CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

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Beijing

CHINA CLASSIFICATION SOCIETY

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART ONE

Brief Introduction

According to the feedback, for initial classification surveys of ships under construction shortly before delivery is to adopt different characters of classification and define the requirements for Initial classification surveys of double classed ships or dual class ships under construction.

TOFD and PAUT notations are revised.

CONTENTS

CHAPTER 2 SCOPE AND CONDITIONS OF CLASSIFICATION

Section 3 CHARACTERS OF CLASSIFICATION AND CLASS NOTATIONS

2.3.1 Characters of classification

2.3.1.3 The hull (including equipment) and machinery (including electrical installations) of a ship that are classed with CCS will be assigned one of the following characters of classification as appropriate according to different conditions:

★ CSA
★ CSM
or
★ CSA
<u>★</u> CSM
or
<u>★</u> CSA
<u>★</u> <u>CSM</u>

The meanings of the characters of classification are:

★ CSA — indicating that the ship's hull structure and equipment have been constructed with plan approval by and under the supervision of CCS and comply with CCS rules. <u>Under special circumstances, the ship's hull structure and equipment have been found upon classification survey by CCS to be in compliance with rules which is at least as effective as that required in CCS rules shortly before delivery of the ship, ★ is replaced by ★̄ ;</u>

<u>★</u> CSA — indicating that the ship's hull structure and equipment have been constructed not with plan approval by and not under the supervision of CCS, and that they have been found upon classification survey by CCS to be in compliance with CCS rules;

★ CSM — indicating that the ship's propulsion and essential auxiliary machinery have been inspected by CCS, and that its machinery and electrical installations have been constructed with plan approval by and under the supervision of CCS and comply with CCS rules. <u>Under special circumstances, the ship's machinery (including electrical installations) have been found upon classification survey by CCS to be in compliance with rules which is at least as effective as that required in CCS rules shortly before delivery of the ship, ★ is replaced by ★̄ ;</u>

<u>★</u> CSM — indicating that the ship's propulsion and essential auxiliary machinery have not been inspected by CCS, and that its machinery and electrical installations have been constructed with plan approval by and under the supervision of CCS and comply with CCS rules;

<u>★</u> <u>CSM</u> — indicating that the ship's machinery and electrical installations have been

constructed not with plan approval by and not under the supervision of CCS, and that they have been found upon classification survey by CCS to be in compliance with CCS rules.

Appendix 1 LIST OF CLASS NOTATIONS FOR SEA-GOING SHIPS

Special Survey Notations **Table H**

Class notation	Description		Technical requirements
~~ANDT (T)~~ TOFD(20%/40%/70%)	Time of flight diffraction (TOFD)	When the following welds are tested by TOFD, if the testing percentage complies with the following requirements, the corresponding notations may be assigned upon application by the ship owner. TOFD(20%): the percentage of welds inspected by TOFD is more than 20%. TOFD(40%): the percentage of welds inspected by TOFD is more than 40%. TOFD(70%): the percentage of welds inspected by TOFD is more than 70%. Survey extent of container ships: all block-to-block butt joints of all upper flange longitudinal structural members in the cargo hold region (thickness≥35 mm), including the topmost strakes of the inner hull/bulkhead, the sheer strake, main deck, coaming plate, coaming top plate, and all attached longitudinal stiffeners. Survey extent of ore carriers: butt welds of the main deck in the cargo area (thickness≥35 mm). Survey extent of LNG and LPG carriers: full penetration welds of integral tanks or independent	Guidelines for the Application of Time-of-Flight Diffraction (TOFD) and Phased Array Ultrasonic Testing (PAUT) Techniques

Class notation	Description		Technical requirements
		tanks, excluding membrane tanks weld and fillet weld.	
~~ANDT (P)~~ PAUT(20%/40%/70%)	Phased array ultrasonic testing (PAUT)	When the following welds are tested by PAUT, if the testing percentage complies with the following requirements, the corresponding notations may be assigned upon application by the ship owner. PAUT(20%): the percentage of welds inspected by PAUT is more than 20%. PAUT(40%): the percentage of welds inspected by PAUT is more than 40%. PAUT (70%): the percentage of welds inspected by PAUT is more than 70%. Survey extent of container ships: all block-to-block butt joints of all upper flange longitudinal structural members in the cargo hold region (thickness≥35 mm), including the topmost strakes of the inner hull/bulkhead, the sheer strake, main deck, coaming plate, coaming top plate, and all attached longitudinal stiffeners. Survey extent of ore carriers: butt welds of the main deck in the cargo area (thickness≥35 mm); full penetration welds between the longitudinal bulkhead and inner bottom plating; full penetration weld connections between lower stool and the inner bottom plating; full penetration weld connections between the lower stool slope plate and lower stool	Guidelines for the Application of Time-of-Flight Diffraction (TOFD) and Phased Array Ultrasonic Testing (PAUT) Techniques

Class notation	**Description**		**Technical requirements**
		shelf plate; full penetration weld connections between the lower stool shelf plate and transverse bulkhead. Survey extent of LNG and LPG carriers: full penetration welds of integral tanks or independent tanks, excluding membrane tanks.	
~~ANDT (TP)~~ TOFD/PAUT(20%/40%/70%)	Joint use of time-of-flight diffraction (TOFD) Technique and phased array ultrasonic testing (PAUT)	When the following welds are tested by TOFD/PAUT, if the testing percentage complies with the following requirements, the corresponding notations may be assigned upon application by the ship owner. TOFD/PAUT(20%): the percentage of welds inspected by TOFD/PAUT is more than 20%. TOFD/PAUT(40%): the percentage of welds inspected by TOFD/PAUT is more than 40%. TOFD/PAUT (70%): the percentage of welds inspected by TOFD/PAUT is more than 70%. Survey extent of container ships: all block-to-block butt joints of all upper flange longitudinal structural members in the cargo hold region (thickness≥35 mm), including the topmost strakes of the inner hull/bulkhead, the sheer strake, main deck, coaming plate, coaming top plate, and all attached longitudinal stiffeners. See the figure below.	Guidelines for Combined Inspection of Time-of-Flight Diffraction (TOFD) Technique and Phased Array Ultrasonic Testing (PAUT) for Marine Thick Plate Weld Joints

Class notation	Description		Technical requirements
		Survey extent of ore carriers: butt welds of the main deck in the cargo area (thickness≥35 mm). Survey extent of LNG and LPG carriers: full penetration welds of integral tanks or independent tanks, excluding membrane tanks weld and fillet weld.	

CHAPTER 3 INSPECTIONS OF PRODUCTS

Appendix 2B
LIST OF CERTIFICATION REQUIREMENTS FOR STATUTORY MARINE PRODUCT PARTS

The existing No.4.21, 4.22, 4.23 are renumbered as 4.23, 4.21, 4.22 accordingly.

CHAPTER 4 SURVEYS DURING CONSTRUCTION

Section 3 TESTING PROCEDURES OF WATERTIGHT COMPARTMENTS

The existing No.11.1 in Table 1, "See 4.4.3 through 4.4.6, as applicable" is replaced by "See 4.4.3 through 4.4.6, as applicable[7]".

