RULES
R022AM01-2026

CHINA CLASSIFICATION SOCIETY

RULES FOR STRUCTURES OF CONTAINER SHIPS

AMENDMENTS

2026

Effective from 1 July 2026

Beijing

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

2 Definitions

2.23 Large openings

A deck opening is to be regarded as a large opening if any of the following conditions applies:

(1) $\frac{b}{B_1} \geq 0.7$;

(2) $\frac{l_H}{l_{BH}} \geq 0.89$;

(3) $\frac{b}{B_1} > 0.6$ and $\frac{l_H}{l_{BH}} > 0.7$.

where: b — breadth of the opening, in m. Where there are several hatches abreast, b is the sum of individual widths of these openings, i.e. $b = b_1 + b_2$, as shown in Figure 2.23;

B_1 — maximum breadth of deck, in m, including opening, measured at the mid-length of the opening;

l_H — length of the opening, in m;

l_{BH} — distance between centrelines of the deck strips at each end of the opening, in m, as shown in Figure 2.23. Where there are no further hatches fore or aft of the one under consideration, then l_{BH} is to be measured to the bulkhead.

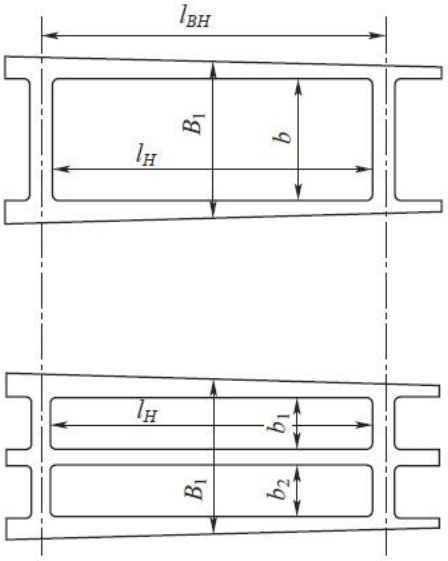


Figure 2.23 Large Openings

3 Class notation

3.2 Other class notations

3.2.1 Other class notations of container ship specified in the Rules are shown in Table 3.2.1.

Other class notations **Table 3.2.1**

No.	Class notation	Explanation and application		Technical requirement
1	GFE	Global finite element strength assessment	(1) The technical requirement for class notation is mandatory for container ships complying with one of the following conditions: 1) Length *L* greater than 250 m; ~~2) Hatch breadth of strength deck greater than 0.89B;~~ ~~3)~~ 2)Unconventional structural arrangement. (2) The technical requirement for class notation is optional for other container ships	Chapter 8 of the Rules
2	FL	Minimum design fatigue life	For container ships of 150 m and over in length, the technical requirement for this notation is mandatory, with suffix (XX, YY) added as follows: XX - wave environmental conditions of ship operation, WW is taken for the environmental condition based on global wave spectrum and NA is taken for the environmental condition based on North Atlantic wave spectrum; YY - fatigue design life, in year; the minimum design fatigue life is 25 years, which may be taken at 5-year intervals starting from the 25th year. E.g., FL(NA, 25) means that design life of 25 years under North Atlantic wave environment	Chapter 10 of the Rules
3	SFA	Spectrum-based fatigue strength assessment	The technical requirement for this notation is optional, with suffix explained the same as No.2	Appendix 1, Chapter 10 of the Rules
4	CLC	Lashing calculation programme of containers	The technical requirement for this notation is ~~optional~~ mandatory and suffixes V, W may be added. Meanings of the suffixes are as follows:: V - specified voyage. Ships applying for securing of containers for specified voyage may be assigned the CLC (V) notation; W- specified weather. Ships applying for securing of containers for specified weather may be assigned the CLC (V, W) notation on the basis of CLC (V)	Chapter 12 of the Rules
5	SAF	Hull structure fatigue strength assessment taking into account linear springing	For container ships satisfying the relevant requirements in 1.1.3, Appendix A of the Rules, hull structure fatigue strength assessment taking into account linear springing is carried out, and the technical requirement for this notation is mandatory	Appendix A of the Rules
6	SWAF	Hull structure fatigue strength assessment taking into account whipping and springing	For container ships satisfying the relevant requirements in 1.1.3, Appendix A of the Rules, hull structure fatigue strength assessment taking into account whipping and springing is carried out, and the technical requirement for this notation is mandatory	Appendix A of the Rules
7	WAU	Hull girder ultimate strength assessment taking into account whipping	For container ships satisfying the relevant requirements in 1.1.3, Appendix A of the Rules, hull girder ultimate strength assessment taking into account whipping is carried out, and the technical requirement for this notation is mandatory	Appendix A of the Rules
8	SLM(B)	Strengthening of bow bottom against slamming	Where the minimum forward draft during navigation is less than 0.04*L*, the flat bottom area extending aft from the fore end is to be strengthened, and this notation may be assigned	[3.2], Section 7, Chapter 6 of the Rules

9	SLM(S)	Strengthening of stern flat bottom against slamming	For large stern flat bottom structures, strengthening of stern bottom against slamming is carried out, and this notation may be assigned	[3.4], Section 7, Chapter 6 of the Rules

Section 3 VERIFICATION OF COMPLIANCE

2 Documents to be submitted

2.2 Drawings and information to be submitted

2.2.1 The drawings and information are to be submitted in accordance with the requirements of PART TWO in CCS Rules for Classification of Sea-going Steel Ships.

2.2.2 The structural drawings are to be indicated as follows:

(1) Scantling of structural members;

(2) Details of connection for the structures;

(3) Specification of design materials, generally including grades, manufacturing processes, welding procedures, heat treatment, etc.;

(4) Information related to the renewal thickness as specified in Chapter 14 (where applicable).

