Amendments to the "Rules for the Classification of Workboats"

RFS/011/AMN/01

Effective from 1/7/2021

Reasons of the amendments:

Part/Chapter/Section/Paragraph amended	Reason
Pt A, Ch 1, Sec 1, [2.1.1]	to give the possibility to complete the workboat service notation by more than one additional service feature
Pt A, Ch 1, Sec 1, [3] (new)	to introduce navigation notations and design categories in order to link the operational category - generally used by the flag Administration - to the weather conditions (wind and significant wave height (Hs)) used in the structural verifications for the determination of the design vertical acceleration at LCG (a_{CG})
Pt B, Ch 1, Sec 1, [1.1.1]	to accept structural scantling according to ISO 12215-5 with safety factor increased of 25% (based on Tasneef experience) for craft with V ≥ 10 $L^{0.5}$ to which the requirements of these Rules - taken from those developed for HSC - are not applicable
Pt B, Ch 2, Sec 2, Table 1	to introduce values of parameter S for calculating the design vertical acceleration at LCG (a_{CG}) specific for taxi (transporting passengers and therefore comparable to a passenger ship) different from those for pilot boats
Pt B, Ch 2, Sec 2, [3.1] (deleted) and figures renumbered	to eliminate the requirements for longitudinal bending moment since the stress due to global longitudinal load (σ_{bl}) is not to be calculated for ships of 24 m of length or less

SECTION 1 FIELD OF APPLICATION OF THE RULES, SERVICE NOTATION AND GENERAL

1 Field of application of the Rules

1.1

1.1.1

These Rules apply for the purpose of classification of vessels - including catamarans and rigid inflatable boats (RIBs) - in commercial use, other than those in use for recreational, sport and pleasure, having a load line length between 4 m and 24 m, with a maximum speed of 45 knots and carrying no more than 12 passengers.

The application of these Rules to vessels with reinforced plastic hull or aluminium alloy hull having different load line length or speed may be considered by the Society on a case by case basis, depending on their specific operation and construction characteristics.

Where necessary, in the various parts of these Rules, specific conditions relevant to the field of application of the requirements are given.

The requirements for assignment of special service notations will be established by Tasneef case by case on the basis of the requirements of Part E of the Rules for the Classification of Ships.

For the purpose of the assignment of special class notations, the requirements of Part F of the Rules for the Classification of Ships are to be complied with, as far as practicable, at Tasneef discretion, in relation to the navigation and service notations, vessel size and hull material.

2 Service Notation

2.1

2.1.1 *(1/7/2021)*

The vessels complying with the classification requirements of these Rules are assigned with the service notation **WORKBOAT**, that may be completed by ~~one of~~ the following additional service features:

- **Crew Transfer Vessel - CTV**: when the workboat is designed to transport technician and other personnel out to sites.
- **Dive Support Vessel - DSV**: when the workboat is designed to support the offshore diving operation.
- **MULTICAT**: when the workboat is designed as multipurpose workboat for offshore works and transport. Normally a multicat is equipped with one or more winches and cranes as well as a spacious flat deck.
- **Patrol and Guard Vessel**: when the workboat is designed to patrol a coastal area or site for security, observation and defense.
- **Pilot boats**: when the workboat is designed to transport maritime pilots from harbors to ships that need piloting, or vice versa.
- **Seismic and Geotechnical Survey Vessel - SGSV**: when the workboat is designed for the purpose of research, seismic survey and mapping at seas.
- **Taxi**: when the workboat is designed to transport paying passengers on rivers, canals, or sea coastal area.
- **Windfarm Service Vessel - WSV**: when the workboat is designed to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

3 Navigation and design category

3.1 Navigation Notations

3.1.1 *(1/7/2021)*

Every classed workboat is to be assigned one navigation notation

3.1.2 *(1/7/2021)*

The navigation notation **unrestricted navigation** is assigned to a ship intended to operate in any area and any period of the year

3.1.3 *(1/7/2021)*

The navigation notation "**NAV 150**" is assigned to ships intended to operate only within 150 nautical miles from a safe haven

3.1.4 *(1/7/2021)*

The navigation notation "**NAV 60**" is assigned to ships intended to operate only within 60 nautical miles from a safe haven

3.1.5 *(1/7/2021)*

The navigation notation "**NAV 30**" is assigned to ships intended to operate only within 30 nautical miles from a safe haven

3.1.6 *(1/7/2021)*

The navigation notation "**NAV 3**" is assigned to ships intended to operate only within 3 nautical miles from a safe haven

3.1.7 *(1/7/2021)*

The assignment of a navigation notation does not absolve the Interested Party from compliance with any international and national regulations established by the Administrations for a ship operating in national waters, or a specific area, or a navigation zone. Neither does it waive the requirements in Pt A, Ch.1, Sec 1, [3.3.1] of Rules for Classification of ship.

3.2 Design categories

3.2.1 *(1/7/2021)*

Every classed workboat is to be assigned one design category as described in Pt B, Ch 2, Sec 2, Tab 2

3.2.2 *(1/7/2021)*

The operation of the vessel is limited to the sea and weather condition of the relevant design category

3.2.3 *(1/7/2021)*

Every classed workboat is to be designed according to a minimum design category against the navigation notation as per Tab 1

Table 1 :

Navigation notation	**design category**			
	A	B	C	D
UNRESTRICTED	X	-	-	-
NAV 150	X	-	-	-
NAV 60	X	X	-	-
NAV 30	X	X	X	-
NAV 3	X	X	X	X

This design category is indicated after the navigation notation.

Example: **unrestricted navigation - "A"**

Example: **NAV30 - "C"**

The service of the workboat is limited to the navigation notation and design category as applicable.

4 General

4.1 Compliance with statutory rules and regulations

4.1.1 With regard to what is not expressly stated or modified in these Rules, for the purpose of classification, the requirements of the Rules for the Classification of Ships, as far as applicable, are to be complied with.

The classification of a vessel, and more in general, Tasneef decisions and acts, do not absolve the Interested Party from compliance with any additional and/or more stringent rules and requirements, issued by the Administration of the state whose flag the vessel is entitled to fly, and/or of the State of the base port from which the vessel operates, and with any other specific provisions issued to this end.

4.2 Abbreviations

4.2.1 Rules

In these Rules, the wording "Rules" is intended to mean the effective Tasneef "Rules for the Classification of Ships"; i. e., when in the text, reference is made to Part A of the Rules, reference is to be made to Part A of the Rules for the Classification of Ships.

4.3 Technical documentation

4.3.1

Technical Documentation is to enable understanding of the design and construction of the vessel and is to confirm compliance with the requirements given in these Rules.

Requirements for documentation are found in the beginning of each section.

