula is to be 1.8 times of the design bottom pressure $P_b$ defined in 2.2.1.

## Section 2 Chainplates

### 3.2.1 General requirements

3.2.1.1 Most rigs are fixed on different positions of hull structure for sailing craft by their individual chainplates. In general, chainplate is a metal plating with pin hole, see Figure 3.2.1.1. The end of chainplate with pin hole is usually used to fix one or two shrouds while another end is fixed on the hull structure. The force withstood by shrouds is transmitted to hull structure by chainplates.

3.2.1.2 The chainplate is generally made of stainless steel for FRP craft or aluminium alloy for aluminium alloy craft.

3.2.1.3 In addition to complying with the scantling requirements specified in 3.2.2, the chainplates are to be firmly fixed on the hull structure.

**3.2.2 Scantling of chainplates**

3.2.2.1 The design load $F_S$ of chainplates is to be determined by the following formulae:

$F_S = F_b$, in N  if only one shroud on chainplate;

$F_S = F_{bs} + 0.5F_{bw}$, in N  if two shrouds on chainplate.

where: $F_b$— breaking load of one shroud, in N;
$F_{bs}$— breaking load of two shrouds, whichever is the greater, in N;
$F_{bw}$— breaking load of two shrouds, whichever is the less, in N.

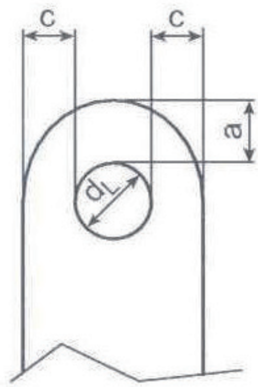


**Figure 3.2.1.1**

3.2.2.2 For the metal chainplate with pin hole, the edge distances $a$ and $c$ (see Figure 3.2.1.1) of circular pin hole are not to be less than the values calculated by the following formulae:

$$a = \frac{F_S}{2tR_{eH}} + \frac{2}{3}d_L \quad \text{mm;}$$

$$c = \frac{F_S}{2tR_{eH}} + \frac{1}{3}d_L \quad \text{mm.}$$

where: $F_S$— design load of chainplate, in N, to be calculated according to 3.2.2.1;
$t$ — thickness of chainplate, in mm;
$d_L$— diameter of pin hole for chainplate, in mm;
$R_{eH}$ — yield strength of metal chainplate, in N/mm$^2$.

## Section 3  Masts

### 3.3.1  General requirements

3.3.1.1  The masts are to have sufficient strength and to be capable of withstanding the sail loads. Masts are to be made of aluminium alloy or carbon fiber reinforced composite materials.

3.3.1.2  The masts are to be firmly connected with hull, the following three ways are usually to be adopted:

(1)  mast step is supported on certain transverse bulkhead of the hull;

(2)  mast step is supported on hull deck or superstructure deck sustained by pillar below;

(3)  mast penetrates deck and extends to the craft bottom with its step being supported by bottom structure.

### 3.3.2  Strength check for connection of mast with hull structure

3.3.2.1  Where the mast is supported by transverse bulkhead, the thickness of bulkhead $t_b$ in way of mast where is supported is not to be less than the value calculated by the following formula:

$$t_b = 1.3\sqrt[3]{\frac{K_{SU} b_m M_{HD}}{b_C E}} \quad \text{mm}$$

where: $K_{SU}$ — safety factor, to be obtained by:

$K_{SU}$= 5.92   for monohull craft;

$K_{SU}$= 5.44   for catamaran;

$b_m$ — breadth of cross-section of mast supported by transverse bulkhead, in mm;

$b_C$ — horizontal distance from chainplate of left/right shroud to centerline of craft, in m, see Figure 3.3.2.1a;

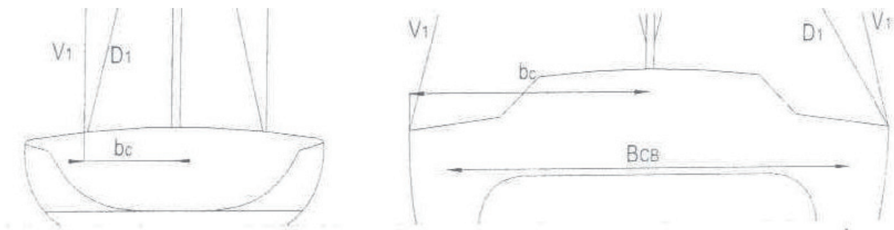


**Figure 3.3.2.1a**

$E$ — elastic modulus of compression for transverse bulkhead material, in N/mm$^2$;