CHAPTER 3 STRUCTURAL DESIGN PRINCIPLES

Section 2 NET SCANTLING APPROACH

1 General requirements

1.3 Scantling compliance

1.3.1 The ~~net~~ required thickness~~, t_{req},~~ is obtained by rounding the ~~net~~ thickness calculated according to the Rules to the nearest half millimetre. ~~For example:~~

~~(1) For 10.75 $\leqslant t_{calc_net}$ < 11.25 mm, the Rules required net thickness is 11.0 mm;~~

~~(2) For 11.25 $\leqslant t_{calc_net}$ < 11.75 mm, the Rules required net thickness is 11.5 mm.~~

Section 3 CORROSION ADDITIONS

1 General requirements

1.2 Corrosion addition determination

1.2.1 The corrosion addition for each of the two sides of a structural member, t_{c1} or t_{c2}, is specified in Table 1.2.1.

(1) The total corrosion addition, t_c, in mm, for both sides of the structural member is obtained by the following formula:

$$t_c = \text{~~Roundup}_{0.5}\text{~~}(t_{c1} + t_{c2}\text{~~)}} + t_{res}$$

(2)For an internal member within a given compartment, the total corrosion addition, t_c is obtained from the following formula:

$$t_c = \text{~~Roundup}_{0.5}\text{~~}(2t_{c1}\text{~~)}} + t_{res}$$

where: t_{c1} is the value specified in Table 1.2.1 for one side exposure to that compartment~~;~~ .

~~$\text{Roundup}_{0.5}(t)$ means that t is rounded to the upper half millimetre;~~

(3)The total corrosion addition, t_c, in mm, for compartment boundaries and internal members made from stainless steel, or aluminium is to be taken as:

$$t_c = t_{res} = 0.5$$

(4)In case of stainless clad steel, the corrosion additions, t_{c1}, for the carbon steel side and t_{c2}, for the stainless steel side are respectively to be taken as:

- t_{c1} as specified for the corresponding compartment in Table 1.2.1
- t_{c2}=0

1.2.2 The corrosion addition of a stiffener is determined according to the location of its connection to the attached plating.

1.2.3 When a local structural member/plate is affected by more than one value of corrosion addition, the most onerous value is to be applied to the entire strake.

1.2.4 The total corrosion addition t_c in general need not be greater than $0.2t_{gr_off}$, except for the check of hull girder strength.

Corrosion addition for one side of a structural member **Table 1.2.1**

Compartment type	Corrosion addition [5], in mm
Exposed to seawater[1]	1.0
Exposed to atmosphere[2]	1.0
Ballast water tank, bilge tank, drain storage tank, chain locker~~[2]~~ [3]	1.0
Void spaces and dry spaces	0.5
Fresh water tank, fuel tank and lube oil tank	0.5
Accommodation spaces	0.0
Cargo hold~~[3]~~ [4]	1.0
Compartments other than those mentioned above	0.5

Notes: (1) Except for the side shell plating between the minimum design ballast draught line and the scantling draught line, for which the one side corrosion addition is taken as 1.0 mm, the one side corrosion addition of other members may be taken as 0.5 mm. For the determination of the corrosion addition of the outer shell plating, the pipe tunnel is considered as for a water ballast tank;

(2)The one side corrosion addition of members may be taken as 0.5 mm, except for the check of hull girder strength;

~~(2)~~(3)1.0 mm is to be added to the plate surface within 3m above the upper surface of the chain locker bottom;

~~(3)~~(4)Except for the one side corrosion addition of inner bottom plating which is to be taken as 1.0 mm, the one side corrosion addition of other members may be taken as 0.5 mm; ~~For transverse bulkhead structure, the corrosion addition is 0.5mm.~~

(5) The reduction of corrosion addition above is not applicable to the check of hull girder strength.

Section 5 STRUCTURAL DETAIL PRINCIPLES

9 Deck and hatch coaming structure

9.3 Strength deck openings

9.3.1 The corners of hatchway opening in the strength deck are to comply with following requirements:

(1) For rounded corners (including those with negative radii), the radius of the hatch corners of the cargo hatchway openings adjacent to the engine room is to be not less than 0.04B, in m; The radius of hatch corners near the ship's sides is not to be less than 0.35 + 0.0005L, in m; The radius of hatch corners in way of other positions is not to be less than 0.25 m;

(2) For parabolic or elliptical corners, the requirements of Figure 9.3.1 are in general to be complied with, and insert plates are not required for the deck in way of the corner.

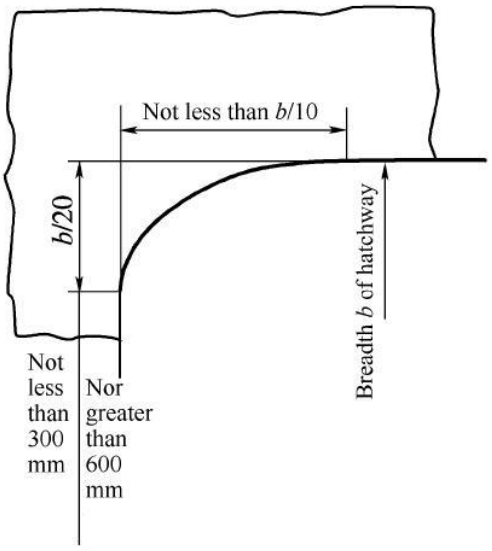
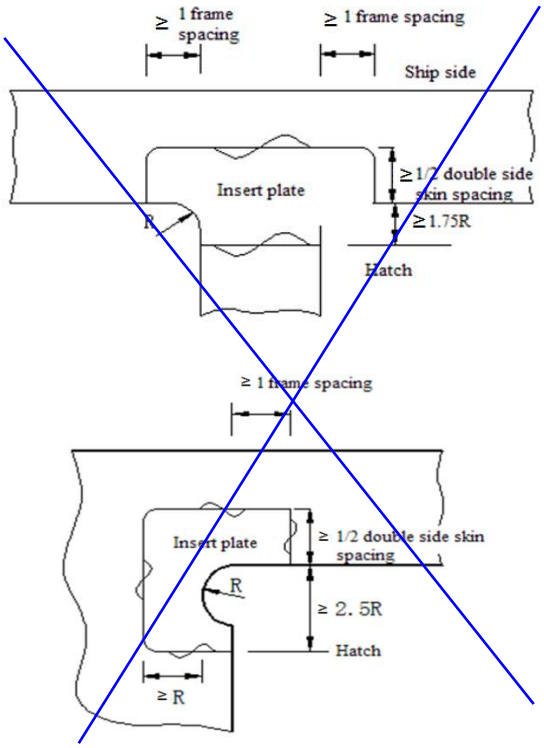


Figure 9.3.1 Parabolic or Elliptical Corners

~~(2)~~(3) For ~~rounded~~ corners with negative radii or not complying with the requirements of (1) and (2), whole ship finite element method according to the requirements of Chapter 8 Yield and Chapter 10 Fatigue or other equivalent method is to be adopted for verification.

