PARTE II RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF SHIPS IDENTIFIED BY THEIR MISSIONS

TÍTULO 43 DREDGERS AND MUD BARGES

SECTION 2 STRUCTURE

CHAPTERS

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- See Part II, Title 11, Section 2

500. Floors, longitudinals, stringers and side transverse girders in the double bottom
-See Part II, Title 11, Section 2

600. Tank top of double bottom

601. In vessels of type B and $L \geq 50$, double bottom is to be built.

602. For vessels of type A, see Title 31 for tank vessels.

603. The thickness is given by the greater of the values in mm:

$$e = 0,01 \times E$$

$$e = 0,0085 \times E \times \sqrt{p}$$

of which:

-E: stiffener spacing in mm;

-p: load defined in chapter E, in thethe case of the hopper is to be revised for thedensity of the material to be transported;

-"e" not less than:

. the thickness of the bottom; and

. the thickness calculated as hopper bulkhead (ATQ).

604. When is expected the use of discharging with buckets, the thickness is to be increased of 3.5 mm.

700. Floors, longitudinals, stringers and side transverse girders in the double bottom

701. The module required for the beams of the tank top and bottom will be calculated by the equation of the Cap. E4., taking into account the respective data of the Sub-Chap. E3, so that in the case of the hopper is to be revised for the density of material to be carried.

702. to 709. -See Part II, Title 11, Section 2

F2. BULKHEADS

100. Definitions
-See Part II, Title 11, Section 2

200. Loadings

201. Will be expressed in t/m2, by the number corresponding to the height, in meters, measured from structural element considered to a point located as follows:

Type	Zona de navegação	
	O1	O2
AEC	main deck level	
ATQ (greatest value)	0,7 m above the air pipe height or of the main deck or of the trunk-deck; 1,3 m above the tank top	0,9 m above the air pipe height or of the main deck or of the trunk-deck; 1,5 m above the tank top

300. Plating of AECs
-See Part II, Title 11, Section 2

400. Stanchions of AECs
-See Part II, Title 11, Section 2

500. Provisions for ATQs

501. In principle, the tanks will not have width of the full extension of the breadth of the vessel. The width should not exceed 0,7 × B.

502. Cofferdams will be built between compartments containing products at risk of contamination.

503. The bulkheads of the hopper are calculated as ATQ, with the maximum pressure obtained from the loadings and revised for the density of the material.

600. Plating of ATQs

601. Will be the greatest of the values below in mm:

$$e = 0,004 \times E \times \sqrt{h \times da + 1}$$
$$e = 0,08 \times \sqrt{L}$$

where:

h: loading height, measured from the lower edge of the plate strake in issue, in m;

da: density of the material within the hopper.

700. Stiffeners of ATQs

701. The section module, in general, will be obtained by the equation:

$$W = 1,19 \times E \times l^2 \times (5 \times h + 3 \times hp)$$

where:

h: loading height, measured from the upper edge of the span *l*, in m;

hp: vertical distance measured between the ends of the span *l*, in m.

702. In the case of the hopper the values obtained in the previous equation and the following equations are to be multiplied by the density of the material.

703. For vertical stiffener the equation is written:

$$W = 1,19 \times E \times l^2 \times (5 \times h + 3 \times l)$$

704. For stiffener on horizontal transverse bulkhead the equation is written:

$$W = 5{,}95 \times h \times E \times l^2$$

705. For stringers supporting vertical struts is used the above equation, being "E" the average of the spans of the struts, above to below, which they support.

706. For vertical girders that support stringers, the section modulus is calculated by the equation:

$$W = 35{,}7 \times h \times \frac{C}{l^2}$$

where:

h: loading height to the level of the stringer supported;
l : span of the vertical girder;

C: the greatest of the values: $l_1 \times l_2^2$ or $l_1^2 \times l_2$
of which:

l_1 and l_2 the distances of the stringer supported to the ends of the span l of the vertical girder.

708. For horizontal stiffener of longitudinal bulkhead the equation is written:

$$W = 5{,}95 \times E \times l^2 \times hi \times yi$$

where:

hi: load height from the level of the element in issue;

$$yi = 0{,}013 \times L \times (1 - \frac{di}{0{,}4 \times D}) + 1$$

800. Sundry tanks

801. The elements are calculated as tank bulkhead, with the cargo height measured up to the air pipe height, but not being taken less than 3 m above the tank.