$M_{HD}$— design righting moment of transverse stability for craft, in N·m, to be obtained by:

for monohull craft, $M_{HD}$ is the maximum righting moment of transverse stability at full load displacement △, in N-mm, may be obtained from transverse stability curve;

for catamaran, $M_{HD}$ may be $M_{HD1}$ or $M_{HD2}$, whichever is the less:

$$M_{HD1} = 5C_{nK} K_{VS} B_{CB} \Delta \qquad \text{N·m}$$
$$M_{HD2} = 0.16 C_{nK} K_{VS} A_S V_{AWK}^2 \left(h_{CE} + h_{LP}\right)$$

where: $C_{nK}$— coefficient of design category for appendage/rig of sailing craft, to be obtained according to 3.1.2.1;

$K_{VS}$— factor, to be calculated by:

for design category I and II catamaran craft, $K_{VS}$= 1.0;

for design category III, IV and V catamaran craft,

$K_{VS}$= 1.0, if $\Delta \geq 4.3 L_{WL}^3$;

$K_{VS} = \dfrac{2.65 L_{WL}^2}{\sqrt[3]{\Delta^2}}$, but not greater than 2, if $\Delta < 4.3\, L_{WL}^3$;

$B_{CB}$— transverse distance between centers of buoyancy for two hulls, see the definition of 1.1.3.1(6);

$A_S$ — sum of full mainsail area and fore triangle sail area for catamaran, in m², see Figure 3.3.2.1b;

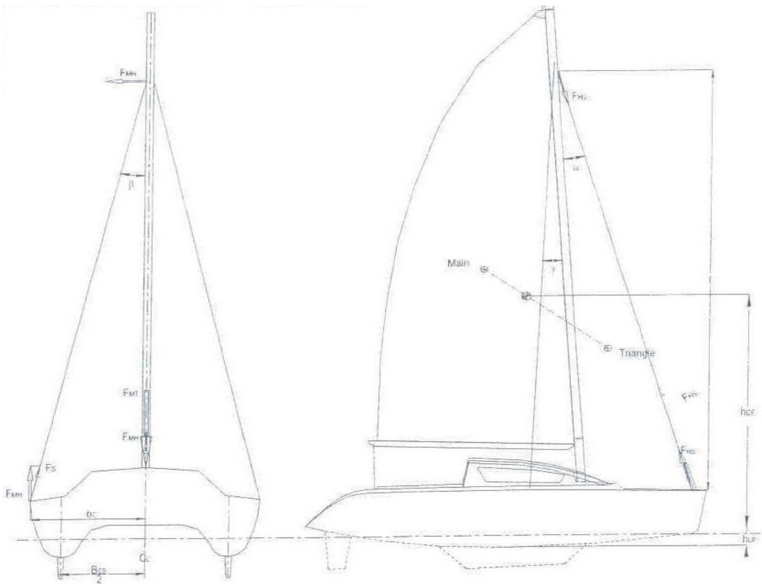


**Figure 3.3.2.1b**

$h_{CE}$— height of the centroid of $A_S$ above loaded waterline, in m, see Figure 3.3.2.1b;

$h_{LP}$— vertical distance from the center of profile area of underwater parts (including hulls and appendages) to full-load waterline, in m, see Figure 3.3.2.1b;

$V_{AWK}$— apparent wind speed for catamaran, in kn,

for design category I and II, $V_{AWK}$= 32, if $L_{WL}$ < 18 m;

$V_{AWK}$= 30, if 18 m ≤ $L_{WL}$ < 20 m;

$V_{AWK}$= 25, if 20 m ≤ $L_{WL}$ < 24 m;

for design category III, IV and V, $V_{AWK}$ = 25.