SECTION 1 DESIGN PRINCIPLES

1 Design principles

1.1 Applications

1.1.1 *(1/7/2021)*

The requirements of Pt B, Ch 1 and Ch 2 apply to glass reinforced plastic vessels and the requirements of Pt B, Ch 1 and Ch 3 apply to alluminium vessels.

Craft with $V \geq 10\ L^{0,5}$ will be individually considered by Tasneef that, in general, may accept scantling according to ISO 12215-5 with safety factor increased of 25%.

1.1.2 Direct calculations

Tasneef may require direct calculations to be carried out, if deemed necessary .

Such calculations are to be carried out based on structural modelling, loading and checking criteria accepted by Tasneef.

1.1.3 Units

Unless otherwise specified, the following units are used in the Rules:

- thickness of plating, in mm,
- section modulus of stiffeners, in cm^3,
- shear area of stiffeners, in cm^2,
- span and spacing of stiffeners, in m,
- stresses, in N/mm^2,
- concentrated loads, in kN,
- distributed loads, in kN/m or kN/m^2.

1.1.4 Definitions and symbols

The definitions of the following terms and symbols are applicable throughout this Chapter and its Appendices and are not, as a rule, repeated in the different paragraphs. Definitions applicable only to certain paragraphs are specified therein.

"Moulded base line": The line parallel to the summer load waterline, crossing the upper side of keel plate or the top of skeg at the middle of length **L**.

"Hull": The hull is the outer boundary of the enclosed spaces of the vessel, except for the deckhouses, as defined below.

"Chine": For hulls that do not have a clearly identified chine, the chine is the hull point at which the tangent to the hull is inclined 50° to the horizontal.

"Bottom": The bottom is the part of the hull between the keel and the chines.

"Main deck": The main deck is the uppermost complete deck of the hull. It may be stepped.

"Side": The side is the part of the hull between the chine and the main deck.

"Castle": A castle is a superstructure extending from side to side of the vessel or with the side plating not being inboard of the shell plating more than 4% of the local breadth. In general, such a superstructure fitted on the weather deck of the vessel is considered as "constituting a step of the strength deck" when it extends within 0,4 **L** amidships for at least 0,15 **L**. Other castles are considered as "not constituting a step of the strength deck".

"Deckhouse": The deckhouse is a decked structure located above the main deck, with lateral walls inboard of the side of more than 4 per cent of the local breadth. Structure located on the main deck and whose walls are not in the same longitudinal plane as the under side shell may be regarded as a deckhouse.

"Cross-deck": For twin-hull vessel, the cross-deck is the structure connecting the two hulls.

"Fore end": Hull region forward of 0,9 **L** from the aft perpendicular.

"Deadrise angle α_d": For hulls that do not have a clearly identified deadrise angle, α_d is the angle between the horizontal and a straight line joining the keel and the chine. For catamarans with non-symmetrical hulls (where inner and outer deadrise angles are different), α_d is the lesser angle.

"Aft end": Hull region abaft of 0,1 **L** from the aft perpendicular.

"Midship area": Hull region between 0,3 **L** and 0,7 **L** from the aft perpendicular.

L : Rule length, in m, equal to L_{WL} where L_{WL} is the waterline measured with the vessel at rest in calm water.

FP : forward perpendicular, i.e. the perpendicular at the intersection of the waterline at draught **T** and the foreside of the stem

AP : aft perpendicular, i.e. the perpendicular located at a distance **L** abaft of the forward perpendicular

B : the greatest moulded breadth, in m, of the vessel

B_w : the greatest moulded breadth, in m, measured on the waterline at draught **T**; for catamarans, B_w is the breadth of each hull

D : depth, in m, measured vertically in the transverse section at the middle of length L from the moulded base line of the hull(s) to the top of the deck beam at one side of the main deck (if the main deck is stepped, **D** will be defined in each separate case at the discretion of Tasneef)

T : draught of the vessel, in m, measured vertically on the transverse section at the middle of length **L**, from the moulded base line of the hull(s) to the full load waterline, with the vessel at rest in

SECTION 2 DESIGN LOADS AND HULL SCANTLING

1 Application

1.1

1.1.1 In general, the requirements from [2] to [6] apply. However, on the basis of the vessel's characteristics and the navigation notation required, Tasneef may accept structural strength checks carried out according to the requirements from [7] to [13].

1.1.2 On the basis of the vessel's characteristics and the navigation notation required, Tasneef may require structural strength checks based also on direct calculations.

2 Design acceleration

2.1 Vertical acceleration at LCG

2.1.1 The design vertical acceleration at **LCG**, a_{CG} (expressed in g), is defined by the Designer and corresponds to the average of the 1 per cent highest accelerations in the most severe sea conditions expected.

Generally, it is to be not less than:

$$a_{CG} = S \cdot \frac{V}{L^{0,5}}$$

where **S** is a parameter with values as indicated in Tab 1.

Lower **S** values, down to 80 per cent of tabular values, may be accepted, if justified, at Tasneef discretion. In exceptional cases greater reductions may be accepted, if justified, at Tasneef discretion, on the basis of model tests and full-scale measurements.

The sea areas referred to in Tab 1 are defined with reference to significant wave heights H_s which are exceeded for an average of not more than 10 percent of the year:

- Open-sea service: $H_s \geq 4,0$ m;
- Restricted open-sea service: 2,5 m $\leq H_s < 4,0$ m
- Moderate environment service: 0,5 m $< H_s < 2,5$ m
- Smooth sea service: $H_s \leq 0,5$ m.

If the design acceleration cannot be defined by the Designer, the a_{CG} value corresponding to the appropriate **S** value reported in Tab 1 will be assumed.

For limit operating conditions allowed for by design parameters, see [2.4].

For vessel the limit in a_{CG} adopted for the purpose of defining limit operating conditions is 2g.

2.2 Longitudinal distribution of vertical acceleration

2.2.1 The longitudinal distribution of vertical acceleration along the hull is given by:

$$a_v = k_v \cdot a_{CG}$$

where:

k_v : longitudinal distribution factor, defined in Fig 1, equal to the greater of 2x/L and 0,8, x being the distance, in m, from aft perpendicular to load point;

a_{CG} : design acceleration at **LCG**, see [2.1.1].

Variation of a_v in the transverse direction may generally be disregarded.

Table 1 *(1/7/2021)*

Type of service	Open sea **(1)**	Restricted open sea	Moderate environment	Smooth sea
Pilot boat	1,33 · C_F	0,40	0,30	Not applicable
Taxi	0,65 · C_F	0,20	0,15	0,09
(1) For this condition, **S** is defined for each separate case, at the discretion of Tasneef, depending on the actual service area.				

For vessel with a particular shape or other characteristics, Tasneef reserves the right to require model tests or full-scale measurements to verify results obtained by the formulae.