CHAPTER 5 SURVEYS AFTER CONSTRUCTION

Section 14 INITIAL CLASSIFICATION SURVEYS OF SHIPS CONSTRUCTED NOT UNDER THE SUPERVISION OF CCS

5.14.2 Initial classification surveys of ships under construction

5.14.2.3 Requirements for double classed ships or dual class ships:

(1) for double classed ships, the scope of survey is to be in accordance with 5.14.2.1 or 5.14.2.2;

(2) for dual class ships, the scope of survey is to be in accordance with the written agreement between two Societies. If the ship applies for the dual class before the date of launching, the scope of survey is to be in accordance with 5.14.2.1 or 5.14.2.2.

CHINA CLASSIFICATION SOCIETY

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART NINE

CONTENTS

Chapter1 RULE GENERAL PRINCIPLES

Section 2 RULE PRINCIPLES

5.3.2 Design loads for SLS, ULS and ALS

The structural assessment of compartment boundaries, e.g. bulkheads, is based on loading condition deemed relevant for the type of ship and the operation the ship is intended for.

To provide consistency of approach, standardised Rule values for parameters, such as GM, R_{roll}, T_{sc} and C_B are applied to calculate the Rule load values.

The probability level of the dynamic global, local and impact loads (see Table 1) is 10^{-8} and is derived using the long-term statistical approach.

The probability level of the sloshing loads (see Table 1) is 10^{-4}.

The design load scenarios for structural verification apply the applicable simultaneously acting local and global load components. The relevant design load scenarios are given in Ch 4, Sec 7.

The simultaneously occurring dynamic loads are specified by applying a dynamic load combination factor to the dynamic load values given in Ch 4. The dynamic load combination factors that define the dynamic load cases are given in Ch 4, Sec 2.

Design load conditions for the hull girder ultimate strength are given in Ch 5, Sec 2.

Table 1: Load scenarios and corresponding rule requirements

Operation	Load type	Design load scenario ~~(specified in Ch 4, Sec 7)~~	Acceptance criteria ~~(specified in Ch 6 and Ch 7)~~
Seagoing operations			
Transit	Static and dynamic loads in heavy weather	S + D	AC-SD
	Impact loads in heavy weather	Impact (I)	AC-I
	Internal sloshing loads	Sloshing (SL)	AC-S
	Cyclic wave loads	Fatigue (F)	-
BWE by flow through or sequential methods	Static and dynamic loads in heavy weather	S + D	AC-SD
Harbour and sheltered operations			
Loading, unloading and ballasting	Typical maximum loads during loading, unloading and ballasting operations	S	AC-S
Tank testing	Typical maximum loads during tank testing operations	S	AC-S
Special conditions in harbour	Typical maximum loads during special operations in harbour, e.g. propeller inspection afloat or dry-docking loading conditions	S	AC-S
Accidental condition			
Flooded conditions	Typically maximum loads on internal watertight subdivision structure in accidental flooded conditions	A	AC-SD AC-S

Section 5 LOADING MANUAL AND LOADING INSTRUMENTS

2.3.2

The loading manual is to describe:

- Envelope results and permissible limits of still water bending moments and shear forces in the ~~hold~~ flooded conditions according to Ch 4, Sec 4,

• The cargo hold(s) or combination of cargo holds that might be empty at full draught. If no cargo hold is allowed to be empty at full draught, this is to be clearly stated in the loading manual,
• Maximum allowable and minimum required mass of cargo and double bottom contents of each hold as a function of the draught at mid-hold position as defined in Ch 4, Sec 8, [4.3],
• Maximum allowable and minimum required mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds. This mean draught may be calculated by averaging the draught of the two mid-hold positions as defined in Ch 4, Sec 8, [4.3],
• Maximum allowable tank top loading together with specification of the nature of the cargo for cargoes other than bulk cargoes,
• Maximum allowable load on deck and hatch covers. If the ship is not approved to carry load on deck or hatch covers, this is to be clearly stated in the loading manual,
• Maximum rate of ballast change together with the advice that a load plan is to be agreed with the terminal on the basis of the achievable rates of change of ballast.

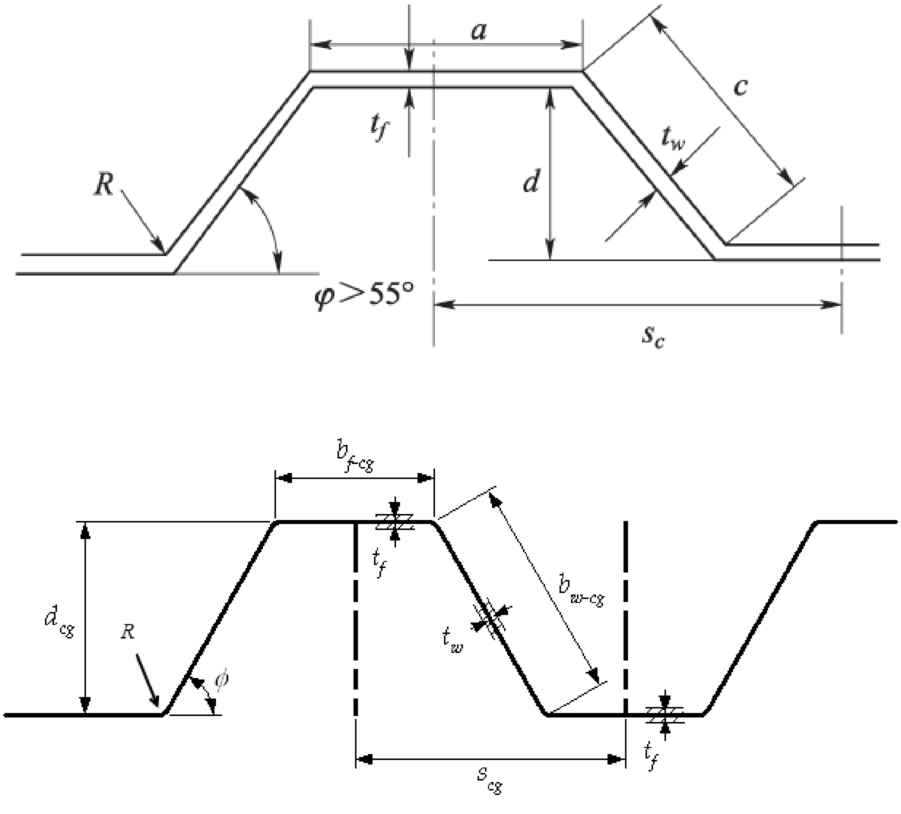
Chapter 3 STRUCTURAL DESIGN PRINCIPLES

Section 6 STRUCTURAL DETAIL PRINCIPLES

10.4.2 Construction

The main dimensions ~~a~~b_{f-cg}, R, ~~c~~b_{w-cg}, ~~d~~d_{cg}, t_f, t_w, ~~s_c~~s_{cg} of corrugated bulkheads are defined in Figure 21.
The corrugation angle φ is not to be less than 55°.
When welds in a direction parallel to the bend axis are provided in the zone of the bend, the welding procedures are to be submitted to the Society for approval.

Figure 21 : Dimensions of a corrugated bulkhead



10.4.3 Corrugated bulkhead depth

The depth of the corrugation, ~~d~~d_{cg}, in mm, is not to be less than:

$$d = \frac{1000 l_c}{C}$$

$$d_{cg} = \frac{1000 l_c}{C}$$

where:

l_c: Mean span of considered corrugation, in m, as defined in [10.4.5].