3.3.2.2 Where the mast step is supported by metal circular pillar, the cross-sectional area $A$ of pillar is not to be less than the value calculated by the following formula:

$$A = \frac{K_{SU}\left[1 + K_P(\ell / r)^2\right]M_{HD}}{90 b_C \sigma_{SW}} \quad \text{cm}^2$$

where: $K_{SU}$ — safety factor, see 3.3.2.1;

$K_P$ — factor, $K_P$ = 1.9 for aluminium alloy pillar; $K_P$ = 1.2 for steel pillar;

$\ell$ — length of pillar in m;

$r$ — minimum radius of inertia of cross section for circular pillar, in cm;

$M_{HD}$— righting moment of transverse stability for craft, in N·m, to be obtained as the same as 3.3.2.1;

$b_C$ — horizontal distance from chainplate of left/right shroud to centerline of craft, in m, see Figure 3.3.2.1;

$\sigma_{SW}$— yield strength of postweld metal pillar, in N/mm$^2$, to be taken $R_{P0.2W}$ for aluminium alloy pillar, and $\sigma_{SW}= R_{eH}$ for steel pillar.

3.3.2.3 Where the mast step penetrates deck and extends to bottom structure, the bottom structure is to be capable of withstanding the compression load of mast. The cut-out in the deck is to be collared with resilient material such as rubber or plywood to give suitable horizontal support to the mast and certain freedom.

# CHAPTER 4  STABILITY

## Section 1  General Provision

### 4.1.1  General requirements

4.1.1.1  The intact stability of all sailing craft is to meet the requirements of this Chapter.

4.1.1.2  CCS accepts the recognized standards, such as ISO standards, as the equivalent requirements of this Chapter.

4.1.1.3  The lightship and the position of centre of gravity for the first sailing craft of the series of newbuildings or that fabricated in batch with the same type by same shipyard are to be determined by an inclining test. The follow-up constructed craft or converted craft is to be re-inclined if the deviation of lightship displacement exceeds 2% or the deviation of the longitudinal position of center of gravity exceeds 1% $L_{WL}$, which are determined by the lightweight survey.

## Section 2  Intact Stability

### 4.2.1  General requirements

4.2.1.1  The intact stability is to be checked for various sailing combinations under fully loaded departure and fully loaded arrival conditions. Where the stability under certain loading condition is worse than those specified above, stability check under such condition is to be supplemented.

4.2.1.2  The standard loading conditions to be checked are as follows:

(1)  fully loaded departure condition: carried with rated passengers, 100% stores and fuel;

(2)  fully loaded arrival condition: carried with rated passengers, 10% stores and fuel.

4.2.1.3  The sailing combinations are at least to include the following:

(1)  full sails;

(2)  half sails (half total area of all sails);

(3)  lowered sails.

4.2.1.4  The maximum Beaufort Wind Scale under which may carry out sail operation for various sailing combinations is to be recorded in the certificate of seaworthiness for craft.

### 4.2.2  Calculation of intact stability

4.2.2.1 Where the intact stability is calculated, the provisions of weight and center of gravity of personnel are to be as follows:

(1) 75 kg for each person;

(2) the height of centre of gravity is 1.0 m above deck level for person standing upright, 0.3 m above the seat in respect of seated person.

**4.2.3 Intact stability criteria**

4.2.3.1 The basic criteria to be satisfied under various sailing combinations are as follows:

(1) the initial metacentric height corrected by free surface of effects is not to be less than 0.30 m;

(2) for the stability range, not to be less than 90° for craft with ballast keel, not to be less than 60° for craft without ballast keel, but may be considered less than 60° for catamaran craft;

(3) the angle of static heel due to a wind load is not to be greater than 20° or 90% of the immersion of deck, whichever is the less;

(4) the righting lever is not to be less than 0.50 m at an angle of heel equal to or greater than 50°;

(5) the area above the wind heeling lever curve $\lambda$ ($\theta$) and below the righting level curve $GZ$ ($\theta$) between the angle of static wind heel and the angle of down-flooding is not to be less than 0.065 m×rad.