Tasneef may require an accelerometer to be installed on the vessel, in general at **LCG**. The information given by the accelerometer is to be immediately readable at the wheel-house.

2.4.2

The significant wave height is related to the vessel's geometric and motion characteristics and to the vertical acceleration a_{CG} by the following formula:

$$\frac{H_s}{T} = 3555 \cdot \frac{C_B \cdot a_{CG}}{\left(\frac{V_x}{L^{0,5}}\right)^2 \cdot (50 - \alpha_{dCG}) \cdot \left(\frac{\tau}{16} + 0,75\right)} - 0,084 \cdot \frac{B_W}{T}$$

where:

H_s : significant wave height,, in m;

α_{dCG} : deadrise angle, in degrees, at **LCG**, taken to be between 10° and 30°;

τ : trim angle during navigation, in degrees, taken to be not less than 4°;

V_x : vessel speed, in knots.

If V_x is replaced by the maximum service speed **V** of the vessel, the previous formula yields the significant height of the limit sea state, H_{sl}.

This formula may also be used to specify the permissible speed in a sea state characterised by a significant wave height equal to or greater than H_{sl}.

3 Overall loads

3.1 ~~Longitudinal bending moment~~

3.1.1 ~~General~~

~~The values of the longitudinal bending moment are given, as a first approximation, by the formulae in [3.1.2]. For large vessel, values from models tests may be taken into account.~~

~~If the actual distribution of weights along the vessel is known, a more accurate calculation may be carried out according to the procedure in [3.1.3]. Tasneef reserves the right to require calculations to be carried out according to [3.1.3] whenever it deems it necessary.~~

3.1.2 ~~Bending moment~~

~~The total bending moments $M_{bl,H}$, in hogging conditions, and $M_{bl,S}$, in sagging conditions, in kN · m, are to be taken as the greatest of those given by the formulae in (a) and (b).~~

~~For vessels having **L** > 100 m, only the formula in (b) is generally to be applied; the formula in (a) is to be applied when deemed necessary by Tasneef on the basis of the motion characteristics of the vessel.~~

~~The total shear force T_{bl}, in kN, is given by the formula in (c).~~

a) ~~Bending moment due to still water loads, wave induced loads and impact loads~~

$$M_{blH} = M_{blS} = 0,55 \cdot \Delta \cdot L \cdot (C_B + 0,7) \cdot (1 + a_{CG})$$

~~where a_{CG} is the vertical acceleration at the **LCG**, defined in [2.1].~~

b) ~~Bending moment due to still water loads and wave induced loads~~

$$M_{blH} = M_{sH} + 0,19 \cdot \frac{S}{S_0} \cdot C \cdot L^2 \cdot B \cdot C_B$$

$$M_{blS} = M_{sS} + 0,11 \cdot \frac{S}{S_0} \cdot C \cdot L^2 \cdot B \cdot (C_B + 0,7)$$

~~where:~~

~~$M_{s,H}$: still water hogging bending moment, in kN·m~~

~~$M_{s,S}$: still water sagging bending moment, in kN·m~~

~~**S** : parameter as indicated in Tab 1, for the considered type of service~~

~~S_0 : parameter as indicated in Tab 1, for "restricted open sea service"~~

~~C : 6 + 0,02 L~~

~~For the purpose of this calculation, C_B may not be taken less than 0,6.~~

c) ~~Total shear force~~

$$T_{bl} = \frac{3,1 \cdot M_{bl}}{L}$$

~~where M_{bl} is the greatest of $M_{bl,H}$ and $M_{bl,S}$ calculated according to (a) and (b), as applicable.~~

3.1.3 ~~Bending moment taking into account the actual distribution of weights~~

a) ~~The distribution of quasi-static bending moment and shear force, due to still water loads and wave induced loads, is to be determined from the difference in weight and buoyancy distributions in hogging and sagging for each loading or ballast condition envisaged.~~

b) ~~For calculation purposes, the following values are to be taken for the design wave:~~

- ~~wave length, in m:~~

$$\lambda = L$$

- ~~wave height, in m:~~

$$h = \frac{L}{15 + \frac{L}{20}}$$

- ~~wave form: sinusoidal.~~

c) ~~In addition, the increase in bending moment and shear force, due to impact loads in the forebody area, for the sagging condition only, is to be determined as specified below. For the purpose of this calculation, the hull is considered longitudinally subdivided into a number of intervals, to be taken, in general, equal to 20.~~

~~For twin hull vessel, the calculation below applies to one of the hulls, i.e. the longitudinal distribution of weight forces g_i and the corresponding breadth B_i are to be defined for one hull.~~

~~The total impact force, n kN, is:~~

$$F_{SL} = \sum q_{SLi} \cdot \Delta x_i$$

where $\mathbf{q}_{SLi}$ is the additional load per unit length, in kN/m, for $\mathbf{x}/\mathbf{L} \geq 0,6$ (see also Fig 2), given by:

$$\mathbf{q}_{SLi} = \mathbf{p}_0 \cdot \mathbf{B}_i \cdot \sin\left[2 \cdot \pi \cdot \left(\frac{\mathbf{x}_i}{\mathbf{L}} - 0,6\right)\right]$$

where

$\Delta \mathbf{x}_i$: length of interval, in m

$\mathbf{x}_i$: distance, in m, from the aft perpendicular

$\mathbf{B}_i$: vessel breadth, in m, at uppermost deck at $\mathbf{x}_i$; for twin-hull vessel, $\mathbf{B}_i$ is the maximum breadth of one hull at the considered longitudinal location

$\mathbf{x}_i$ and $\mathbf{B}_i$: to be measured at the centre of interval **i**

$\mathbf{p}_0$: maximum hydrodynamic pressure, in kN/m²:

$$\mathbf{p}_0 = \frac{\mathbf{a}_{v1} \cdot \mathbf{G} \cdot (\mathbf{r}_0 + \mathbf{x}_W^2)}{\mathbf{f}_{SL} \cdot [\mathbf{r}_0^2 + 0,5 \cdot \mathbf{L} \cdot (\mathbf{x}_{SL} - \mathbf{x}_W) - \mathbf{x}_{SL} \cdot \mathbf{x}_W]}$$