C: Coefficient to be taken as:

$C = 15$ for tank and water ballast cargo hold bulkheads.

$C = 18$ for dry cargo hold bulkheads.

10.4.4 Actual section modulus of corrugations

The net section modulus of a corrugation may be obtained, in cm^3, from the following formula:

$$Z = \left[\frac{d(3at_f + ct_w)}{6} \right] 10^{-3}$$

$$Z = \left[\frac{d_{cg}\left(3b_{f-cg}t_f + b_{w-cg}t_w\right)}{6} \right] 10^{-3}$$

where:

t_f, t_w: Net thickness of the plating of the corrugation, in mm, shown in Figure 21.

~~d~~d_{cg}, ~~a~~$b_{f\text{-}cg}$, ~~c~~$b_{w\text{-}cg}$: Dimensions of the corrugation, in mm, shown in Figure 21.

Where the web continuity is not ensured at ends of the bulkhead, the net section modulus of a corrugation is to be obtained, in cm^3, from the following formula:

$$Z = 0.5at_f d10^{-3}$$

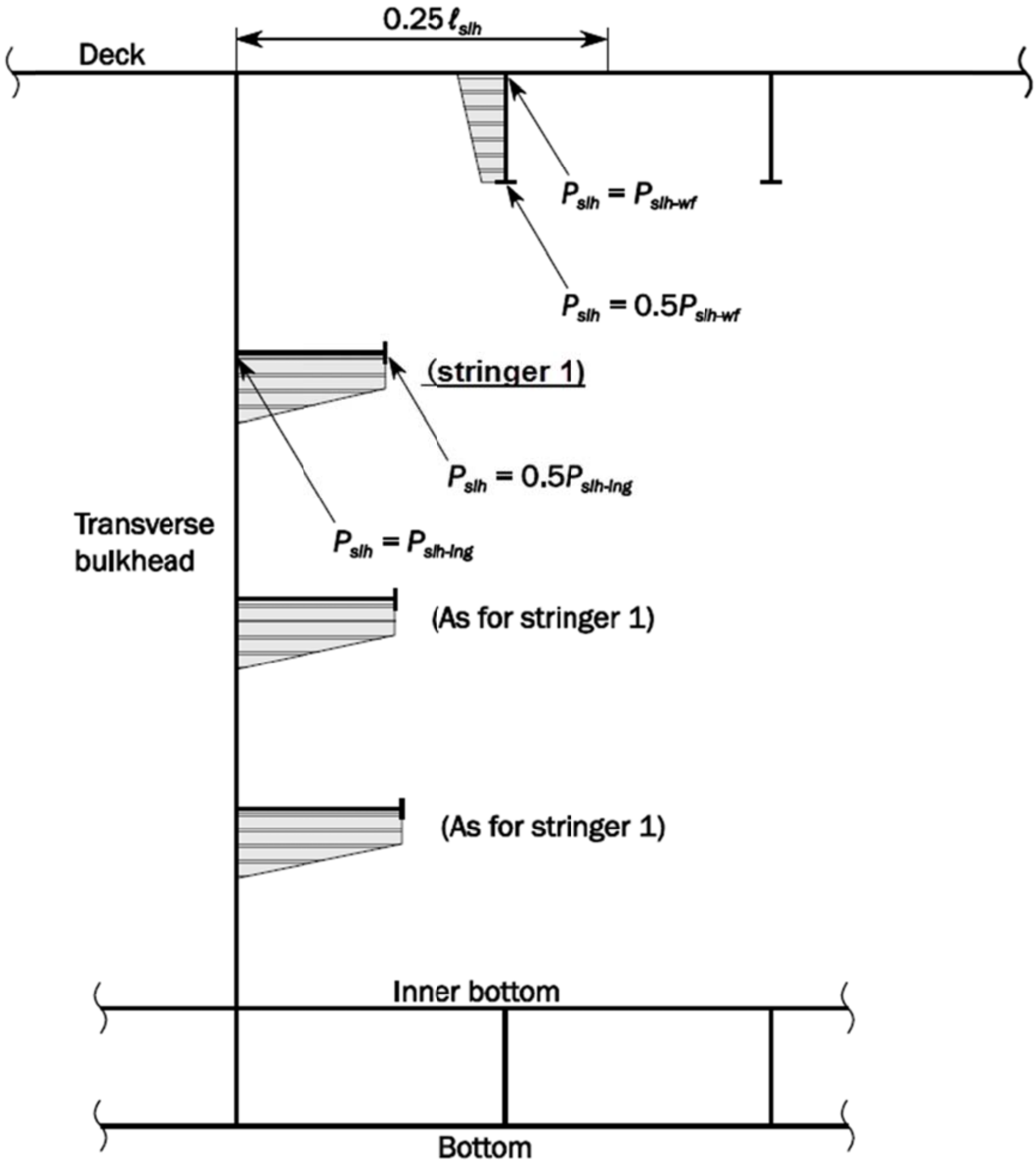
$$Z = 0.5b_{f-cg}t_f d_{cg} 10^{-3}$$

Chapter 4 LOADS

Section 6 INTERNAL LOADS

6.3.4 Sloshing pressure on internal web frames or transverse stringers adjacent to a transverse bulkhead

Figure 13 : Sloshing pressure distribution on transverse stringers and web frames



6.4.3 Sloshing pressure in way of longitudinal bulkheads

The sloshing pressure in way of longitudinal bulkheads including wash bulkheads due to transverse liquid motion, $P_{slh\text{-}t}$, in kN/m^2, for a particular filling level, is to be taken as:

$$P_{slh-t} = 7\rho_{slh} g f_{slh}\left(\frac{b_{slh}}{B} - 0.3\right) GM^{0.75}$$

where:

b_{slh} : Effective sloshing breadth defined in [6.4.2].