9.3.2 For strength deck, insert plates are generally required at the hatch rounded corners, ~~generally~~ extending to the extent complying with Figure 9.3.2 (*R* is the radius of hatch corners, *e* is not to be less than 760 mm and for longitudinal framing, not to be less than one longitudinal spacing). The thickness and material of the insert plates are not to be less than those of adjacent strength deck. If the extension of the insert plates can not meet above requirements, whole ship finite element yield strength assessment and local refining analysis in Chapter 8 or other equivalent methods are to be adopted for verification.



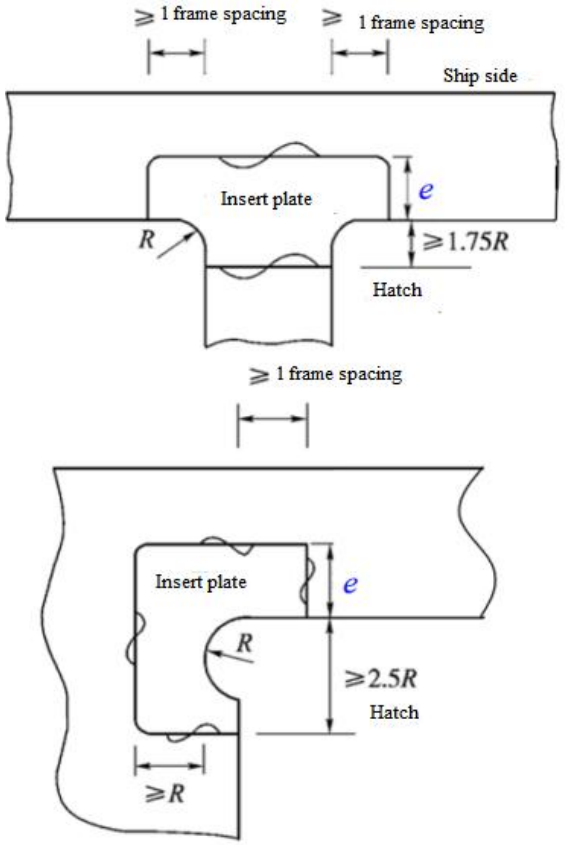


Figure 9.3.2 Insert Plate of Rounded Corner

9.4 Hatch coamings of container hold

~~9.4.2 The coaming thickness t is not to be less than that obtained from the following formula:~~

~~$$t = 8H\sqrt{\frac{R_{eH}}{235}}$$ mm, but not less than 11 mm~~

~~where: H hatch coaming height, in m;~~

~~R_{eH} yield stress of the material, in N/mm^2.~~

9.4.2 The structures of hatch coamings of container hold are to comply with relevant requirements of Section 20, Chapter 2, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

CHAPTER 4 LOADS

Section 1 GENERAL PROVISIONS

1 General

1.1 Application

1.1.1 Scope

This Chapter provides the design load for strength and fatigue assessments.

The load combinations are to be derived for the design load scenarios specified in Section 7 of this Chapter. This Section uses the concept of design load scenarios to specify design load sets which cover the typical operating modes of a container ship.

1.1.5 Loads for strength assessment

The strength assessment is to be undertaken for all applicable design load scenarios and the final assessment is to be made on the most onerous strength requirement.

Each design load scenario for strength assessment is composed of a Static (S) load case or a Static + Dynamic (S+D) load case, where the static and dynamic loads are dependent on the loading condition being considered.

The static loads are defined in the following sections:

(1) Still water hull girder loads in Section 4 of this Chapter.

(2) External loads in Section 5 of this Chapter.

(3) Internal loads in Section 6 of this Chapter.

The EDWs for the strength assessment and the dynamic load combination factors for global loads are listed in Ch 4, Sec 2, [2].

The dynamic load components are defined in the following sections:

(1) Dynamic hull girder load components in Ch 4, Sec 4.

(2) External loads in Ch 4, Sec 5.

(3) Internal loads in Ch 4, Sec 6.

1.1.6 Loads for fatigue assessment

Each design load scenario for fatigue assessment is composed of a Static + Dynamic (S+D) load case, where the static and dynamic loads are dependent on the loading condition being considered.

Section 2 DYNAMIC LOAD CASES

Symbols

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

a_{surge}, $a_{pitch\text{-}x}$, a_{sway}, $a_{roll\text{-}y}$, a_{heave}, $a_{roll\text{-}z}$, $a_{pitch\text{-}z}$: Acceleration components, as defined in Ch 4, Sec 3.

f_{xL} — Ratio between X-coordinate of the load point and L, to be taken as:

$f_{xL} = \frac{x}{L}$, but not to be taken less than 0.0 or greater than 1.0.

f_{TL} — Ratio between draught at a loading condition and L, to be taken as:

$$f_{TL} = \frac{T_{LC}}{L};$$

f_T — Ratio between draught at a loading condition and scantling draught, to be taken as:

$$f_T = \frac{T_{LC}}{T_{SC}}, \text{ but is not to be taken less than 0.5;}$$

T_{LC} — Draught, in m, amidships for the considered loading condition;

f_{BL} — Ratio between ship breadth and rules length, to be taken as:

$$f_{BL} = \frac{B}{L};$$

$f_{lp\text{-OSA}}$ — Longitudinal distribution coefficient of torsional moment for OSA Load Case, to be taken as:

$f_{lp\text{-OSA}} = -(0.2 + 0.3f_T)$, for $x/L < 0.4$;

$f_{lp\text{-OSA}} = (0.2 + 0.3f_T)(11.5f_{xL} - 5.6)$, for $0.4 \leq x/L < 0.6$;

$f_{lp\text{-OSA}} = 1.3(0.2 + 0.3f_T)$, for $0.6 \leq x/L$;

$C_{b\text{-}LC}$ — Block coefficient for the considered loading condition, as defined in Section 3 of this Chapter;

$C_{W\text{-}LC}$ — Waterplane coefficient for the considered loading condition, as defined in Section 3 of this Chapter.