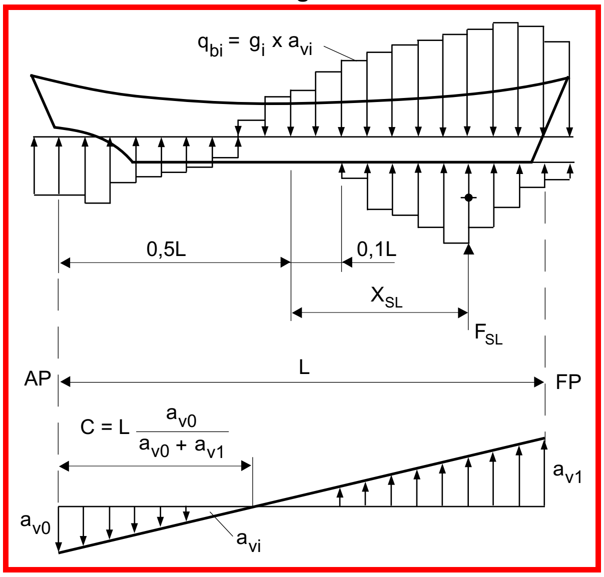
$\mathbf{a}_{v1}$: vertical design acceleration at the forward perpendicular, as defined in Fig. 2

$\mathbf{G}$: weight force, in kN:

$$\mathbf{G} = \sum \mathbf{g}_i \cdot \Delta \mathbf{x}$$

$\mathbf{g}_i$: weight per unit length, in kN/m, of interval **i**; for twin-hull vessel, is to be defined for one hull $\mathbf{g}_i$;

Figure 2-



$\mathbf{x}_W$: distance, in m, of **LCG** from the midship perpendicular:

$$\mathbf{x}_W = \frac{\sum(\mathbf{g}_i \cdot \Delta \mathbf{x}_i \cdot \mathbf{x}_i)}{\sum(\mathbf{g}_i \cdot \Delta \mathbf{x}_i)} - 0,5 \cdot \mathbf{L}$$

$\mathbf{r}_0$: radius of gyration, in m, of weight distribution:

$$\mathbf{r}_0 = \left(\frac{\sum[\mathbf{g}_i \cdot \Delta \mathbf{x}_i \cdot (\mathbf{x}_i - 0,5\ \mathbf{L})^2]}{\sum(\mathbf{g}_i \cdot \Delta \mathbf{x}_i)}\right)$$

normally $0,2 \cdot \mathbf{L} < \mathbf{r}_0 < 0,25 \cdot \mathbf{L}$ (guidance value)

$\mathbf{x}_{SL}$: distance, in m, of centre of surface $\mathbf{F}_{SL}$ from the midship perpendicular, given by:

$$\mathbf{x}_{SL} = \frac{1}{\mathbf{f}_{SL}} \sum(\Delta \mathbf{x}_i \cdot \mathbf{x}_i \cdot \mathbf{B}_i) \cdot \sin\left[2\pi \cdot \left(\frac{\mathbf{x}_i}{\mathbf{L}} - 0,6\right)\right] - 0,5\ \mathbf{L}$$

$\mathbf{f}_{SL}$: $\sum(\Delta \mathbf{x}_i \cdot \mathbf{B}_i) \cdot \sin\left[2\pi \cdot \left(\frac{\mathbf{x}_i}{\mathbf{L}} - 0,6\right)\right]$, in m²

d) The resulting load distribution $\mathbf{q}_{si}$, in kN/m, for the calculation of the impact induced sagging bending moment and shear force is:

1) For $\mathbf{x}/\mathbf{L} < 0,6$

$$\mathbf{q}_{si} = \mathbf{q}_{bi} = \mathbf{g}_i \cdot \mathbf{a}_{vi}$$

where:

$\mathbf{a}_{vi}$: total dimensionless vertical acceleration at interval **i**:

$$\mathbf{a}_{vi} = \mathbf{a}_h + \mathbf{a}_p \cdot (\mathbf{x}_i - 0,5\ \mathbf{L})$$

$\mathbf{a}_h$: acceleration due to heaving motion

$\mathbf{a}_p$: acceleration due to pitching motion

$\mathbf{a}_h$ and $\mathbf{a}_p$: are relative to **g**

$\mathbf{a}_h =$: $\frac{\mathbf{F}_{SL}}{\mathbf{G}}\left[\frac{\mathbf{r}_0^2 - \mathbf{x}_{SL} \cdot \mathbf{x}_W}{\mathbf{r}_0^2 - \mathbf{x}_W^2}\right]$

$\mathbf{a}_p =$: $\frac{\mathbf{F}_{SL}}{\mathbf{G}}\left[\frac{\mathbf{x}_{SL} - \mathbf{x}_W}{\mathbf{r}_0^2 - \mathbf{x}_W^2}\right]$, in $\mathbf{m}^{-1}$

2) For $\mathbf{x}/\mathbf{L} \geq 0,6$

$$\mathbf{q}_{si} = \mathbf{q}_{bi} - \mathbf{q}_{SLi}$$

e) The impact induced sagging bending moment and shear force are obtained by integration of the load distribution $\mathbf{q}_{si}$ along the hull. They are to be added to the respective values calculated according to (i) in order to obtain the total bending moment and shear force due to still water loads, wave induced loads and impact loads.

3.2 Twin-hull vessel transverse loads

3.2.1 General

For twin-hull vessel, the hull connecting structures are to be checked for load conditions specified in [3.2.2] and [3.2.3] below. These load conditions are to be considered as acting separately. Design moments and forces given in the following paragraphs are to be used unless other values are verified by model tests, full-scale measurements or any other information provided by the Designer (see [2.4.1], Requirements for model tests).

For vessel with structural arrangements that do not permit a realistic assessment of stress conditions based on simple models, the transverse loads are to be evaluated by means of direct calculations carried out in accordance with criteria specified in [5] or other criteria considered equivalent by

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3.2.2 Transverse bending moment and shear force

The transverse bending moment $\mathbf{M}_{bt}$, in KN · m, and shear force $\mathbf{T}_{bt}$, in KN · m, are given by:

$$\mathbf{M}_{bt} = \frac{\Delta \cdot \mathbf{b} \cdot \mathbf{a}_{CG} \cdot \mathbf{g}}{5}$$

$$\mathbf{T}_{bt} = \frac{\Delta \cdot \mathbf{a}_{CG} \cdot \mathbf{g}}{4}$$

where:

b : transverse distance, in m, between the centres of the two hulls;

$\mathbf{a}_{CG}$: vertical acceleration at LCG, defined in [2.1].

3.2.3 Transverse torsional connecting moment

The twin-hull transverse torsional connecting moment, in kN · m, about a transverse axis is given by:

$$\mathbf{M}_{tt} = 0{,}125 \cdot \Delta \cdot \mathbf{L} \cdot \mathbf{a}_{CG} \cdot \mathbf{g}$$

where $\mathbf{a}_{CG}$ is the vertical acceleration at LCG, defined in [2.1], which need not to be taken greater than 1,0 g for this calculation.