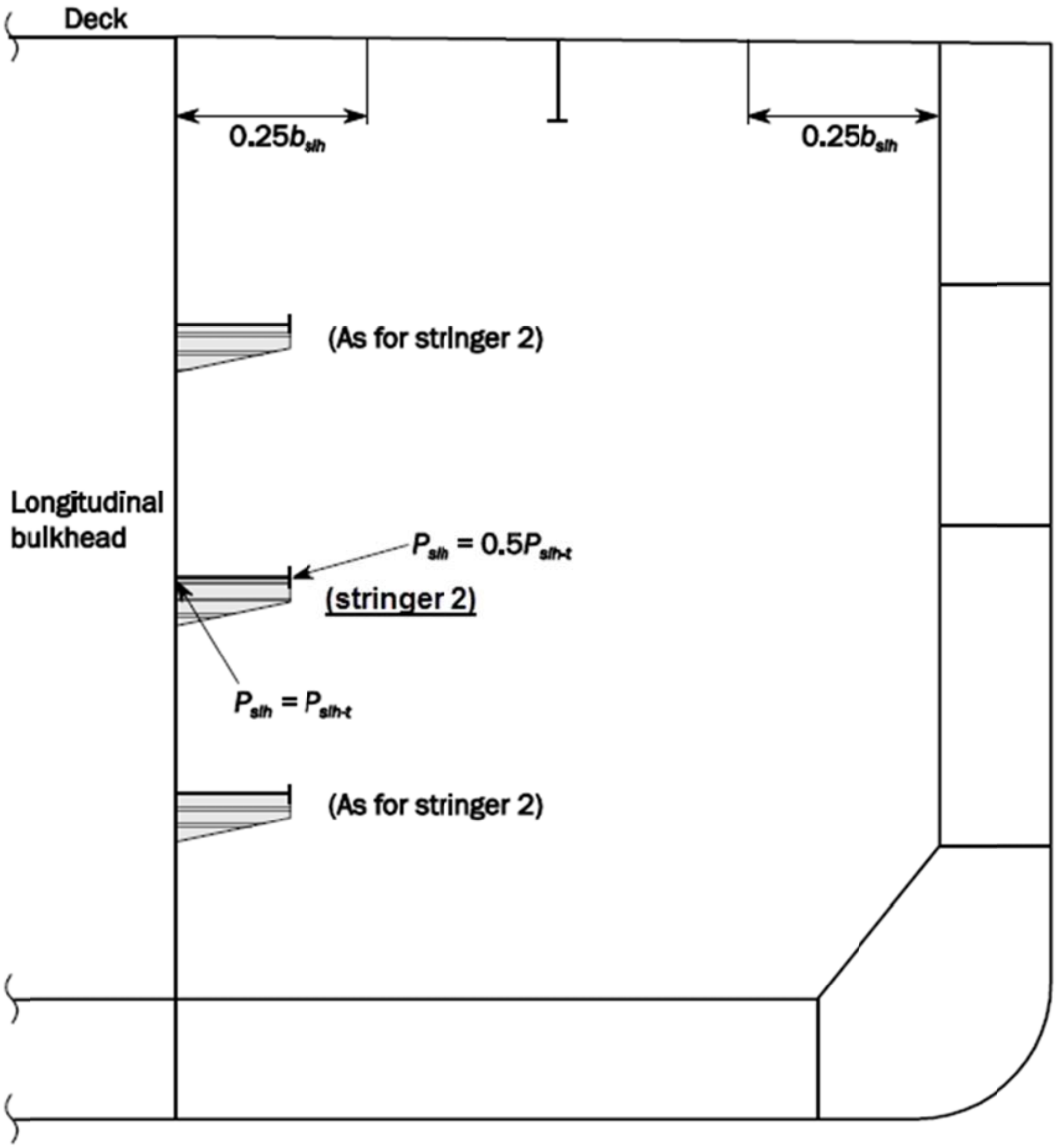
GM : Metacentric height, given in Ch 4, Sec 3, [2.1.1].

For the calculation of sloshing pressure in ballast tanks the ‘ballast condition’ is to be used for oil tankers and the ‘normal ballast condition’ for bulk carriers.

For the calculations of sloshing pressure in cargo tanks of oil tankers, the ‘partial load condition’ is to be used.

f_{slh} : Coefficient defined in [6.3.3].

Figure 14 : Sloshing pressure distribution on longitudinal stringers and girders



7 DESIGN PRESSURE FOR TANK TESTING

7.1 Definition

7.1.1

The actual strength testing is to be carried out in accordance with Ch 1, Sec 2, [3.8.4]. In order to assess the structure, static design pressures are to be applied.

The design pressure for tank testing, P_{ST}, in kN/m^2, is to be taken as:

$$P_{ST} = 10(z_{ST} - z)$$

where:

z_{ST}: Design testing load height, in m, as defined in Table 13.

Table 13 : Design testing load height z_{ST}

Compartment	z_{ST}
Hopper side tanks, topside tanks, double side tanks, fore and aft peaks used as tank, ~~cofferdams~~	The greater of the following: $z_{ST} = z_{top} + h_{air}$ $z_{ST} = z_{top} + 2.4$

(partial table shown only)

Section 8 LOADINGCONDITIONS

3.1.1 Seagoing conditions

The following seagoing loading conditions are to be included, as a minimum, in the loading manual:

a) Heavy ballast condition where the ballast tanks may be full, partially full or empty. Where ballast tanks are partially full, the conditions in [2.2.1] are to be complied with. The fore peak water ballast tank is to be full, if fitted. If upper and lower fore peak tanks are fitted, the lower is required to be full and the upper tank may be full, partially full or empty. All the cargo tanks are to be empty including cargo tanks suitable for the carriage of water ballast at sea. The draught at the forward perpendicular is not to be less than that for the normal ballast condition. The propeller is to be fully immersed. The trim is to be by the stern and is not to exceed 0.015 ~~L~~ L_{LL}.

4.1.1 Seagoing conditions

The following seagoing loading conditions are to be included, as a minimum, in the loading manual:

a) Cargo loading conditions as defined in [4.1.2] to [4.1.4].

b) Heavy ballast condition where the ballast tanks may be full, partially full or empty. Where ballast tanks are partially full, the conditions in [2.2.1] are to be complied with. The propeller immersion I/D_P is to be at least 60%. The trim is to be by the stern and is not to exceed 0.015 ~~L~~ L_{LL}. The moulded forward draught is not to be taken less than the smaller of 0.03 L or 8 m.

Chapter 5 HULL GIRDER STRENGTH

Section 1 HULL GIRDER YIELDING STRENGTH

3.4.4 Shear force correction for a ship with two longitudinal bulkheads between the cargo tanks

…

A_{1-n50}, A_{2-n50}, A_{3-n50} : Net areas, as defined in ~~Table 5~~ Table 7, in m^2.

f_3 : Shear force distribution factor, as defined in Table ~~5~~7.

3.5 Effective net thickness for longitudinal bulkheads between cargo tanks of oil tankers - Correction due to loads from transverse bulkhead stringers

3.5.1

In way of transverse bulkhead stringer connections, within areas as specified in ~~Figure 7~~ Figure 8, the equivalent net thickness of plate, $t_{sti\text{-}k\text{-}n50}$ in mm, where the index k refers to the identification number of the stringer, is not to be taken greater than:

Appendix 1 DIRECT CALCULATION OF SHEAR FLOW

1.2.2

Assuming the cross section is composed of line segments as shown in Figure 1, the determinate shear flow can be calculated by the following equation.

$$q_{Dk} = q_D(\ell) = -\frac{t_{n50}\ell}{2\times 10^6 I_{y-n50}}\left(z_k + z_i - 2z_n\right) + q_{Di}$$

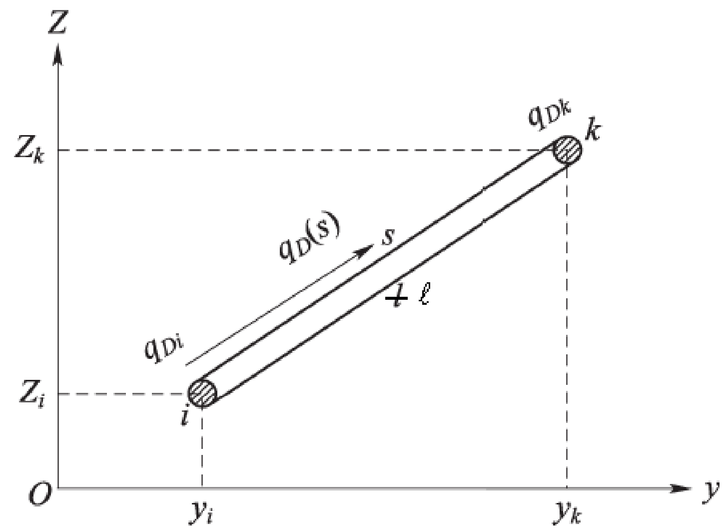
where:

q_{Dk}, q_{Di} : Determinate shear flow at node k and node i respectively, in N/mm.