1 General requirements

1.1 Definition of dynamic load cases

~~1.1.1 The following Equivalent Design Waves (EDW) are to be used to generate the dynamic load cases for structural assessment:~~

~~(1) HVM load cases:~~

~~HVM-1 and HVM-2: Head sea EDWs that minimise and maximise the vertical wave bending moment amidships respectively.~~

~~(2) HVS load cases:~~

~~HVS-1 and HVS-2: Head sea EDWs that minimise and maximise the vertical wave shear force at 0.75L from stern respectively.~~

~~(3) FVM load cases:~~

~~FVM-1 and FVM-2: Following sea EDWs that minimise and maximise the vertical wave bending moment at 0.25L from stern respectively.~~

~~(4) BSR load cases:~~

~~BSR-1P and BSR-2P: Beam sea EDWs that minimise and maximise the roll motion downward and upward on the port side respectively with waves from the port side.~~

~~BSR-1S and BSR-2S: Beam sea EDWs that maximise and minimise the roll motion downward and upward on the starboard side respectively with waves from the starboard side.~~

~~(5) BSP load cases:~~

~~BSP-1P and BSP-2P: Beam sea EDWs that maximise and minimise the hydrodynamic pressure at the waterline amidships on the port side respectively.~~

~~BSP-1S and BSP-2S: Beam sea EDWs that maximise and minimise the hydrodynamic pressure at the waterline amidships on the starboard side respectively.~~

~~(6) OST load cases:~~

~~OST-1P and OST-2P: Oblique sea EDWs that minimise and maximise the torsional moment at 0.75L from the stern with waves from the port side respectively.~~

~~OST-1S and OST-2S: Oblique sea EDWs that maximise and minimise the torsional moment at 0.75L from the stern with waves from the starboard side respectively.~~

~~(7) OHM load cases:~~

~~OHM-1P and OHM-2P: Oblique sea EDWs that minimise and maximise the horizontal bending moment amidships with waves from the port side respectively.~~

~~OHM-1S and OHM-2S: Oblique sea EDWs that minimise and maximise the horizontal bending moment amidships with waves from the starboard side respectively.~~

~~(8) OHS load cases:~~

~~OHS-1P and OHS-2P: Oblique sea EDWs that minimise and maximise the horizontal shear force at 0.75L from the stern with waves from the port side respectively.~~

~~OHS-1S and OHS-2S: Oblique sea EDWs that maximise and minimise the horizontal shear force at 0.75L from the stern with waves from the starboard side respectively.~~

~~(9) OVA load cases:~~

~~OVA-1P and OVA-2P: Oblique sea EDWs that minimise and maximise the vertical acceleration at L of bow with waves from the port side respectively.~~

~~OVA-1S and OVA-2S: Oblique sea EDWs that maximise and minimise the vertical acceleration at L of bow with waves from the starboard side respectively.~~

~~Note 1: 1 and 2 denote the maximum or the minimum dominate load component for each EDW.~~

~~Note 2: P and S denote that the weather side is on port side and on starboard side respectively.~~

~~1.1.2 FVM and OVA load cases are not to be used for fatigue assessment.~~

1.1.1 The following Equivalent Design Waves (EDW) are to be used to generate the dynamic load cases for structural assessment, which may be selected by referring to Table 1.1.1(1).

Selection of Equivalent Design Waves (EDW) Table 1.1.1(1)

Dynamic load cases	Basic	Block coefficient C_b	
		≤0.73	>0.73
HVM	√	-	-
HVS	-	√	-
HSA	-	-	√
FVMf	-	√	-
FVM	-	-	√
BSR	√	-	-
BSP	√	-	-
OSTf	√	-	-
OHM	-	√	-

OHS	√	-	-
OSA	-	-	√
OVA	-	√	-
Note: FVMf, HSA, OSA and OVA load cases are not to be used for fatigue assessment.			

1.1.2 Basic dynamic load cases

(1) HVM load cases:

HVM-1 and HVM-2: Head sea EDWs that minimise and maximise the vertical wave bending moment amidships respectively.

(2) BSR load cases:

BSR-1P and BSR-2P: Beam sea EDWs that minimise and maximise the roll motion downward and upward on the port side respectively with waves from the port side.

BSR-1S and BSR-2S: Beam sea EDWs that maximise and minimise the roll motion downward and upward on the starboard side respectively with waves from the starboard side.

(3) BSP load cases:

BSP-1P and BSP-2P: Beam sea EDWs that maximise and minimise the hydrodynamic pressure at the waterline amidships on the port side respectively.

BSP-1S and BSP-2S: Beam sea EDWs that maximise and minimise the hydrodynamic pressure at the waterline amidships on the starboard side respectively.

(4) OSTf load cases:

OSTf-1P and OSTf-2P: Oblique sea EDWs that minimise and maximise the torsional moment at 0.75L from the stern with waves from the port side respectively.

OSTf-1S and OSTf-2S: Oblique sea EDWs that minimise and maximise the torsional moment at 0.75L from the stern with waves from the starboard side respectively.

(5)OHS load cases:

OHS-1P and OHS-2P: Oblique sea EDWs that minimise and maximise the horizontal shear force at 0.75L from the stern with waves from the port side respectively.

OHS-1S and OHS-2S: Oblique sea EDWs that maximise and minimise the horizontal shear force at 0.75L from the stern with waves from the starboard side respectively.

Note 1: 1 and 2 denote the maximum or the minimum dominate load component for each EDW.

Note 2: P and S denote that the weather side is on port side and on starboard side respectively.

1.1.3 The following load cases are also to be considered for ships with C_b>0.73:

(1) HSA load cases:

HSA-1 and HSA-2: Head sea EDWs that minimise and maximise the vertical acceleration at bow respectively.