3.3 Small waterplane area twin-hull (SWATH) vessel-Forces

3.3.1 Side beam force

The design beam side force, in kN, (see Fig ~~3~~2) is given by:

$$\mathbf{F}_Q = 12{,}5 \cdot \mathbf{T} \cdot \Delta^{2/3} \cdot \mathbf{d} \cdot \mathbf{L}_S$$

where:

d : $1{,}55 - 0{,}75 \cdot \tanh\left(\frac{\Delta}{11000}\right)$

$\mathbf{L}_S$: $2{,}99 \cdot \tanh\lambda - 0{,}725$

λ : $\frac{0{,}137 \cdot \mathbf{A}_{lat}}{\mathbf{T} \cdot \Delta^{1/3}}$

$\mathbf{A}_{lat}$: lateral area, in m², projected on a vertical plane, of one hull with that part of strut or struts below waterline at draught T.

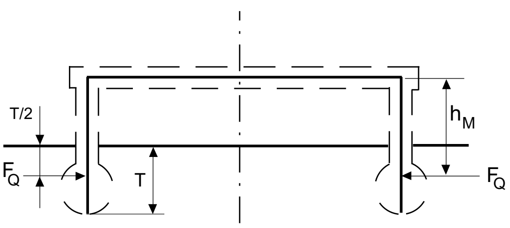
The lateral pressure, in kN/m², acting on one hull is given by:

$$\mathbf{p}_Q = \frac{\mathbf{F}_Q}{\mathbf{A}_{lat}}$$

The distribution of the lateral force $\mathbf{F}_Q$ can be taken as constant over the effective length $\mathbf{L}_e = \mathbf{A}_{lat} / \mathbf{T}$, in m. The constant lateral force per unit length, in kN/m, is thus given by:

$$\mathbf{q}_Q = \frac{\mathbf{F}_Q}{\mathbf{L}_e}$$

Figure 2~~3~~



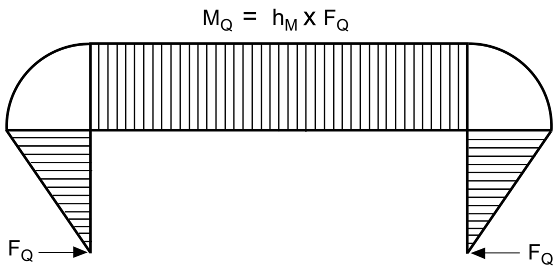
3.3.2 Bending moment

The corresponding design bending moment, in KN · m, is given by:

$$\mathbf{M}_Q = \mathbf{h}_M \cdot \mathbf{F}_Q$$

$\mathbf{h}_M$: half the draught T plus the distance from the waterline at draught T to the midpoint of the cross-deck structure (see Fig ~~4~~3), in m.

Figure 3~~4~~



4 Local loads

4.1 Introduction

4.1.1 Design loads defined in this Article are to be used for the resistance checks provided for in [6] to obtain scantlings of structural elements of hull and deckhouses.

Such loads may be integrated or modified on the basis of the results of model tests or fullscale measurements. Model tests are to be carried out in irregular sea conditions with significant wave heights corresponding to the operating conditions of the vessel. The scale effect is to be accounted for by an appropriate margin of safety.

The characteristic value to be assumed is defined as the average of the 1 per cent highest values obtained during testing. The length of the test is, as far as practicable, to be sufficient to guarantee that statistical results are stationary.

4.2 Loads

4.2.1 General

The following loads are to be considered in determining scantlings of hull structures:

- impact pressures due to slamming, if expected to occur;
- sea pressures due to hydrostatic heads and wave loads;
- internal loads.

External pressure generally determines scantlings of side and bottom structures; internal loads generally determine scantlings of deck structures.

Where internal loads are caused by concentrated masses of significant magnitude (e.g. tanks, machinery), the capacity of the side and bottom structures to withstand such loads is to be verified according to criteria stipulated by Tasneef. In such cases, the inertial effects due to acceleration of the vessel are to be taken into account.

Such verification is to disregard the simultaneous presence of any external wave loads acting in the opposite direction to internal loads.

4.2.2 Load points

Pressure on panels and strength members may be considered uniform and equal to the pressure at the following load points:

- for panels: lower edge of the plate, for pressure due to hydrostatic head and wave load; geometrical centre of the panel, for impact pressure.
- for strength members: centre of the area supported by the element.

Where the pressure diagram shows cusps or discontinuities along the span of a strength member, a uniform value is to be taken on the basis of the weighted mean value of pressure calculated along the length.

4.3 Impact pressure on the bottom

4.3.1 If slamming is expected to occur, the impact pressure, kN/m², considered as acting on the bottom is not less than:

$$p_{sl} = 70 \cdot \frac{\Delta}{S_r} \cdot K_1 \cdot K_2 \cdot K_3 \cdot a_{CG}$$

where:

Δ : displacement, in tonnes (see [2.4]). For twin hull-vessel, Δ in the above formula is to be taken as half of the vessel displacement.

S_r : reference area, m²:

$$S_r = 0{,}7 \cdot \frac{\Delta}{T}$$

For twin-hull vessel, Δ in the above formula is to be taken as half the vessel displacement.

K_1 : longitudinal bottom impact pressure distribution factor (Fig ~~5~~4):

$0{,}5 + x/L$, for $x/L < 0{,}5$

$1{,}0$, for $0{,}5 \le x/L \le 0{,}8$

$3{,}0 - 2{,}5 \cdot x/L$, for $x/L > 0{,}8$

where **x** distance, in m, from aft perpendicular to load point

K_2 : factor accounting for impact area

$$K_2 = 0{,}455 - 0{,}35 \cdot \frac{u^{0,75} - 1{,}7}{u^{0,75} + 1{,}7}$$

where

u : $100 \cdot \frac{s}{S_r}$

s : area, m², supported by the element (plating, stiffener, floor or girder). For plating, the supported area is the spacing between the stiffeners multiplied by their span, without taking for the latter more than three times the spacing between the stiffeners.

where:

$K_2 \ge 0{,}50$, for plating

$K_2 \ge 0{,}45$, for stiffeners

$K_2 \ge 0{,}35$, for girders and floors.

K_3 : $(70 - \alpha_d)/(70 - \alpha_{dCG})$

factor accounting for shape and deadrise of the hull, where α_{dCG} is the deadrise angle, in degrees, measured at **LCG**; values taken for α_d and α_{dCG} are to be between 10° and 30°.

a_{CG} : design vertical acceleration at LCG, defined in [2].