ℓ : Length of line segments, in m.

z_k, z_i : Z coordinate of the end point of line segment, in m, as defined in Figure 1.

Figure 1: Definition of line segment



Appendix2 HULL GIRDER ULTIMATE CAPACITY

SYMBOLS

For symbols not defined in this article, refer to Ch 1, Sec 4.

$I_{y\text{-}n50}$: Moment of inertia, in m^4, of the hull transverse section around its horizontal neutral axis, to be calculated according to Ch 5, Sec 1.

$Z_{B\text{-}n50}$, $Z_{D\text{-}n50}$: Section moduli, in m^3, at bottom and deck, respectively, defined in Ch 5, Sec 1.

R_{eHs} : Minimum yield stress, in N/mm^2, of the material of the considered stiffener.

R_{eHp} : Minimum yield stress, in N/mm^2, of the material of the considered plate.

$A_{s\text{-}n50}$: Net sectional area, in cm^2, of stiffener, without attached plating.

$A_{p\text{-}n50}$: Net sectional area, in cm^2, of attached plating.

z_i : z coordinate, in m, of centre of gravity of the i^{th} element.

Chapter 7 DIRECT STRENGTH ANALYSIS

Section 2 CARGO HOLD STRUCTURAL STRENGTH ANALYSIS

4.4.8 Procedure to adjust vertical and horizontal bending moments for midship cargo hold region

$M_{lineload}$: Vertical bending moment, in kNm, at position x, due to application of vertical line loads at frames according to method 2, to be taken as:

$$M_{lineload} = -(x - x_{aft})F - \sum_i (x - x_i)\delta w_i \text{ when } x_i < x$$

F : Reaction force, in kN, at model ends due to application of vertical loads to frames as defined in Table 7.

x : X-coordinate, in m, of frame in way of the mid-hold.

w_i : vertical load, in kN, at web frame station i applied to generate required shear force.

$\delta w_i = -\delta w_1$ when frame i is within after hold

$\delta w_i = \delta w_2$ when frame i is within mid-hold

$\delta w_i = -\delta w_3$ when frame i is within forward hold

In case the target horizontal bending moment needs to be reached, an additional horizontal bending moment is to be applied at the ends of the cargo tank FE model to generate this target value within the mid-hold. The additional horizontal bending moment is to be taken as:

…

4.5.2 Torsional moment due to local loads

Torsional moment, in kNm, at longitudinal station i due to local loads, $M_{T\text{-}FEMi}$, in kNm, is determined by the following formula (see Figure 20):

$$M_{T-FEMi} = \sum_k [f_{hik}(z_{ik} - z_r)] - \sum_k (f_{vik} y_{ik})$$

where:

$M_{T\text{-}FEMi}$: Lumped torsional moment, in kNm, due to local load at longitudinal station i.

z_r: Vertical coordinate of torsional reference point, in m:

For bulk carrier, $z_r = 0$.

For oil tanker, $z_r = z_{SC}$, shear centre at the middle of the mid-hold.

f_{hik}: Horizontal nodal force, in kN, of node k at longitudinal station i.

f_{vik}: Vertical nodal force, in kN, of node k at longitudinal station i.

y_{ik}: Y-coordinate, in m, of node k at longitudinal station i.

z_{ik}: Z-coordinate, in m, of node k at longitudinal station i.

$M_{T\text{-}FEM0}$: Lumped torsional moment, in kNm, due to local load at aft end of the FE model (forward end for foremost cargo hold model), taken as:

~~$M_{T-FEM0} = \sum_k [f_{h0k}(z_{0k} - z_r)] - \sum_k (f_{v0k} y_{0k}) + R_{H\_fwd} \cdot (z_{ind} - z_r)$~~

~~for foremost cargo hold model~~

$$M_{T-FEM0} = -\sum_k [f_{h0k}(z_{0k} - z_r)] + \sum_k (f_{v0k} y_{0k}) + R_{H\_fwd} \cdot (z_{ind} - z_r)$$

for foremost cargo hold model

$$M_{T-FEMO} = \sum_k [f_{h0k}(z_{0k} - z_r)] - \sum_k (f_{v0k} y_{0k}) + R_{H_{aft}} \cdot (z_{ind} - z_r)$$

for the other cargo hold models

R_{H_fwd}: Horizontal reaction forces, in kN, at the forward end, as defined in [4.4.3].

R_{H_aft}: Horizontal reaction forces, in kN, at the aft end, as defined in [4.4.3].

z_{ind}: Vertical coordinate, in m, of independent point as defined in [2.5.3].

CHAPTER 8 BUCKLING

Section 2 SLENDERNESS REQUIREMENTS

5.3.1 Edge reinforcements of bracket edges

The depth of stiffener web, h_W in mm, of edge stiffeners in way of bracket edges is not to be less than:

~~$h_w = C\ell_b \sqrt{\frac{R_{eH}}{235}}$~~ $h_w = C\ell_b / 1000 \sqrt{\frac{R_{eH}}{235}}$ or 50 mm, whichever is greater.

where:

C: Slenderness coefficient taken as:

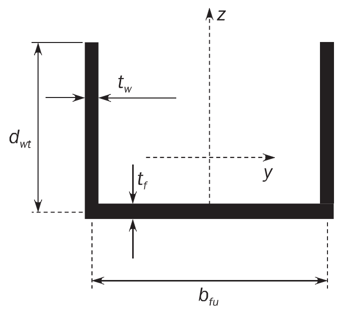
- C = 75 for end brackets.
- C = 50 for tripping brackets.

R_{eH}: Specified minimum yield stress of the stiffener material, in N/mm^2.

Section 5 BUCKLING CAPACITY

3.1.3 Elastic torsional buckling stress

Table 7: Cross sectional properties

	~~$I_{sv-net50} = \frac{1}{3}(b_{fu} t_f^3 + 2 d_{wt} t_w^3) 10^{-4}$~~ $I_{sv} = \frac{1}{3}(b_{fu} t_f^3 + 2 d_{wt} t_w^3) 10^{-4}$	cm^4
	$y_0 = 0$	cm
	$z_0 = -\frac{d_{wt}^2 \, t_w 10^{-1}}{2 d_{wt} \, t_w + b_f \, t_f} - \frac{0.5 \, d_{wt}^2 \, t_w 10^{-1}}{d_{wt} \, t_w + b_{fu} \, t_f / 6}$	cm
	$c_{warp} = \frac{b_{fu}^2 d_{wt}^3 t_w \left(3 d_{wt} t_w + 2 b_{fu} t_f\right)}{12\left(6 d_{wt} t_w + b_{fu} t_f\right)} 10^{-6}$	cm^6

Chapter 9 FATIGUE

Section 1 GENERAL CONSIDERATIONS

6.3.1

The loading conditions to be considered for bulk carriers and corresponding fraction of time for each loading condition, $\alpha_{(j)}$, are defined respectively in Table 2 and Table 3 depending on the ship's type (BC-A, BC-B, BC-C). The standard loading conditions for fatigue assessment of bulk carriers are provided in Ch 4, Sec 8, [5.2].