(2) FVM load cases:

FVM-1 and FVM-2: Following sea EDWs that minimise and maximise the vertical wave bending moment amidships respectively.

(3) OSA load cases:

OSA-1P and OSA-2P: Oblique sea EDWs that minimise and maximise the pitch acceleration with waves from the port side respectively.

OSA-1S and OSA-2S: Oblique sea EDWs that minimise and maximise the pitch acceleration with waves from the starboard side respectively.

1.1.4 The following load cases are also to be considered for ships with $C_b \leq 0.73$:

(1)HVS load cases:

HVS-1 and HVS-2: Head sea EDWs that minimise and maximise the vertical wave shear force at 0.75L from stern respectively.

(2)FVMf load cases:

FVMf-1 and FVMf-2: Following sea EDWs that minimise and maximise the vertical wave bending moment at 0.25L from stern respectively.

(3) OHM load cases:

OHM-1P and OHM-2P: Oblique sea EDWs that minimise and maximise the horizontal bending moment amidships with waves from the port side respectively.

OHM-1S and OHM-2S: Oblique sea EDWs that minimise and maximise the horizontal bending moment amidships with waves from the starboard side respectively.

(4) OVA load cases:

OVA-1P and OVA-2P: Oblique sea EDWs that minimise and maximise the vertical acceleration at L of bow with waves from the port side respectively.

OVA-1S and OVA-2S: Oblique sea EDWs that maximise and minimise the vertical acceleration at L of bow with waves from the starboard side respectively.

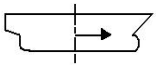
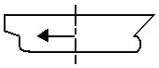
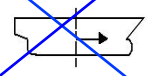
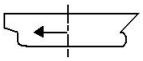
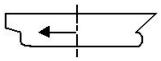
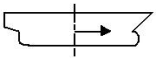
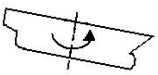
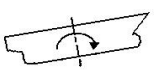
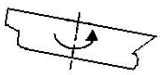
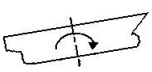
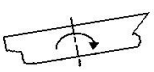
2 Dynamic load cases for strength assessment

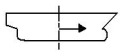
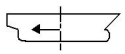
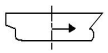
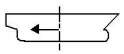
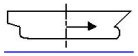
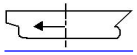
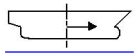
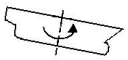
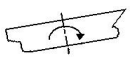
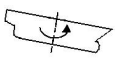
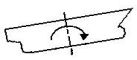
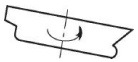
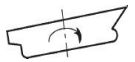
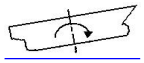
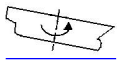
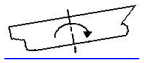
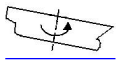
2.1 Description of dynamic load cases

2.1.1 Table 2.1.1(1) to Table 2.1.1(3) describe the ship motions responses and the global loads corresponding to each dynamic load case to be considered for the strength assessment.

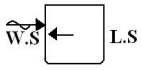
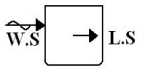
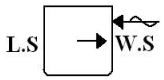
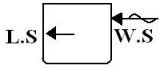
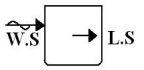
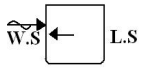
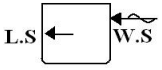
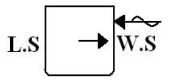
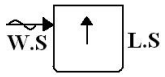
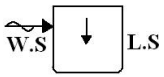
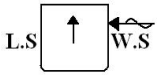
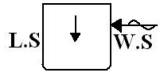
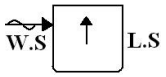
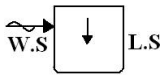
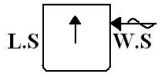
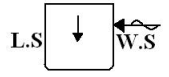
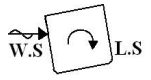
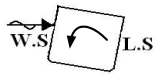
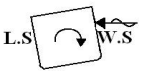
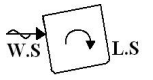
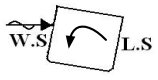
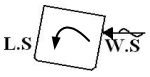
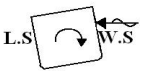
Ship responses for ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVMf and FVM load cases - Strength assessment

Table 2.1.1(1)

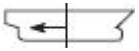
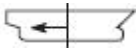
~~Load case~~	~~HVM-1~~	~~HVM-2~~	~~HVS-1~~	~~HVS-2~~	~~FVM-1~~	~~FVM-2~~
~~EDW~~	~~HVM~~		~~HVS~~		~~FVM~~	
~~Heading~~	~~Head~~		~~Head~~		~~Following~~	
~~Effect~~	~~Max. vertical bending moment~~		~~Max. vertical shear force~~		~~Max. vertical bending moment~~	
~~VWBM~~	~~Sagging~~	~~Hogging~~	~~Sagging~~	~~Hogging~~	~~Sagging~~	~~Hogging~~
~~VWSF~~	~~Negative aft Positive fore~~	~~Positive aft Negative fore~~	~~Negative aft Positive fore~~	~~Positive aft Negative fore~~	~~Negative aft Positive fore~~	~~Positive aft Negative fore~~
~~HWBM~~	-	-	-	-	-	-
~~HWSF~~	-	-	-	-	-	-
~~TM~~	-	-	-	-	-	-
~~Surge~~	~~To stern~~	~~To bow~~	~~To stern~~	~~To bow~~	~~To bow~~	~~To stern~~
~~a_{surge}~~						
~~Sway~~	-	-	-	-	-	-
~~a_{sway}~~	-	-	-	-	-	-
~~Heave~~	~~Down~~	~~Up~~	~~Down~~	~~Up~~	~~Down~~	~~Up~~
~~a_{heave}~~						
~~Roll~~	-	-	-	-	-	-
~~a_{roll}~~	-	-	-	-	-	-
~~Pitch~~	~~Bow down~~	~~Bow up~~	~~Bow down~~	~~Bow up~~	~~Bow up~~	~~Bow down~~
~~a_{pitch}~~						