F4. DECK

100. to 300. -See Part II, Title 11, Section 2

400. Cross beams and transverse girders

401. to 404. -See Part II, Title 11, Section 2

405. For transverse girders of the hopper at the deck level, the combined stresses, from the application of maximum forces indicated above, should meet the following formula:

$$\sigma c = \sqrt{\sigma^2 + 3 \times \tau^2} \quad \leq 13{,}73 \text{ daN/mm}^2 \; (14 \text{ kgf/mm}^2)$$

where :

σ: bending plus normal stress
τ: shear plus torsion stress

406. The ends of these beams which embed in structural rings of the side frames should ensure the continuity of the strength module in the embedment.

CHAPTER G
PRINCIPLES OF HULL GIRDER DESIGN

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G 4. WAVE LOADS

100. Wave bending moment

101. When the wave bending moment is not made by direct calculation, the moment caused by the waves, in special for vessels of L≥ 60 m, is to be calculated by the equations showed in G2.102.

102. The vertical Wave bending moment Mw, at each section along the ship length are given by the following formulae:

$M_{WV,H} = + 190 M C L^2 B (C_B + 0{,}7) \times 10^{-3}$ kN.m for positive moment.

$M_{WV,S} = - 110 M C L^2 B (C_B + 0{,}7) \times 10^{-3}$ kN.m for negative moment.

where:

M = distribution factor given in Figure F.G4.301.1.

C = c_n as indicated in G3.101.

$C_n = 10{,}75 - \left(\frac{300-L}{100}\right)^{3/2}$ for 90 m ≤ L ≤300 m

$C_n = 10{,}75$ for 300 m < L <350 m

$C_n = 10{,}75 - \left(\frac{L-350}{150}\right)^{3/2}$ for 350 m ≤ L ≤500m

k = material factor

k = 1, 0 for ordinary hull structural steel

k < 1,0 for higher tensile steel according with Part II, Title 11, Section 2, Subchapter C3.200.
L = length defined in Title 11, section 1, sub-chapter A2.

B = greatest moulded breadth in metres.

C_B = block coefficient not to be taken less than 0,6.

FIGURE F.G4.202.1. – DISTRIBUTION FACTOR M

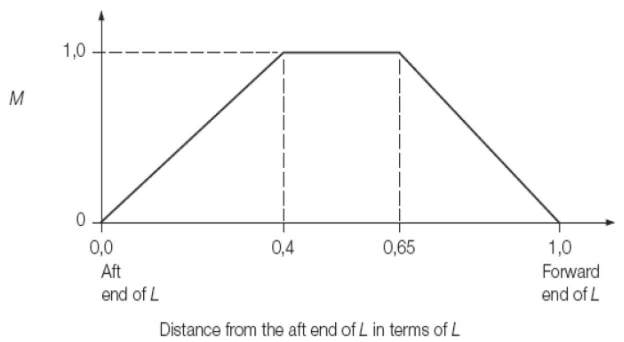


TABLE T.G4.302.1: DISTRIBUTION FACTOR *M*

HULL TRANSVERSE SECTION LOCATION	DISTRIBUTION FACTOR *M*
$0 \le x < 0{,}4L$	$2{,}5\frac{x}{L}$
$0{,}4L \le x \le 0{,}65L$	1,0
$0{,}65L < x \le L$	$2{,}86\left(1-\frac{x}{L}\right)$

103. The wave vertical shear forces, Q_{WV}, at each section along the length of the ship are given by the following formulae:

$Q_{WV}(+) = +\,30\,F_1 CLB\,(C_b + 0,7)$ kN for positive shear force

$Q_{WV}(-) = -\,30\,F_2 CLB\,(Cb + 0,7) \times 10^{-2}$ kN for negative shear force.

where:

F_1, F_2 = Distribution factors given in Figures F. G4.203.1 and F.H4.203.2

104. The calculation of the actual midship section modulus should be submitted to RBNA for approval.

FIGURE F. G4.203.1 – DISTRIBUTION FACTOR

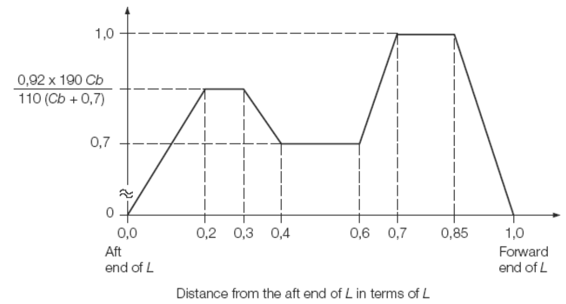


FIGURE F.G4.203.2 – DISTRIBUTION FACTOR F_2

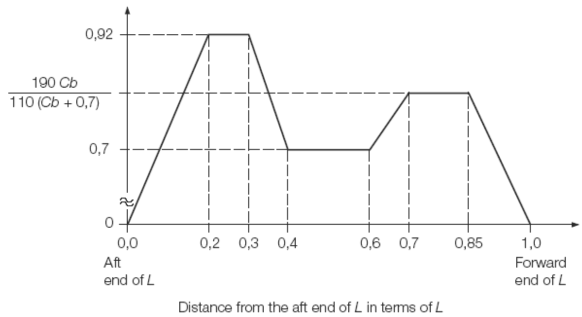


TABLE T.G4.203.1: DISTRIBUTION FACTOR *F2*

HULL TRANSVERSE SECTION LOCATION	POSITIVE WAVE SHEAR FORCE	NEGATIVE SHEAR FORCE
$0 \le x < 0{,}2L$	$2{,}5A\frac{x}{L}$	$4{,}6\frac{x}{L}$
$0{,}2L \le x < 0{,}3L$	0,95A	0,92
$0{,}3L < x < 0{,}4L$	$(0{,}92A-7)\left(0{,}4-\frac{x}{L}\right)+0{,}7$	$2{,}2\left(0{,}4-\frac{x}{L}\right)+0{,}7$
$0{,}4L \le x \le 0{,}6L$	0,7	0,7
$0{,}6L < x < 0{,}7L$	$3\left(\frac{x}{L}-0{,}6\right)+0{,}7$	$(10A-7)\left(\frac{x}{L}-0{,}6\right)+0{,}7$
$0{,}7L \le x \le 0{,}85L$	1	A
$0{,}85L < x \le L$	$6{,}67\left(1-\frac{x}{L}\right)$	$6{,}67A\left(1-\frac{x}{L}\right)$
NOTE: $A = \frac{190CB}{110(CB+0{,}7)}$		

200. Harbour condition

201. The vertical wave shear force in harbor condition at any hull transverse section is obtained, in kN, from the following formula:

$Q_{WV,P} = 0{,}4Q_{WV}$

where:

Q_{WV} is defined in G4.303

300. Horizontal wave bending moment

301. The horizontal wave bending moment at any hull transverse section, in kN.m, is given by:

$$M_{WH} = (0{,}3 + \frac{L}{2000}) M f_p C L^2 T_{LC} C_B$$

where:

M = Distribution factor given in Figure F.H4.202.1 and the Table T.G4.202.1

T_{LC} = Midship draught, in m, in the considered loading condition

302. For verification of the external pressure apply the conditions showed in the Part II, Title 1, section 2, subchapter E6.

400. Still water bending moment

401. The design still water bending moments $M_{SW,H}$ and $M_{SW,S}$ at any hull transverse section are the maximum still water bending moments calculated, in hogging and sagging conditions, respectively, at that hull transverse section for the loading conditions. Greater values may be considered if defined by the designer.

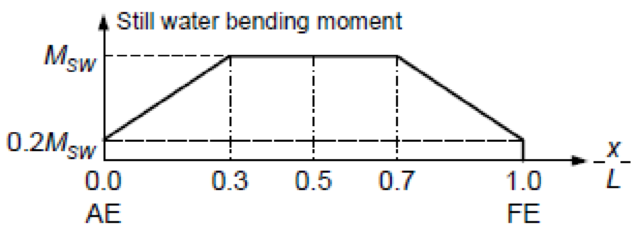
402. If the design still water bending moments are not defined, at a preliminary design stage, at any hull transverse section, the longitudinal distributions shown in Figure F.G4.403.1.may be considered.

403. FigureF.G4.403.1, *MSW* is the design still water bending moment amidships, in hogging or sagging conditions, whose values are to be taken not less than those obtained, in kN.m, from the following formulae:

$M_{SW,H} = 175 C L^2 B (C_B + 0{,}7) 10^{-3} - M_{WV,H}$, hogging conditions.

$M_{SW,S} = 175 C L^2 B (C_B + 0{,}7) 10^{-3} - M_{WV,S}$, sagging conditions.

