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Safer and Cleaner Shipping

CSR Harmonisation

Hull girder and local prescriptive requirements

Industry Presentation

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HG and local prescriptive Rules Content

- Hull girder
  - HG strength
  - HG ultimate strength
  - HG residual strength
- Local requirements
  - Minimum thickness requirements
  - Local prescriptive requirements
  - Design load sets for local requirements
  - Ship type specific requirements, Part 2

Hull girder strength

- **Permissible HG bending and HG shear stresses**

Operation	Design Load	Permissible hull girder stress					
		σ_{perm}					τ_{perm}
		x/L ≤ 0.1	0.1 < x/L ≤ 0.3	0.3 < x/L ≤ 0.7	0.7 < x/L ≤ 0.9	x/L ≥ 0.9	
Seagoing	S+D	140/*k*	Linear interp.	190/*k*	Linear interp.	140/*k*	120/*k*
Harbour/sheltered water	S	105/*k*	Linear interp.	143/*k*	Linear interp.	105/*k*	105/k
Seagoing in flooded condition for BC-A and BC-B ships	A:S+D	140/*k*	Linear interp.	190/*k*	Linear interp.	140/*k*	120/*k*

- **Hull girder bending strength** $\sigma_L = \frac{M_{sw} + M_{wv}}{Z_{n50}} 10^{-3} \leq \sigma_{perm}$

Hull girder strength

- **Hull girder shear strength**

The positive and negative permissible vertical shear forces are to comply with the following criteria:

- For seagoing operation:

  $|Q_{sw}| \leq Q_R - |Q_{wv}|$

- For harbour/sheltered water operation:

  $|Q_{sw-p}| \leq Q_R$

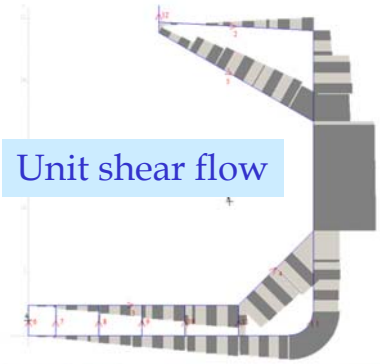
- For seagoing operation in flooded condition, for BC-A and BC-B ships:

  $|Q_{sw-f}| \leq Q_R - |Q_{wv}|$

where:

Q_R : Total vertical hull girder shear capacity, in kN

$$Q_R = \min_i \left(\frac{\tau_{i-perm} \; t_{i-n50}}{q_{vi}} \right) 10^{-3}$$



Hull girder ultimate strength

- **Scope**
  - **Assessment within the cargo area and machinery space**
- **Two methods:**
  - **Single step method: for tanker**
  - **Incremental-iterative method: for both tanker and bulk carrier**

$$M \leq \frac{M_U}{\gamma_R}$$ in hogging & sagging

γ_R : Partial safety factor

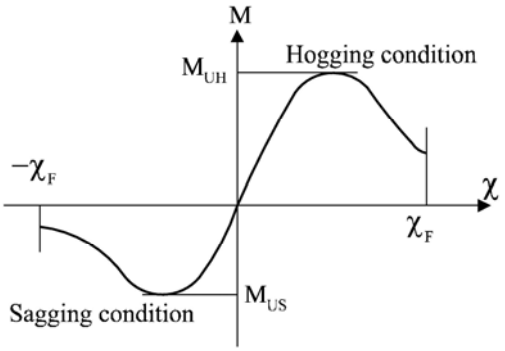
$\gamma_R = \gamma_M \gamma_{DB}$

1.1

- Hogging
  - 1.25 BCA
  - 1.10 OT, BCB, BCC
- Sagging: 1.0

$$M = \gamma_S M_{sw-U} + \gamma_W M_{wv}$$

1.0 1.2 / 1.3



Hull girder residual strength

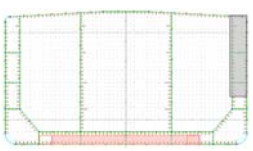
- **Scope**
  - **Assessment within the cargo area and machinery space**
  - **Damage extent for collision and grounding**

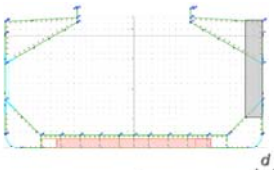
$$M = \gamma_S M_{sw-U} + \gamma_W M_{wv}$$

1.0 0.67

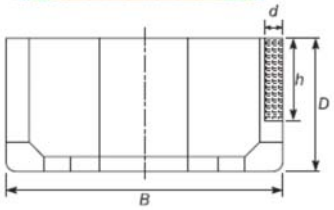
$$M \leq \frac{M_{UD}}{\gamma_R C_{NA}}$$