4.4 Impact pressure on bottom of cross-deck and internal sides (for twin-hull vessel)

4.4.1 Slamming on bottom of the cross-deck (wet deck) is assumed to occur if the distance, in m, between the waterline at draught **T** and the wet deck is less than Z_{wd}, where:

Z_{wd} : $0{,}05 \cdot L$, if $L \le 65$ m

Z_{wd} : $3{,}25 + 0{,}0214 \cdot (L - 65)$, if $L > 65$ m

In such a case, the impact pressure, in kN/m², considered as acting on the wet deck is not less than:

$$p_{sl} = 3 \cdot K_2 \cdot K_{CD} \cdot V \cdot V_{sl} \cdot \left(1 - 0{,}85\frac{H_A}{H_S}\right)$$

where:

K_2 : as defined in [4.3]

K_{CD} : longitudinal wet deck impact pressure distribution factor (Fig ~~6~~5):

$0{,}5 \cdot (1{,}0 - x/L)$ for $x/L < 0{,}2$

$0{,}4$ for $0{,}2 \le x/L \le 0{,}7$

$6{,}0 \cdot x/L - 3{,}8$ for $0{,}7 < x/L \le 0{,}8$

$1{,}0$ for $x/L > 0{,}8$

x : distance, in m, from aft perpendicular to load point.

V : vessel's speed, in knots,

H_a : air gap, in m

V_{SL} : relative impact velocity, in m/s, given by:

$$V_{SL} = \frac{4 \cdot H_S}{L^{0,5}} + 1$$

H_S : significant wave height, in m.

If slamming is considered to occur on the wet deck, the impact pressure on the internal sides is obtained by interpolation between the pressure considered as acting on the bottom and the pressure P_{SL} at wet deck.

If the wet deck at a transverse section considered is not parallel to the design waterline the impact pressure P_{SL} will be considered in each separate case by Tasneef.

4.5 Sea pressures

4.5.1 The sea pressure, in kN/m², considered as acting on the bottom and side shell is not less than p_{smin}, defined in Tab 3, or less than:

$$p_s = 10 \cdot \left[T + 0{,}75 \cdot S - \left(1 - 0{,}25 \cdot \frac{S}{T}\right) \cdot z\right], \text{ for } z \le T$$

$$p_s = 10 \cdot (T + S - z), \text{ for } z > T$$

where:

Figure 7

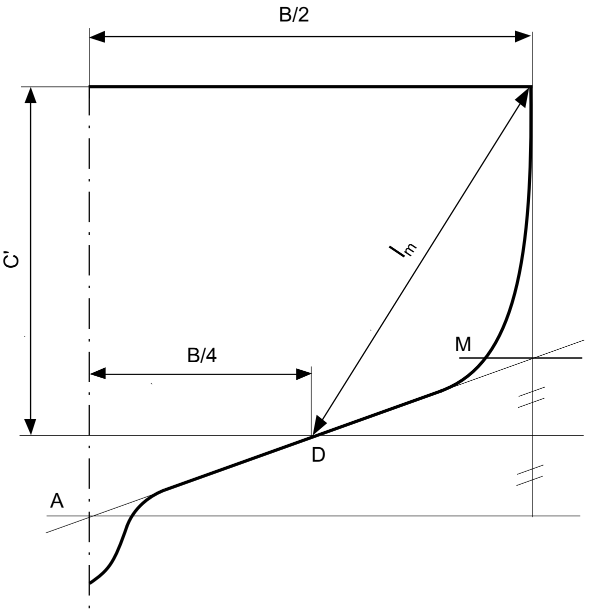


Table 4

	SF
General	6
Members subject to impact load	4,5
Transverse watertight bulkheads	5
Sides and ends of superstructures and deckhouses	4
Members subject to the test pressure $\mathbf{p}_e$	4

Table 5

		SF
Core of sandwich	General	3
	Sandwiches subject to impact load	2,5
Web of primary members	General	5
	Stiffeners subject to impact load	3,5
	Stiffeners on transverse watertight bulkhead	4
	Stiffeners of sides and ends of superstructures and deckhouses	3
	Stiffeners calculated with the test pressure $\mathbf{p}_e$	3

6.3.2 Single skin laminates

a) **General**

The bending stress, in N/mm², of the laminate is to be multiplied by the following reduction factor $\mathbf{K}_s$:

$$\mathbf{k_s} = \mu_1 \cdot \alpha \cdot \mathbf{r_c^2}$$

where:

μ_1 : factor equal to:

$$\mu_1 = \begin{cases} 1 & \text{if } \mathbf{l} \geq 2 \cdot \mathbf{s} \\ 1 - 1{,}5 \cdot \left(1 - \dfrac{\mathbf{l}}{2 \cdot \mathbf{s}}\right)^2 & \text{if } \mathbf{s} < \mathbf{l} < 2 \cdot \mathbf{s} \\ 0{,}625 & \text{if } \mathbf{l} \leq \mathbf{s} \end{cases}$$

where:

l : span of stiffener, in m

s : length, in m, as defined in Fig ~~8~~7 or Fig ~~9~~8

α : $1 - 3 \cdot \left(\dfrac{\mathbf{a}}{\mathbf{s}}\right) \cdot \left(1 - \dfrac{\mathbf{a}}{\mathbf{s}}\right)$

in the case of shell plating with ω stiffeners (see Fig ~~8~~7) α is not to be taken less than 0,4; **a** is the length, in m, shown in Fig ~~8~~7.

$\mathbf{r}_c$: $1 - 0{,}8 \cdot \dfrac{\mathbf{f}}{\mathbf{s}}$

without being less than 0,85, where **f**, in m, is shown in Fig ~~9~~8.

In the case of unstiffened shell plating with a large curvature, a relevant study of the stress is to be submitted to Tasneef for examination.

b) **Scantlings of single skin laminates**

The minimum thicknesses of the single skin laminate plates are not to be, as a rule, less than the following values:

- $1{,}5 \cdot (\mathbf{L} + 10)^{0{,}5}$

  for bottom and bilge plates,

- $1{,}25 \cdot (\mathbf{L} + 10)^{0{,}5}$

  for shell plating,

- $(\mathbf{L} + 10)^{0{,}5}$

  for other plating.

Lower values can be considered if a justification is submitted to Tasneef

The bending stress, in N/mm², due to the design pressure **p** (defined in [4]) is given by the formula:

$$\sigma_d = \mathbf{k_s} \cdot \frac{\mathbf{V}}{[\mathbf{I}]} \cdot \frac{\mathbf{p} \cdot \mathbf{s}^2}{12} \cdot 10^3$$

where:

V : maximum distance of the neutral axis of the laminate, in mm, as defined in Sec 1, [1.1.3](b)

[I] : inertia of the laminate, by mm of width, in mm⁴/mm, as defined in Sec 1, [1.1.3](b).

The bending stress due to the design pressure σ_d is given by the following formula:

$$\sigma_d < \frac{\sigma_{br}}{\mathbf{SF}}$$

where:

σ_{br} : breaking bending strength of the laminate, as defined in Sec 1, [1.1.3](b),

SF : safety factor, as defined in [6.3.1].

The bending stress σ_{de}, in N/mm², calculated for the test pressure $\mathbf{p}_e$ is to be:

When the superstructure deck is the strength deck, the scantlings of the sides of superstructures are to be determined as for the side shell plates.