FIGURE F.G4.403.1. – PRELIMINARY STILL WATER BENDING MOMENT DISTRIBUTION



G5. HULL GIRDER STRESSES

100. Normal stresses

101. General

102. The normal stresses in a member made in material other than steel with a Young's modulus *E* equal to 2.06 10^5 N/mm², included in the hull girder transverse sections obtained from the following formula:

$$\sigma_1 = \frac{E}{2{,}06.10^5} \sigma_{1S}$$

where:

σ_{1S}= Normal stress, in N/mm2, in the member under consideration, calculated according to G5.201 considering this member as having the steel equivalent sectional area *ASE* defined in G5.103.

103. Where a member contributing to the longitudinal strength is made in material other than steel with a Young's modulus *E* equal to 2,06 10^5 N/mm^2, the steel equivalent sectional area that may be included in the hull girder transverse sections is obtained, in m^2, from the following formula:

$$A_{SE} = \frac{E}{2{,}06.10^5} A_M$$

where:

A_M= Sectional area, in m^2, of the member under consideration.

200. Normal stresses induced by vertical bending moments

201. The normal stresses induced by vertical bending moments are obtained, in N/mm2, from the following formulae:

a. at any point of the hull transverse section, located below z_{VD}, where $z_{VD} = V_D + N$:

$$\sigma_1 = \frac{Msw + Mwv}{ZA} 10^{-3}$$

b. at the bottom:

$$\sigma_1 = \frac{Msw + Mwv}{ZAB} 10^{-3}$$

$$\sigma_1 = \frac{Msw + Mwv}{ZAD} 10^{-3}$$

where:

M_{SW} = Design still water bending moment, in kN.m, at the hull transverse section considered:

$M_{SW} = M_{SW,H}$, in hogging conditions.

$M_{SW} = M_{SW,S}$, in sagging conditions.

M_{WV} = Vertical wave bending moment, in kN.m, at the hull transverse section considered:

$M_{WV} = M_{WV,H}$, in hogging conditions.

$M_{WV} = M_{WV,S}$, in sagging conditions.

Z_A= the section modulus at any point of a hull transverse section in m³.

Z_{AB}= The section modulus at bottom and at deck, in m^3.

Z_{AD}= The section modulus at deck obtained in m^3.

where:

V_D : Vertical distance, in m, taken equal to:

$V_D = z_D - N$

where:

z_D:z co-ordinate, in m, of strength deck at side, with respect to the reference coordinate system.

202. If continuous trunks or hatch coamings are taken into account in the calculation of I_Y.

$$V_D = (Z_T - N)\left(0{,}9 + 0{,}2\frac{YT}{B}\right) \geq Z_D - N$$

where:

y_T, z_T: Y and Z co-ordinates, in m, of the top of continuous trunk or hatch coaming with respect to the reference co-ordinate system defined in y_T and z_T are to be measured for the point which maximizes the value of V_D.

If longitudinal ordinary stiffeners or girders welded above the strength deck are taken into account in the calculation of I_Y, V_D is to be obtained from the formula given above for continuous trunks and hatch coamings. In this case, y_T and z_T are the Y and Z co-ordinates, in m, of the top of the longitudinal stiffeners or girders with respect to the reference co-ordinate system defined below:

N = Vertical distance, in m, from the base line to the horizontal neutral axis of the hull transverse section.

I_Y = Moment of inertia, in m^4, of the hull transverse section about its horizontal neutral axis calculated by the following equation:

$I_{YR} = 3SM_{min.}L.\ 10^{-6}$

$SM_{min.}$= Minimum section modulus defined in Part II, Title 11, Section 2, Subchapter H2.

I_Z : Moment of inertia, in m4, of the hull transverse section about its vertical neutral defined in Part II, Title 11, Section 2, Subchapter H2.

300. Buckling strength

301. The buckling check of plating and structural members is to be in accordance with the Title 11, Section 2, taking into account the maximum compressive stress taking into account the sagging and hogging conditions, for the navigation and dreading situations.