Load case	HVM-1	HVM-2	HVS-1	HVS-2	HSA-1	HSA-2	FVMf-1	FVMf-2	FVM-1	FVM-2
EDW	HVM		HVS		HSA		FVMf		FVM	
Heading	Head		Head		Head		Following		Following	
Effect	Max. vertical bending moment		Max. vertical shear force		Max. vertical acceleration		Max. vertical bending moment		Max. vertical bending moment	
VWBM	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging
VWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	-	-	-	-	-	-	-	-	-	-
HWSF	-	-	-	-			-	-		
TM	-	-	-	-	-	-	-	-	-	-
Surge	To stern	To bow	To stern	To bow	To stern	To bow	To bow	To stern	To bow	To stern
a_{surge}										
Sway	-	-	-	-	-	-	-	-	-	-
a_{sway}	-	-	-	-	-	-	-	-	-	-
Heave	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up
a_{heave}										
Roll	-	-	-	-	-	-	-	-	-	-
a_{roll}	-	-	-	-	-	-	-	-	-	-
Pitch	Bow down	Bow up	Bow down	Bow up	Bow down	Bow up	Bow up	Bow down	Bow up	Bow down
a_{pitch}										

Ship responses for BSR and BSP load cases - Strength assessment **Table 2.1.1(2)**

Load case	BSR-1P	BSR-2P	BSR-1S	BSR-2S	BSP-1P	BSP-2P	BSP-1S	BSP-2S
EDW	BSR		BSR		BSP		BSP	
Heading	Beam				Beam			
Effect	Max. roll				Max.pressure at waterline			
VWBM	-	-	-	-	Sagging	Hogging	Sagging	Hogging
VWSF	-	-	-	-	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	Stbd tensile	Port tensile	Port tensile	Stbd tensile	Stbd tensile	Port tensile	Port tensile	Stbd tensile
HWSF	-	-	-	-	-	-	-	-
TM	-	-	-	-	-	-	-	-
Surge	-	-	-	-	-	-	-	-
a_{surge}	-	-	-	-	-	-	-	-
Sway	To starboard	To portside	To portside	To starboard	To portside	To starboard	To starboard	To portside
a_{sway}								
Heave	Down	Up	Down	Up	Down	Up	Down	Up
a_{heave}								
Roll	Portside down	Portside up	Starboard down	Starboard up	Portside down	Portside up	Starboard down	Starboard up
a_{roll}								
Pitch	-	-	-	-	-	-	-	-
a_{pitch}	-	-	-	-	-	-	-	-

Ship responses for ~~OST, OHM, OHS and OVA~~ OSTf, OHM, OHS, OSA and OVA load cases - Strength assessment Table 2.1.1(3)

Load case	OSTf-1P	OSTf-2P	OSTf-1S	OSTf-2S	OHM-1P	OHM-2P	OHM-1S	OHM-2S
EDW	OST				OHM			
Heading	Oblique				Oblique			
Effect	Max. torsional moment				Max. horizontal bending moment			
VWBM	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging
VWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	Port tensile	Stbd tensile	Stbd tensile	Port tensile	Port tensile	Stbd tensile	Stbd tensile	Port tensile
HWSF	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore
TM	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore
Surge	To bow	To stern	To bow	To stern	To stern	To bow	To stern	To bow
a_{surge}								
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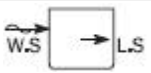
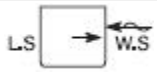
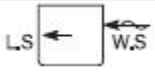
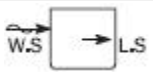
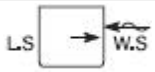
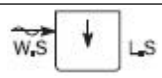
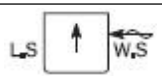
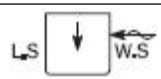
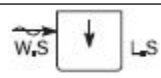
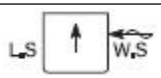
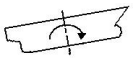
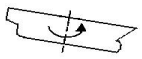
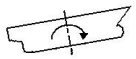
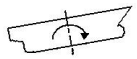
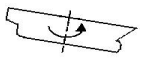
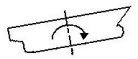
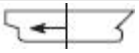
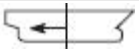
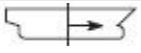
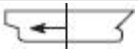
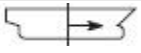
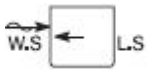
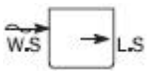
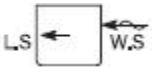
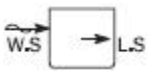
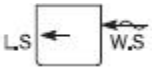
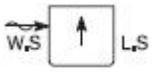
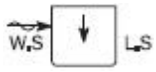
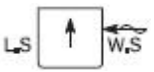
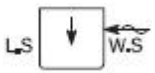
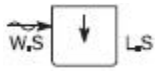
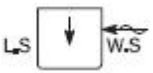
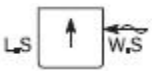
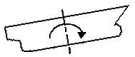
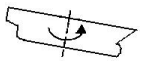
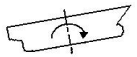
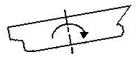
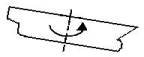
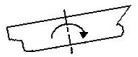
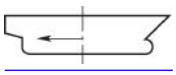
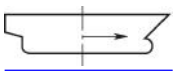
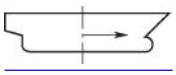
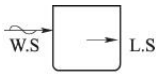
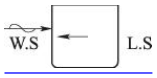
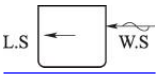
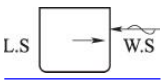
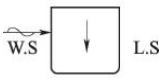
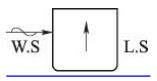
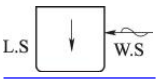
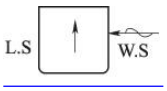
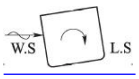
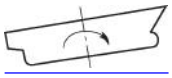
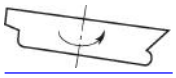
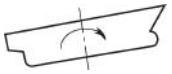
a_{sway}								
Heave	Down	Up	Down	Up	Down	Up	Down	Up
a_{heave}								
Roll	Portside down	Portside up	Starboard down	Starboard up	Portside down	Portside up	Starboard down	Starboard up
a_{roll}								
Pitch	Bow up	Bow down	Bow up	Bow down	Bow down	Bow up	Bow down	Bow up
a_{pitch}								