Table 3 : Fraction of time for each loading condition of bulk carriers

Ship length	Loading conditions	$\alpha_{(j)}$	
		BC-A	BC-B, BC-C
$L < 200$ m	Homogeneous	0.60	0.70
	Alternate	0.10	-
	Normal ballast(1)	0.15	0.05
	Heavy ballast(1)	0.15	0.25
$L \geq 200$ m	Homogeneous	0.25	0.50
	Alternate	0.25	-
	Normal ballast	0.20	0.20
	Heavy ballast	0.30	0.30

(1) For BC-B and BC-C without heavy ballast cargo hold, fraction of time $\alpha_{(j)}$ for normal ballast is ~~30%~~ 0.30 and for heavy ballast 0~~%~~.

Section 3 FATIGUE EVALUATION

3.2 Mean stress effect

3.2.1 Correction factor for mean stress effect

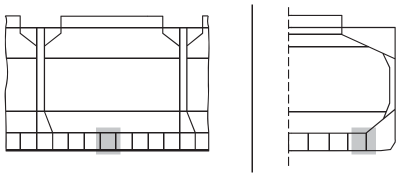
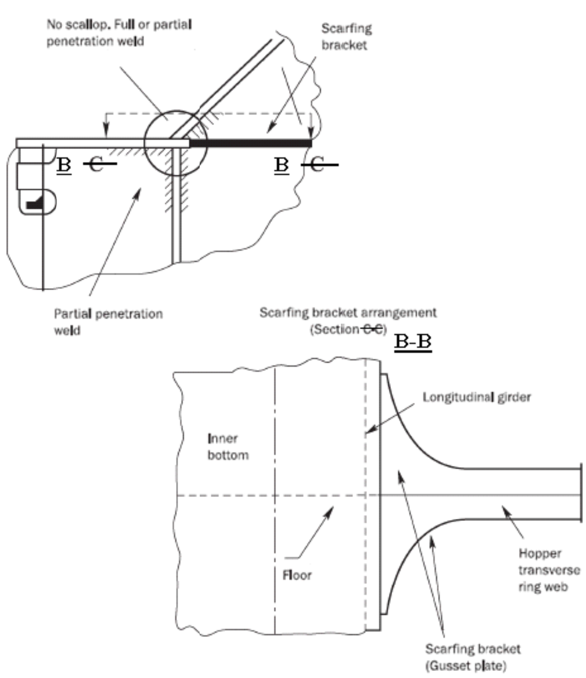
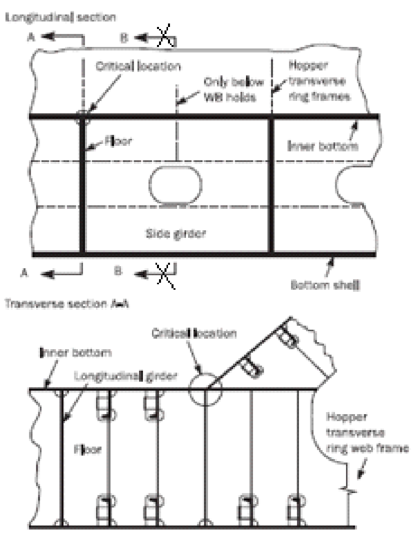
$\sigma_{mean,\ i(j)}$: Fatigue mean stress, in N/mm^2, for base material calculated according to [3.2.2] or welded joint calculated according to ~~[3.2.2]~~ [3.2.3] or [3.2.4] as applicable.

Section 6 DETAIL DESIGN STANDARD

4.1.6

Table 5: Design standard E – hopper knuckle connection detail, welded, bulk carrier

Connections of floors in double bottom tanks to hopper tanks Welded knuckle connection of hopper tank sloping plating to inner bottom plating

<table>
<tr><th>Critical areas</th><th>Design standard E</th></tr>
<tr><td></td><td rowspan="3">a) Improvement at the knuckles

</td></tr>
<tr><td>Critical locations</td></tr>
<tr><td>
</td></tr>
</table>

Chapter 10 OTHER STRUCTURES

Section 1 FORE PART

2.1.2 Bottom girders

A supporting structure is to be provided at the centreline either by extending the centreline girder to the stem or by providing a deep girder or centreline bulkhead.

Where a centreline girder is fitted, the minimum depth and thickness is not to be less than that required for the depth of the double bottom in the neighbouring cargo ~~tank~~ hold region, and the upper edge is to be stiffened.

In case of transverse framing, the spacing of bottom girders is not to exceed 2.5 m.

In case of longitudinal framing, the spacing of bottom girders is not to exceed 3.5 m.

3.2.7 Primary supporting members

b) Simplified calculation of slamming shear force

For simple arrangements of primary supporting members, where the grillage ~~affect~~ effect may be ignored, the shear force, Q_{SL}, in kN, is given by

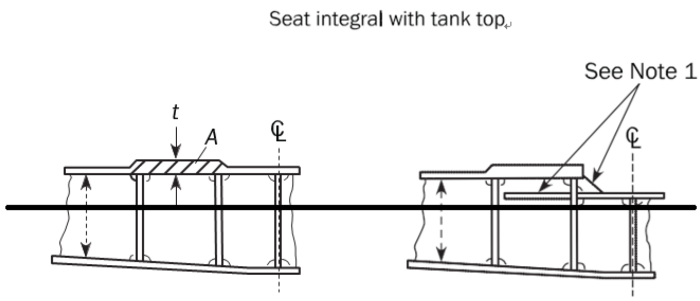
$$Q_{SL} = f_{pt} f_{dist} F_{SL}$$

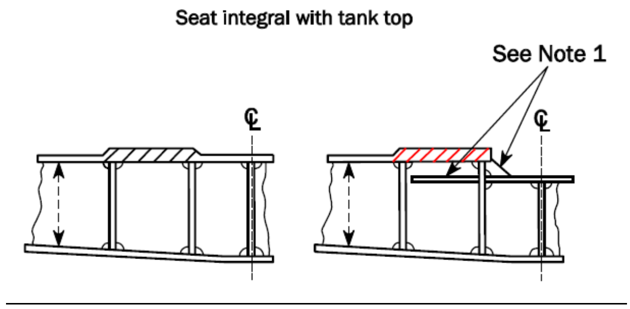
Section 2 MACHINERY SPACE

3.1.2

In the case of higher power internal combustion engines or turbine installations, the foundations are generally to be integral with the double bottom structure. Consideration is to be given to substantially increase the inner bottom plating thickness in way of the engine foundation plate or the turbine gear case and the thrust bearing, see Type 1 of Figure 1.

Figure 1: Machinery foundations Type 1





Section 3 AFT PART

3.1.2

Cast steel and fabricated stern frames are to be strengthened by adequately spaced plates with gross thickness not less than 80% of required thickness for stern frames, t_1, as defined in Table 1 or Table 2. Abrupt changes of section are to be avoided in castings; all sections are to have adequate tapering radius.