1.0 1.1 1.0

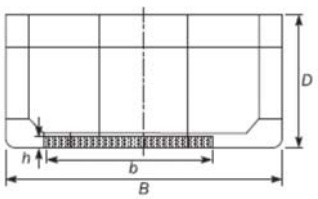




Collision	Single side	Double side
Height, h	0.75D	0.60D
Depth, d	B/16	B/16

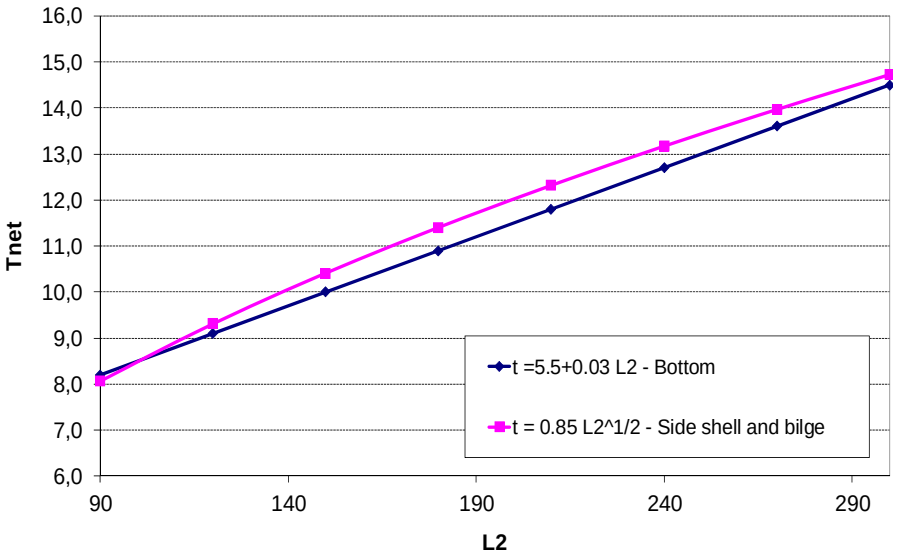


Grounding	Bulk carriers	Oil tankers
Height, h	Min (B/20, 2)	Min (B/15, 2)
Breadth, b	0.60B	0.60B



Minimum thickness

- From CSR-OT and CSR-BC
- Tables f(L) for
  - Plates
  - Stiffeners
  - Primary supporting members



$$L_2 = Min\ (L, 300)$$

Prescriptive requirements

- Prescriptive requirements defined for
  - Both ship types
  - Covering the entire ship length
  - Additional requirements for fore part, aft part and engine room in Pt1, Ch10
  - Ship type specific requirements in Pt2, Ch1 (BC) and Ch2 (OT)

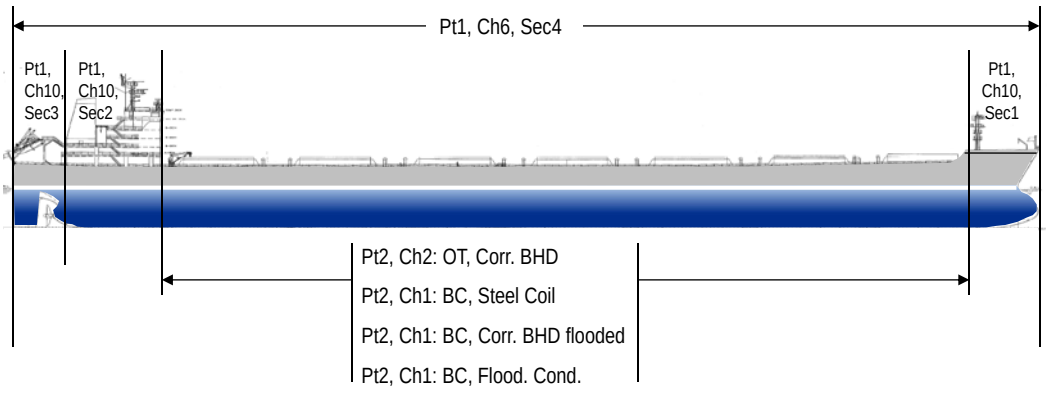


Plate strength:

$$t = 0.0158\ \alpha_p\ s \sqrt{\frac{|P|}{\chi\ C_a\ R_{eH}}}$$

Bending strength:

$$Z = \frac{|P|\ s\ \ell_{bdg}^{\ 2}}{f_{bdg}\ \chi\ C_s\ R_{eH}}$$

Shear strength:

$$t_w = \frac{f_{shr}\ |P|\ s\ \ell_{shr}}{d_{shr}\ \chi\ C_t\ \tau_{eH}}$$

Design load sets

$$t = 0.0158\,\alpha_p\, s \sqrt{\frac{|P|}{\chi\, C_a\, R_{eH}}} \qquad Z = \frac{|P|\, s\, \ell_{bdg}^{\,2}}{f_{bdg}\, \chi\, C_s\, R_{eH}}$$

$$C_{a,s} = \beta - \alpha \frac{|\sigma_{hg}|}{R_{eH}}$$

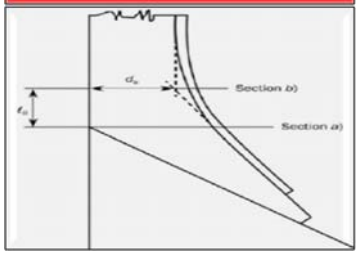
$$\sigma_{hg} = \left(\frac{M_{sw} + M_{wv-LC}}{I_{y-n50}} (z - z_{NA}) - \frac{M_{wh-LC}}{I_{z-n50}} y \right) 10^{-3}$$