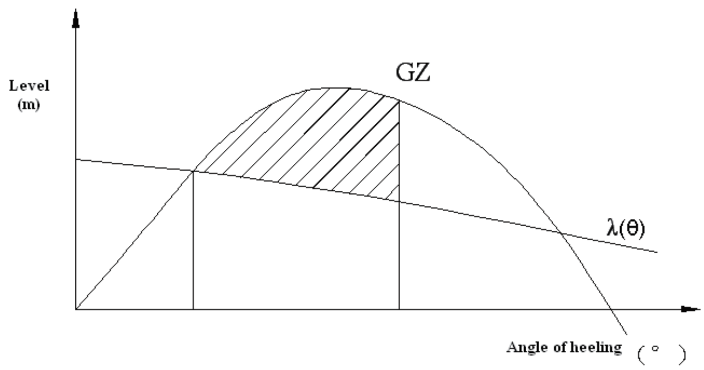


**Figure 4.2.3.1 Stability Curve for Sailing Craft**

4.2.3.2 The wind heeling curve is to be calculated as the following formula:

(1) Wind force $F$ is to be calculated by:

$$F = 1/2\ C_S \rho\ A\ V^2 \quad \text{N}$$

where: $C_S$ — coefficient of shape, to be of 1.1;
$\rho$ — density of air, to be of 1.222 kg/m$^3$;
$A$ — protected area of hull and sail above waterline, in m$^2$;

$V$ — maximum wind velocity at which may carry out sail operation corresponding to various sailing combinations (i.e. velocity of gust, in general, 1.5 times of the steady wind velocity), in m/s. The relationship between the Beaufort Wind Scale and steady wind velocity is given in Table 4.2.3.2.

**Beaufort Wind Scale** **Table 4.2.3.2**

| Wind Scale | Category | Steady wind velocity (m/s) |
|---|---|---|
| 0 | Calm | 0 ~ 0.2 |
| 1 | Light airs | 0.3 ~ 1.5 |
| 2 | Light breeze | 1.6 ~ 3.3 |
| 3 | Gentle breeze | 3.4 ~ 5.4 |
| 4 | Moderate breeze | 5.5 ~ 7.9 |
| 5 | Fresh breeze | 8.0 ~ 10.7 |
| 6 | Strong breeze | 10.8 ~ 13.8 |
| 7 | Near gale | 13.9 ~ 17.1 |
| 8 | Fresh gale | 17.2 ~ 20.7 |
| 9 | Strong gale | 20.8 ~ 24.4 |
| 10 | Whole gale | 24.5 ~ 28.4 |
| 11 | Strom | 28.5 ~ 32.6 |
| 12 | Hurricane | > 32.7 |

(2) The wind heeling level $\lambda$ (0) is to be calculated by:

$$\lambda (0) = FZ / (9810\Delta) \qquad \text{m}$$

where: $Z$ — vertical distance between a point at one half the mean draught and centroid of area $A$, in m;
$\Delta$ — displacement under the loading condition to be checked, in t.

(3) The wind heeling level curve $\lambda (\theta)$ is to be calculated by:

$$\lambda (\theta) = \lambda (0) (\cos\theta)^2$$

4.2.3.3 Where the angle of down-flooding is determined, openings for normal access and ventilation are to be taken into consideration. Any openings may lead to further immersion, regardless of its scantling, the heel angle of immersion is not to be less than 40°, excluding the air pipe.

# CHAPTER 5 OPERATIONAL REQUIREMENTS

## Section 1 Owner's Manual

**5.1.1 General requirements**

5.1.1.1 Owner's manual is to be available onboard each craft, which is to provide due consideration to environment and contents must be necessary for safety operation, equipment and system (refer to ISO 10240 — Small Craft – Owner's Manual).

## Section 2 Operation

**5.1.2 Personnel onboard craft**

5.1.2.1 All personnel onboard craft are to be trained properly and familiar with usage of safety equipment (including rigging, signals, life raft, etc.) and emergency operation (including hoisting or lowering sails, re-embarkation for person overboard, towing, etc.).

5.1.2.2 It is to ensure that personnel onboard craft have obtained the operation and maintenance experience before the craft is maneuvered.

5.1.2.3 The personnel onboard the craft are to capable of emergency handling under worst climate conditions, and controlling the craft speed and direction in the case of different sea conditions timely.

5.1.2.4 Each craft is to be maneuvered according to the requirements of Owner's Manual.