Continue

Load case	OHS-1P	OHS-2P	OHS-1S	OHS-2S	OVA-1P	OVA-2P	OVA-1S	OVA-2S
EDW	OHS				OVA			
Heading	Oblique				Oblique			
Effect	Max. horizontal shear force				Max. vertical acceleration			
VWBM	Sagging	Hogging	Sagging	Hogging	Hogging	Sagging	Hogging	Sagging
VWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore
HWBM	Port tensile	Stbd tensile	Stbd tensile	Port tensile	Stbd tensile	Port tensile	Port tensile	Stbd tensile
HWSF	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore
TM	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore
Surge	To bow	To stern	To bow	To stern	To bow	To stern	To bow	To stern
a_{surge}								
Sway	To starboard	To portside	To portside	To starboard	To portside	To starboard	To starboard	To portside
a_{sway}								
Heave	Down	Up	Down	Up	Up	Down	Up	Down
a_{heave}								
Roll	Portside down	Portside up	Starboard down	Starboard up	Portside down	Portside up	Starboard down	Starboard up
a_{roll}								
Pitch	Bow up	Bow down	Bow up	Bow down	Bow up	Bow down	Bow up	Bow down
a_{pitch}								

Continue

Load case	OSA-1P	OSA-2P	OSA-1S	OSA-2S
EDW	OSA			
Heading	Oblique			
Effect	Max. pitch acceleration			
VWBM	Hogging	Sagging	Hogging	Sagging
VWSF	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore
HWBM	Stbd tensile	Port tensile	Port tensile	Stbd tensile
HWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore
TM	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore
Surge	To bow	To stern	To bow	To stern
a_{surge}				
Sway	To portside	To starboard	To starboard	To portside
a_{sway}				
Heave	Up	Down	Up	Down
a_{heave}				
Roll	Portside down	Portside up	Starboard down	Starboard up
a_{roll}				
Pitch	Bow up	Bow down	Bow up	Bow down
a_{pitch}				

2.2 Load combination factors

2.2.1 The load combinations factors, LCFs for the global loads and inertia load components for strength assessment are defined in:

Table 2.2.1(1): LCFs for ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVMf and FVM load cases.

Table 2.2.1(2): LCFs for BSR and BSP load cases.

Table 2.2.1(3): LCFs for ~~OST, OHM, OHS and OVA~~ OSTf, OHM, OHS, OSA and OVA load cases.

Load combinations factors, LCFs for ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVMf and FVM load cases - Strength assessment Table 2.2.1(1)

~~Load component~~		~~LCF~~	~~HVM-1~~	~~HVM-2~~	~~HVS-1~~	~~HVS-2~~	~~FVM-1~~	~~FVM-2~~
~~Hull girder loads~~	~~M_{wv}~~	~~C_{WV}~~	~~-1~~	~~1~~	~~-1~~	~~1~~	~~-1~~	~~1~~
	~~Q_{wv}~~	~~C_{QW}~~	~~$-f_{ip}$~~	~~f_{ip}~~	~~$-f_{ip}$~~	~~f_{ip}~~	~~$-f_{ip}$~~	~~f_{ip}~~
	~~M_{wh}~~	~~C_{WH}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~Q_{wh}~~	~~C_{QH}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~M_{wt}~~	~~C_{WT}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
~~Longitudinal accelerations~~	~~a_{surge}~~	~~C_{XS}~~	~~$0.71-8.88f_{TL}$~~	~~$8.88f_{TL}-0.71$~~	~~$0.76-8.88f_{TL}$~~	~~$8.8f_{TL}-0.76$~~	~~$-0.07-4.29f_{TL}$~~	~~$4.29f_{TL}+0.07$~~
	~~$a_{pitch-x}$~~	~~C_{XP}~~	~~-0.6~~	~~0.6~~	~~-0.66~~	~~0.66~~	~~0.1~~	~~-0.1~~
	~~gsinφ~~	~~C_{XG}~~	~~0.56~~	~~-0.56~~	~~0.6~~	~~-0.6~~	~~-0.15~~	~~0.15~~
~~Transverse accelerations~~	~~a_{sway}~~	~~C_{YS}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~a_{roll-y}~~	~~C_{YR}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~gsinθ~~	~~C_{YG}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
~~Vertical accelerations~~	~~a_{heave}~~	~~C_{ZH}~~	~~$7.9f_{TL}-0.09$~~	~~$0.09-7.9f_{TL}$~~	~~$8.5f_{TL}-0.1$~~	~~$0.1-8.5f_{TL}$~~	~~0.14~~	~~-0.14~~
	~~a_{roll-z}~~	~~C_{ZR}~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~$a_{pitch-z}$~~	~~C_{ZP}~~	~~-0.6~~	~~0.6~~	~~-0.66~~	~~0.66~~	~~0.1~~	~~-0.1~~

Load component		LCF	HVM-1	HVM-2	HVS-1	HVS-2	HSA-1	HSA-2
Hull girder loads	M_{wv}	C_{WV}	-1	1	-1	1	-0.7	0.7
	Q_{wv}	C_{QW}	$-f_{lp}$	f_{lp}	$-f_{lp}$	f_{lp}	$-0.6f_{lp}$	$0.6f_{lp}$
	M_{wh}	C_{WH}	0	0	0	0	0	0
	Q_{wh}	C_{QH}	0	0	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	$1.05-1.14C_{b-LC}$	$1.14C_{b-LC}-1.05$	$0.76-8.8f_{TL}$	$8.8f_{TL}-0.76$	$1.02-12.7f_{TL}$	$12.7f_{TL}-1.02$
	$a_{pitch-x}$	C_{XP}	$0.0011L-0.81$	$0.81-0.0011L$	-0.66	0.66	-1	1
	$g\sin\varphi$	C_{XG}	0.56	-0.56	0.6	-0.6	0.85	-0.85
Transverse accelerations	a_{sway}	C_{YS}	0	0	0	0	0	0
	a_{roll-y}	C_{YR}	0	0	0	0	0	0
	$g\sin\theta$	C_{YG}	0	0	0	0	0	0
Vertical accelerations	a_{heave}	C_{ZH}	$9.2f_{TL}-0.17$	$0.17-9.2f_{TL}$	$8.5f_{TL}-0.1$	$0.1-8.5f_{TL}$	$6.32f_{TL}+0.08$	$-6.32f_{TL}-0.08$
	a_{roll-z}	C_{ZR}	0	0	0	0	0	0
	$a_{pitch-z}$	C_{ZP}	$0.0011L-0.81$	$0.81-0.0011L$	-0.66	0.66	-1	1