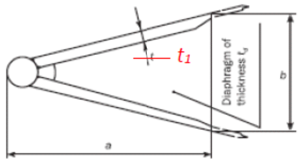
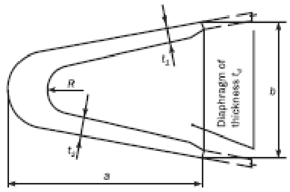
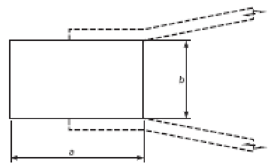
3.2 Propeller posts

3.2.1 Gross scantlings of propeller posts

The gross scantlings of propeller posts are not to be less than those obtained from the formulae in Table 1 for single screw ships and Table 2 for twin screw ships.

Scantlings and proportions of the propeller post which differ from those above may be considered acceptable provided that the section modulus of the propeller post section about its longitudinal axis is not less than that calculated with the propeller post scantlings in Table 1 or Table 2, as applicable.

Table 1: Single screw ships - Gross scantlings of propeller posts

Gross scantlings of propeller posts, in mm	Fabricated propeller post 	Cast propeller post 	Bar propeller post, cast or forged, having rectangular section 
a	$50\ L_1^{1/2}$	$33\ L_1^{1/2}$	$10\sqrt{7.2L-256}$
b	$35\ L_1^{1/2}$	$23\ L_1^{1/2}$	$10\sqrt{4.6L-164}$
t_1	$2.5\ L_1^{1/2}$	$3.2\ L_1^{1/2}$	-
t_2	-	$4.4\ L_1^{1/2}$	-
t_d	$1.3\ L_1^{1/2}$	$2.0\ L_1^{1/2}$	-
R	-	50mm	-

3.3 Connections

3.3.4 Connection with centre ~~keelson~~ girder

Where the stern frame is made of cast steel, the lower part of the stern frame is to be fitted, as far as practicable, with a longitudinal web for connection with the centre ~~keelson~~ girder.

Section 4 TANKS SUBJECT TO SLOSHING

1 GENERAL

1.3 Application of sloshing pressure

1.3.5 Application of design sloshing pressure due to transverse liquid motion

The design sloshing pressure due to transverse liquid motion, ~~P_{shl-t}~~ P_{slh-t}, as defined in Ch 4, Sec 6, [6.4.3], is to be applied to the following members as shown in Figure 2.

Chapter 12 CONSTRUCTION

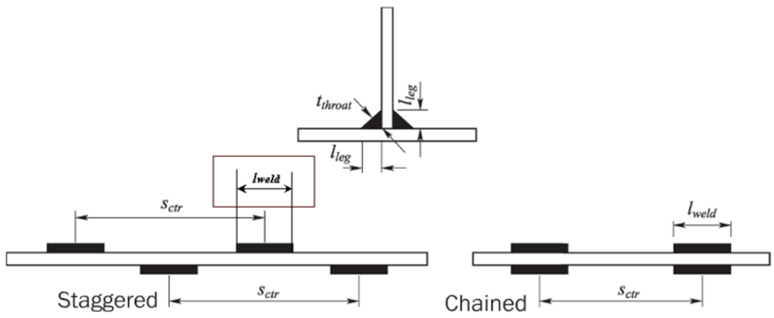
Section 3 DESIGN OF WELD JOINTS

2.5.3

The throat size t_{throat}, in mm, as shown in Figure 4, is not to be less than:

$$t_{throat} = \frac{l_{leg}}{\sqrt{2}}$$

Figure 4: Weld scantlings definitions



4 OTHER TYPES OF JOINTS

4.1 Lapped joints

4.1.3 Overlaps for lugs

The overlaps for lugs and collars in way of cut-outs for the passage of stiffeners through webs and bulkhead plating are not to be less than three times the thickness of the lug but need not be greater than 50 mm.

Chapter 13 SHIP IN OPERATION - RENEWAL CRITERIA

Section 1 PRINCIPLES AND SURVEY REQUIREMENTS

1.3.2 Hull girder sectional properties

The Midship section plan to be supplied onboard the ship is to include the minimum required hull girder sectional properties, as defined in Ch 5, Sec 1, for the typical transverse sections of all cargo holds.

PART 2 SHIP TYPES

Chapter 1 BULK CARRIERS

Section 2 STRUCTURAL DESIGN PRINCIPLES

3.3.4 Openings in strength deck - Corner of hatchways

a) Within the cargo hold region

For cargo hatchways located within the cargo hold region, insert plates, ~~whose~~the thicknesses of which are to be determined according to the formula given after, are to be fitted in way of corners where the plating cut-out has a circular profile.

The radius of circular corners is not to be less than 5% of the hatch width, where a continuous longitudinal deck girder is fitted below the hatch coaming.

Corner radius, in the case of the arrangement of two or more hatchways athwartship, is considered by the Society on a case-by-case basis.

For hatchways located within the cargo hold region, insert plates are, in general, not required in way of corners where the plating cut-out has an elliptical or parabolic profile and the half axes of elliptical openings, or the half lengths of the parabolic arch, are not less than:

- 1/20 of the hatchway width or 600 mm, whichever is the lesser, in the transverse direction.
- Twice the transverse dimension, in the fore and aft direction.

Where insert plates are required, their net thickness is to be obtained, in mm, from the following formula:

$$t_{INS} = (0.8 + 0.4\ell / b)\,t_{off}$$

without being taken less than t_{off} or greater than 1.6 t_{off}.

where:

ℓ: Width, in m, in way of the corner considered, of the cross deck strip between two consecutive hatchways, measured in the longitudinal direction, see Pt 1, Ch 3, Sec 6, Figure 15.

b: Width, in m, of the hatchway considered, measured in the transverse direction, see Pt 1, Ch 3, Sec 6, Figure 15

t_{off} : Offered net thickness, in mm, of the deck at the side of the hatchways.

For the extreme corners of end hatchways, insert plates are required. The net thickness of these insert plates is to be 60% greater than the net offered thickness of the adjacent deck plating. A lower thickness may be accepted by the Society on the basis of calculations showing that stresses at hatch corners are lower than permissible values.

Where insert plates are required, the arrangement is shown in Pt 1, Ch 9, Sec 6, Table 15, in which d_1, d_2, d_3 and d_4 are to be greater than the stiffener spacing.

For ships having length L of 150 m or above, the corner radius, the thickness and the extent of insert plate may be determined by the results of a direct strength assessment according to Pt 1, Ch 7, including buckling check and fatigue strength assessment of hatch corners according to Pt 1, Ch 8 and Pt 1, Ch 9 respectively. For such type of ships it is recommended to arrange circular hatch corners.

b) Outside the cargo hold region

For hatchways located outside the cargo hold region, a reduction in the thickness of the insert plates in way of corners may be considered by the Society on a case-by-case basis.