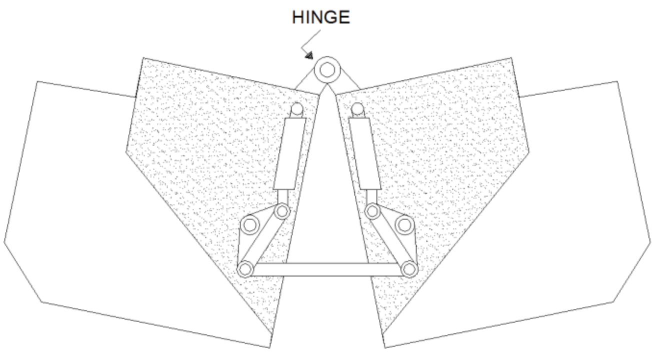
400. Hinge pins

401. The forces acting on hinges mechanisms and locking devices are to be obtained by direct calculation based in the worst load condition which can be expected in any service or condition.

402. The RBNA will require the resolution of the static and dynamic system of forces acting on the hulls taking due account of the relative locations of hinges, actuating mechanisms and locking devices for approval.

403. In general, one half of the load acting on one half of the hull may be assumed to act on the forward hinge assembly and one half on the after hinge assembly.

FIGURE F.G5.303.1 – HINGE



500. Net pressure per meter ship length

501. The net pressure per meter length resulting from the spoil pressure and the hydrostatic load take into account the wave height in a Beaufort state, is to be calculated in accordance with the following formula:

$$= (1/2\ (p\ (H - T_s)^2 - 1{,}025\ (T - T_s)^2)\ \text{tones /m})$$

where:

p = net pressure per meter ship length resulting from the spoil pressure and the hydrostatic load, figure T.501.1 taking into account the probable wave height.

H = height of spoil above base line, in meters

T_s = depth of hopper seal, in meters

FIGURE F.G5.500.1 – BEAUFORT SCALE AND PROBABLE WAVE HEIGHT

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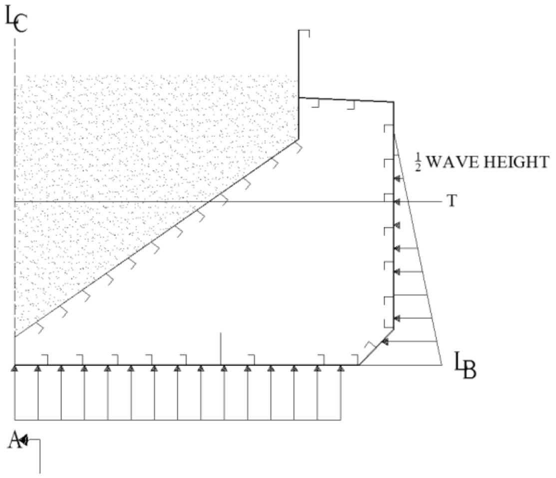

TABLE T.500.1 – BEAUFORT SCALE AND PROBABLE WAVE HEIGHT

Beaufort	Description term		Wind speeds		Wave height (m)	
number	Wind	Wave	knots	m/s	probable	maximum
0	Calm	-	< 1	0 - 0.2	-	-
1	Light air	Ripples	01/mar	0.3 - 1.5	0.1	0.1
2	Light breeze	Small wavelets	04/jun	1.6 - 3.3	0.2	0.3
3	Gentle breeze	Large wavelets	07/out	3.4 - 5.4	0.6	1
4	Moderate breeze	Small waves	nov/16	5.5 - 7.9	1	1.5
5	Fresh breeze	Moderate waves	17 - 21	8.0 - 10.7	2	2.5
6	Strong breeze	Large waves	22 - 27	10.8 - 13.8	3	4
7	Near gale	Large waves	28 - 33	13.9 - 17.1	4	5.5
8	Gale	Moderately high waves	34 - 40	17.2 - 20.7	6	7.5
9	Strong gale	High waves	41 - 47	20.8 - 24.4	7	10
10	Storm	Very high waves	48 - 55	24.5 - 28.4	9	12.5
11	Violent storm	Exceptionally high waves	56 - 63	28.5 - 32.6	11.5	16
12	Hurricane	Exceptionally high waves	64 - 71	32.7 - 36.9	14	> 16
13	Hurricane	Exceptionally high waves	72 - 80	37.0 - 41.4	> 14	> 16
14	Hurricane	Exceptionally high waves	81 - 89	41.5 - 46.1	> 14	> 16
15	Hurricane	Exceptionally high waves	90 - 99	46.2 - 50.9	> 14	> 16
16	Hurricane	Exceptionally high waves	100 - 109	51.0 - 56.0	> 14	> 16
17	Hurricane	Exceptionally high waves	109 - 118	56.1 - 61.2	> 14	> 16