The plating thickness of sides of long superstructures is to be increased by 25% over a length of about one sixth of the vessel breadth on each end of the superstructure.

6.8.4 Stiffener scantlings

Stiffener scantlings are to be calculated in accordance with [6.3.4].

Scantlings of side stiffeners of superstructures and deckhouses need not exceed those of side stiffeners of the tier immediately below, based on the same span and spacing.

Tasneef reserves the right to require a special examination of superstructure frames:

- where the decks at ends of the considered frame are not stiffened in the same way,
- where the frame span exceeds 4 m,
- for passenger vessels.

In the case of a superstructure or deckhouse contributing to longitudinal strength, the vertical stiffeners between windows on the sides are to be individually examined.

6.9 Principles of building

6.9.1 Definitions

The stiffeners with the lower spacing are defined in this chapter as ordinary stiffeners.

Depending on the direction of ordinary stiffeners, a structure is made of one of the following systems:

- longitudinal framing,
- transverse framing.

Ordinary stiffeners are supported by structural members, defined as primary stiffeners, such as:

- keelsons or floors,
- stringers or web frames,
- reinforced beams or deck stringers.

6.9.2 General provisions

The purpose of this item [6.9.2] is to give some structural details which may be recommended. However, they do not constitute a requirement; different details may be proposed by builders and agreed upon by Tasneef provided that builders give justifications, to be defined in each special case.

Arrangements are to be made to ensure the continuity of longitudinal strength:

- in areas with change of stiffener framing,
- in areas with large change of strength,
- at connections of ordinary and primary stiffeners.

Arrangements are to be made to ensure the continuity of transverse strength in way of connections between hulls of catamarans and axial structure.

Structure discontinuities and rigid points are to be avoided; when the strength of a structure element is reduced by the presence of an attachment or an opening, proper compensation is to be provided.

Openings are to be avoided in highly stressed areas, in particular at ends of primary stiffeners, and for webs of primary stiffeners in way of pillars.

If necessary, the shape of openings is to be designed to reduce stress concentration.

In any case, the corners of openings are to be rounded.

Connections of the various parts of a hull, as well as attachment of reinforcing parts or hull accessories, can be made by moulding on the spot, by bonding separately moulded, or by mechanical connections.

Bulkheads and other important reinforcing elements are to be connected to the adjacent structure by corner joints (see Fig ~~10~~9) on both sides, or equivalent joint.

The mass per m² of the corner joints is to be at least 50% of the mass of the lighter of the two elements to be fitted, and at least 900 g/m² of mat or its equivalent.

The width of the layers of the corner joints is to be worked out according to the principle given in Fig ~~10~~9.

The connection of the various parts of the hull, as well as connection of reinforcing members to the hull, can be made by adhesives, subject to special examination by Tasneef

6.9.3 Plates

The edges of the reinforcements of one layer are not to be juxtaposed but to overlap by at least 50 mm; these overlaps are to be offset between various successive layers.

Prefabricated laminates are fitted by overlapping the layers, preferably with chamfering of edges to be connected.

The thickness at the joint is to be at least 15% higher than the usual thickness.

Changes of thickness for a single-skin laminate are to be made as gradually as possible and over a width which is, in general, not to be less than thirty times the difference in thickness, as shown in Fig 1~~1~~0.

The connection between a single-skin laminate and a sandwich laminate is to be carried out as gradually as possible over a width which is, in general, not to be less than three times the thickness of the sandwich core, as shown in Fig 1~~2~~1.

a) **Deck-side shell connection**

   This connection is to be designed both for the bending stress shown in Fig 1~~3~~2, caused by vertical loads on deck and horizontal loads of seawater, and for the shear stress caused by the longitudinal bending.

   In general, the connection is to avoid possible loosening due to local bending, and ensure longitudinal continuity. Its thickness is to be sufficient to keep shear stresses acceptable.

   Fig 1~~4~~3 to Fig 1~~7~~6 give examples of deck-side shell connections.

b) **Bulkhead-hull connection**

   In some cases, this connection is needed to distribute the local load due to the bulkhead over a sufficient length of hull. Fig 1~~8~~7 and Fig 1~~9~~8 give possible solutions. The scantlings of bonding angles are determined according to the loads acting upon the connections.

The builder is to pay special attention to connections between bulkheads of integrated tanks and structural members.

c) **Passages through hull**

Passages of metal elements through the hull, especially at the level of the rudder stock, shaft brackets, shaft-line, etc., are to be strongly built, in particular when subjected to alternating loads.

Passages through hull should be reinforced by means of a plate and counterplate connected to each other.

d) **Passages through watertight bulkheads**

The continuous omega or rectangle stiffeners at a passage through a watertight bulkhead are to be watertight in way of the bulkhead.

e) **Openings in deck**

The corners of deck openings are to be rounded in order to reduce local stress concentrations as much as possible, and the thickness of the deck is to be increased to maintain the stress at a level similar to the mean stress on the deck.

The reinforcement is to be made from a material identical to that of the deck.

6.9.4 Stiffeners

Primary stiffeners are to ensure structural continuity.

Abrupt changes in web height, flange breadth and cross-sectional area of web and flange are to be avoided.

In general, at the intersection of two stiffeners of unequal sizes (longitudinals with web-frames, floors, beams or frames with stringers, girders or keelsons), the smallest stiffeners (longitudinals or frames) are to be continuous, and the connection between the elements is to be made by corner joints according to the principles defined in [6.9.2].

Fig ~~20~~19 to Fig 2~~2~~1 give various examples of stiffeners.

Connections between stiffeners are to ensure good structural continuity. In particular, the connection between deck beam and frame is to be ensured by means of a flanged bracket. However, some types of connections without bracket may be accepted, provided that loads are light enough. In this case, stiffeners are to be considered as supported at their ends.

6.9.5 Pillars

Connections between metal pillars subject to tensile loads and the laminate structure are to be designed to avoid tearing between laminate and pillars.

Connections between metal pillars subject to compressive loads and the laminate structure are to be carried out by mean of intermediate metal plates. The welding of the pillar to the metal plate is to be carried out before fitting of the plate on board vessel.

Fig 2~~2~~1 gives the principle for connection between the structure and pillars subject to compressive loads.

6.9.6 Engine seating

The engine seating is to be fitted on special girders suitably positioned between floors, which locally ensure sufficient strength in relation to pressure and weight loads.

Fig 2~~4~~3 gives an example of possible seating.