Item	Design load set	Load component	Draught	Design load	Loading condition
External shell and exposed deck	SEA-1	P_{ex}	T_{SC}	S+D	Full Load condition (1)
	SEA-2	P_{ex}	T_{SC}	S	Harbour condition
Water ballast tank (oil tanker and bulk carrier)	WB-1	$P_{in} - P_{ex}$ (2)	T_{BAL}	S+D	Normal ballast condition
	WB-2	$P_{in} - P_{ex}$ (2)	T_{BAL}	S+D	Normal ballast condition Water ballast exchange
	WB-3	$P_{in} - P_{ex}$ (2)	$0.25T_{SC}$	S	Harbour/test condition

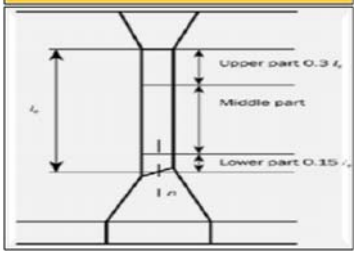
Item	Design load set	Load component	Draught	Design load	Loading condition
Water ballast tank (bulk carrier) and bulk cargo hold assigned as ballast hold	WB-4	$P_{in} - P_{ex}$ (2)	T_{BAL-H} (6)	S+D	Heavy ballast condition
	WB-5 (3)	$P_{in} - P_{ex}$ (2)	T_{BAL-H} (6)	S+D	Heavy ballast condition Water ballast exchange
	WB-6 (4)	P_{in}	-	S	Harbour/test condition
Cargo oil tank	OT-1	P_{in}	T_{SC}	S+D	Full Load condition
	OT-2	P_{in}	$0.6T_{SC}$	S+D	Partial load condition
	OT-3	P_{in}	-	S	Harbour/Test condition
Bulk cargo hold	BC-1	P_{in}	T_{SC}	S+D	Homogeneous loadingfully filled
	BC-2	P_{in}	-	S	
	BC-3	P_{in}	T_{SC}	S+D	Homogeneous heavy cargo, partially filled (BC-A, B ships)
	BC-4	P_{in}	-	S	
	BC-5	P_{in}	T_{SC}	S+D	Alternate light cargo, fully filled (BC-A ships)
	BC-6	P_{in}	-	S	
	BC-7	P_{in}	T_{SC}	S+D	Alternate heavy cargo, partially filled (BC-A ships)
	BC-8	P_{in}	-	S	
Other tanks (fuel oil tank, fresh water tank)	TK-1	$P_{in} - P_{ex}$ (2)	T_{BAL}	S+D	Normal ballast condition
	TK-2	$P_{in} - P_{ex}$ (2)	$0.25T_{SC}$	S	Harbour/test condition
Compartments not carrying liquids	FD-1 (5)	P_{in}	T_{SC}	S+D	Flooded condition
	FD-2 (5)	P_{in}	-	S	Flooded condition
Exposed deck, internal decks or platforms	DL-1 (7)	P_{dl}, F_U	T_{BAL}	S+D	Normal ballast condition
	DL-2 (7)	P_{dl}, F_U	-	S	Harbour condition

Specific requirements in Part 2

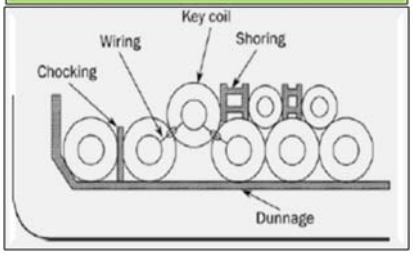
BC Side frame



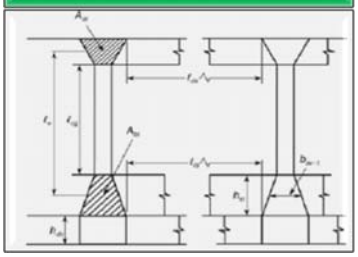
BC Corrugation



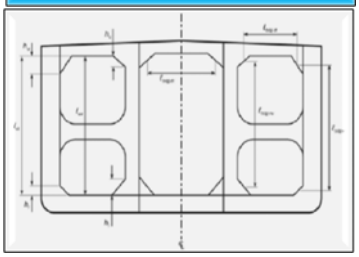
BC Steel coils



OT Corrugated Bhd.



OT PSM Prescriptive Req.



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Thank you for your attention !