Section 3 HULL LOCAL SCANTLINGS

3.3.3 Effective shedder plates

Provided that effective shedder plates are fitted as shown in Figure 4, when calculating the section modulus at the lower end of the corrugations (Sections '1' in Figure 4), the net area, in cm^2, of flange plates may be increased by~~ the factor~~ I_{SH} to be taken as:

3.3.4 Effective gusset plates

Provided that effective gusset plates are fitted, when calculating the section modulus at the lower end of the corrugations (Sections '1' in Figure 5 and Figure 6), the net area, in cm^2, of flange plates may be increased by~~ the factor~~ I_G to be taken as:

Section 4 HULL LOCAL SCANTLINGS FOR BULK CARRIERS L<150M

4.2.2 Loading conditions

The severest loading conditions from the loading manual or otherwise specified by the designer are to be considered for the calculation of P_{in} in design load sets BC-~~9~~11 to BC-~~10~~12.

If primary supporting members support deck structure or tank/watertight boundaries, applicable design load sets in Pt 1, Ch 6, Sec 2, Table 1 are also to be considered.

Table 3 : Design load sets for primary supporting members in cargo hold region

Item	Design load set	Load component	Draught	Design load	Loading condition
Bulk cargo hold assigned as ballast hold	WB-4	$P_{in} - P_{ex}$ (1)	$T_{BAL\text{-}H}$ (3)	S+D	Heavy ballast condition
	WB-6	P_{in}	-	S	Harbour/test condition
Bulk cargo hold	BC-~~9~~11	$P_{in} - P_{ex}$ (1)	T_{SC}	S+D	Cargo loading condition
	BC-~~10~~12	$P_{in} - P_{ex}$ (1)	-	S	Harbour condition
Compartments not carrying liquids	FD-1 (2)	P_{in}	T_{SC}	S+D	Flooded condition
	FD-2 (2)	P_{in}		S	Flooded condition

(1) P_{ex} is to be considered for external shell only.
(2) FD-1 and FD-2 are not applicable to external shell.
(3) Minimum draught among heavy ballast conditions is to be used.

4.7.2 Net section modulus, net shear sectional area and web thickness

The net section modulus Z, in cm^3, the net shear sectional area A_{shr}, in cm^2, and the net web thickness t_w, in mm, subjected to lateral pressure are not to be less than the values obtained from the following formulae:

$$Z = \frac{|P| S l_{bdg}^2}{f_{bdg} C_{s-pr} R_{eH}} 10^3$$

$$A_{shr} = \frac{5 |P| S l_{shr}}{C_{t-pr} \tau_{eH}}$$

$$t_w = 1.75 \sqrt[3]{\frac{h_w C_{t-pr} \tau_{eH}}{10^4 C_5} A_{shr}}$$

where:

P : Design pressure in kN/m^2, for the design load set being considered according to Pt 1, Ch 6, Sec 2, [2.1.3], calculated at the mid-point of span ℓ of a web frame located midway between transverse bulkheads of holds.

S : Spacing of primary supporting members, in m.

ℓ_{bdg} : Effective bending span, in m, of primary supporting members, measured between the supporting members as defined in Pt 1, Ch 3, Sec 7, [1.1.6].

ℓ_{shr} : Effective shear span, in m, of primary supporting members, measured between the supporting members as defined in Pt 1, Ch 3, Sec 7, [1.1.7].

f_{bdg} : Bending moment factor:

• For continuous ~~stiffeners~~ primary supporting members and where end connections are fitted consistent with idealisation of the ~~stiffener~~ primary supporting members ~~as~~ having as fixed ends and is not to be taken higher than:

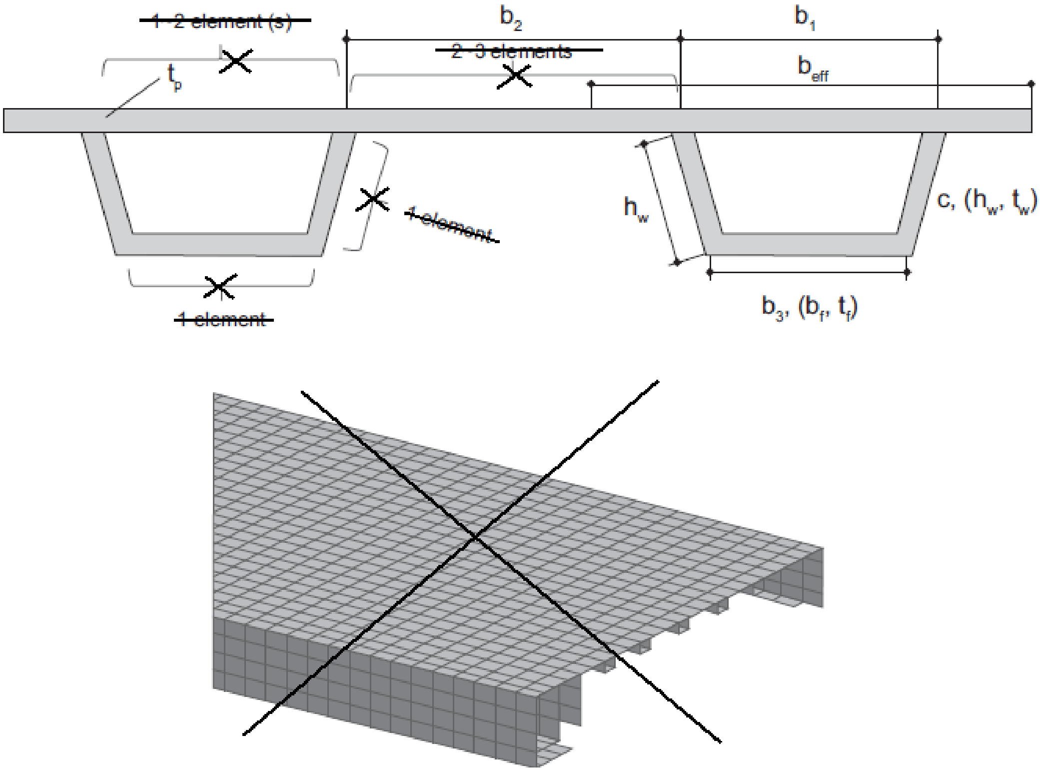
$f_{bdg} = 10$

• For ~~stiffeners~~ primary supporting members with reduced end fixity, the yield check is to be considered on a case-by-case basis.

Section 5 CARGO HATCH COVERS

5.1.1 Application

Figure 1: Example of hatch cover fitted with U type stiffener



Chapter 2 OIL TANKERS

Section 3 HULL LOCAL SCANTLING

1.4.2 Net shear area of centre girders

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n_1 : Coefficient taken as:

$$n_1 = 0.00935\left(\frac{l_{shr}}{S}\right)^2 - 0.163\left(\frac{l_{shr}}{S}\right) + 1.289$$

n_2 : Coefficient taken as:

$$n_2 = 1.3 - \left(\frac{S}{12} \right)$$

S : Double bottom floor spacing, in m, as defined in Pt 1 Ch 3 Sec 7 [1.2.2].

……

1.4.3 Net shear area of side girders

……

n_3 : Coefficient taken as:

$$n_3 = 1.072 - 0.0357 \left(\frac{l_{shr}}{S} \right)$$

n_4 : Coefficient taken as:

$$n_4 = 1.2 - \left(\frac{S}{18} \right)$$

S : Double bottom floor spacing, in m, as defined in Pt 1 Ch 3 Sec 7 [1.2.2].

……