Figure 10

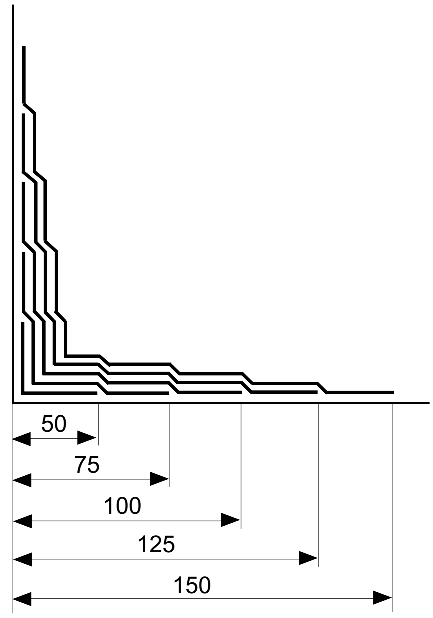


Figure 11

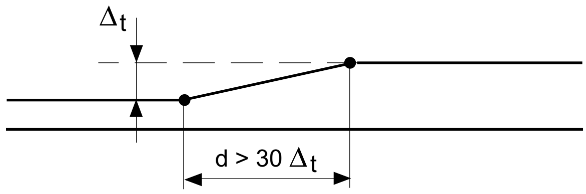


Figure 12

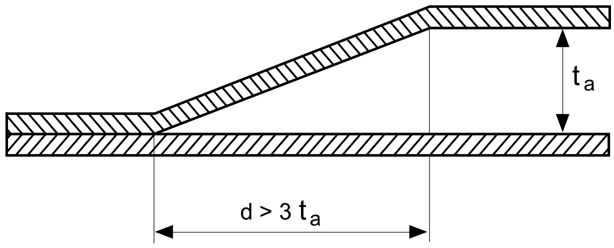
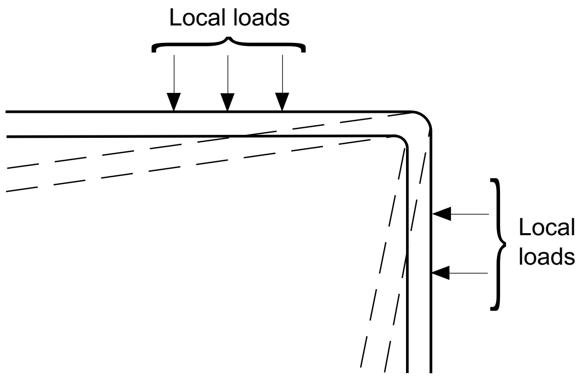


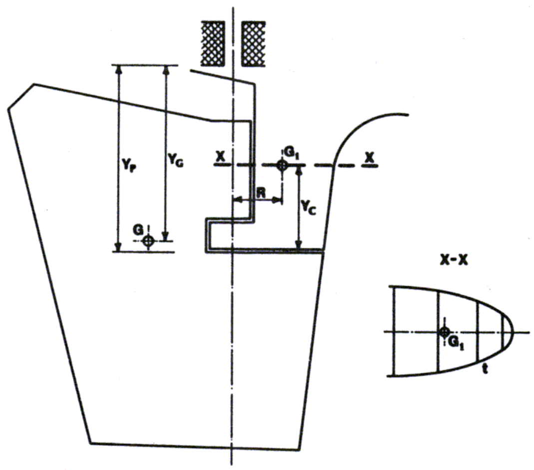
Figure 13



The thickness t_{ch} is to be gradually tapered to the thickness of the bottom and, in the case of hulls having a U-shaped keel, t_{ch} is to extend transversally to the bottom plating with adequate tapering.

When the hull is prefabricated in two halves, the keel joint is to be carried out with adequate overlapping of the layers of reinforcement on both sides of the bottom.

Figure 25



G : centroid of the rudder

G$_1$: centroid of the sect. **X** - **X** of the rudder horn

8.2 Stem and sternpost or sternframe (transom)

8.2.1 The stem and the sternpost are to have thickness not less than:

- t_{ch}, extending up to the full load waterline;
- t_1 (given by the formula in [9.3], using $s = s_r$ and $K_{V1} = 1$) extending up to the above-mentioned waterline as far as the deck or edge

The thickness t_s, in mm, of the transom is to be not less than the value t_2 for the side plating of the hull given in [9.3] using $K_{V2} = 1$. When outboard or stern drive engines are fitted, the thickness t_s is to be suitably increased or, alternatively, a structure with double plating and a core in plywood may be used such that, in the opinion of the Designer, the strength of the transom is adequate in relation to the weight and output of the engines.

8.3 Rudder horn

8.3.1 Rudder horns of semi-spade rudders are to be adequately dimensioned in relation to the force acting on the pintle.

For rudders with one pintle only, this condition is generally satisfied when the generic section X - X has:

- section modulus **Z** with respect to the longitudinal axis, in cm^3,
- area **a** of the figure bounded by the rudder's external contour, in cm^2,
- average thickness **t** of the rudder shell, in cm, such as to satisfy the following relation:

$$\frac{0,1\,A p Y_G}{Y_p}\left(\frac{Y_C}{Z}+\sqrt{\frac{Y_C^2}{Z^2}+\frac{R^2}{t^2 a^2}}\right) \le 0,15$$

where:

A : the total rudder area, in m^2

p : external pressure on the rudder, in kN/m^2, given by:

$p = 9,8\, K_0\, (V+3)^2 \times 10^{-3}$ where:

- **K** : 8,75 for rudders inside the propeller jet
  7,35 for rudders outside the propeller jet
- **V** : speed of the vessel, in knots
- **R** : distance from the centroid of the section considered of the rudder horn to the centreline of the rudder stock, in cm
- Y_g, Y_p, Y_c: distances, in cm, shown in Fig 2~~5~~4.

The connection of the rudder horn to the hull will be subject to special consideration by Tasneef on a case-by-case basis.

8.4 Propeller shaft brackets

8.4.1 For double arm or single arm propeller shaft brackets made of steel or other metal, the requirements in Part B, Chapter 10, Sec 3 of the Rules apply.

9 Bottom, side and deck plating

9.1 General

9.1.1 The thickness of external and deck plating given by the requirements in this Chapter is to be increased as far as necessary such as to ensure the hull longitudinal strength, when prescribed (see [7.3]).

9.2 Bottom plating

9.2.1

The thickness t_1 of bottom plating, in mm, is to be not less than:

$$t_1 = 3,9\,\frac{s}{s_r}\sqrt{L-3}\,K_{of}K_{V1}$$

or less than the thickness of side plating or, in any case, less than 3 mm, where:

L : length of the hull defined in Ch 1, Sec 1, [1.1.4];

s and s$_r$: spacing defined in [7.1];

K_{of} : coefficient relative to the mechanical properties of the laminate of bottom plating, defined in [7.5];

K_{V1} : coefficient relative to high speed hulls defined in [7.7]

The thickness of the bottom is to extend transversally up to not less than 150 mm above the full load waterline and, in any case, beyond the chine in the case of chine units.