Continue

Load component		LCF	FVMf-1	FVMf-2	FVM-1	FVM-2
Hull girder loads	M_{wv}	C_{WV}	-1	1	-1	1
	Q_{wv}	C_{QW}	$-f_{lp}$	f_{lp}	$-f_{lp}$	f_{lp}
	M_{wh}	C_{WH}	0	0	0	0
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	$-0.07-4.29f_{TL}$	$4.29f_{TL}+0.07$	-0.12	0.12
	$a_{pitch\text{-}x}$	C_{XP}	0.1	-0.1	0.08	-0.08
	$g\sin\varphi$	C_{XG}	-0.15	0.15	-0.12	0.12
Transverse accelerations	a_{sway}	C_{YS}	0	0	0	0
	$a_{roll\text{-}y}$	C_{YR}	0	0	0	0
	$g\sin\theta$	C_{YG}	0	0	0	0
Vertical accelerations	a_{heave}	C_{ZH}	0.14	-0.14	0.13	-0.13
	$a_{roll\text{-}z}$	C_{ZR}	0	0	0	0
	$a_{pitch\text{-}z}$	C_{ZP}	0.1	-0.1	0.08	-0.08

Load combinations factors, LCFs for BSR and BSP load cases - Strength assessment

Table 2.2.1(2)

Load component		LCF	BSR-1P	BSR-2P	BSR-1S	BSR-2S
Hull girder loads	M_{wv}	C_{WV}	0	0	0	0
	Q_{wv}	C_{QW}	0	0	0	0
	M_{wh}	C_{WH}	$1.29-23f_{TL}$	$23f_{TL}-1.29$	$23f_{TL}-1.29$	$1.29-23f_{TL}$
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch\text{-}x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	$0.74-1.72\omega_R$	$1.72\omega_R-0.74$	$1.72\omega_R-0.74$	$0.74-1.72\omega_R$
	$a_{roll\text{-}y}$	C_{YR}	1	-1	-1	1
	gsinθ	C_{YG}	-1	1	1	-1
Vertical accelerations	a_{heave}	C_{ZH}	$1.02-0.17T_R$	$0.17T_R-1.02$	$1.02-0.17T_R$	$0.17T_R-1.02$
	$a_{roll\text{-}z}$	C_{ZR}	1	-1	-1	1
	$a_{pitch\text{-}z}$	C_{ZP}	0	0	0	0

Load component		LCF	BSR-1P	BSR-2P	BSR-1S	BSR-2S
Hull girder loads	M_{wv}	C_{WV}	0	0	0	0
	Q_{wv}	C_{QW}	0	0	0	0
	M_{wh}	C_{WH}	$1.05-14.5f_{TL}$	$14.5f_{TL}-1.05$	$14.5f_{TL}-1.05$	$1.05-14.5f_{TL}$
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch\text{-}x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	$0.67C_{b\text{-}LC}-0.29$	$0.29-0.67C_{b\text{-}LC}$	$0.29-0.67C_{b\text{-}LC}$	$0.67C_{b\text{-}LC}-0.29$
	$a_{roll\text{-}y}$	C_{YR}	1	-1	-1	1
	gsinθ	C_{YG}	-1	1	1	-1

Vertical accelerations	a_{heave}	C_{ZH}	0.62-4.6f_{TL}	4.6f_{TL}-0.62	0.62-4.6f_{TL}	4.6f_{TL}-0.62
	a_{roll-z}	C_{ZR}	1	-1	-1	1
	$a_{pitch-z}$	C_{ZP}	0	0	0	0

Continue

Load component		LCF	BSP-1P	BSP-2P	BSP-1S	BSP-2S
Hull girder loads	M_{wv}	C_{WV}	-0.22	0.22	-0.22	0.22
	Q_{wv}	C_{QW}	-0.22f_{lp}	0.22f_{lp}	-0.22f_{lp}	0.22f_{lp}
	M_{wh}	C_{WH}	0.91-14.5f_{TL}	14.5 f_{TL}-0.91	14.5f_{TL}-0.91	0.91-14.5f_{TL}
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch-x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	0.82ω_R-0.91	0.91-0.82ω_R	0.91-0.82ω_R	0.82ω_R-0.91
	a_{roll-y}	C_{YR}	0.95-0.15T_R	0.15T_R-0.95	0.15T_R-0.95	0.95-0.15T_R
	gsinθ	C_{YG}	-0.3	0.3	0.3	-0.3
Vertical accelerations	a_{heave}	C_{ZH}	1	-1	1	-1
	a_{roll-z}	C_{ZR}	0.95-0.15T_R	0.15T_R-0.95	0.15T_R-0.95	0.95-0.15T_R
	$a_{pitch-z}$	C_{ZP}	0	0	0	0

Load component		LCF	BSP-1P	BSP-2P	BSP-1S	BSP-2S
Hull girder loads	M_{wv}	C_{WV}	0.13-7.14f_{TL}	7.14f_{TL}-0.13	0.13-7.14f_{TL}	7.14f_{TL}-0.13
	Q_{wv}	C_{QW}	（0.13-7.14f_{TL}）f_{lp}	（7.14f_{TL}-0.13）f_{lp}	（0.13-7.14f_{TL}）f_{lp}	（7.14f_{TL}-0.13）f_{lp}
	M_{wh}	C_{WH}	0.62-9.17f_{TL}	9.17f_{TL}-0.62	9.17f_{TL}-0.62	0.62-9.17f_{TL}
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch-x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0

Transverse accelerations	a_{sway}	C_{YS}	-0.57-2.9f_{TL}	0.57+2.9f_{TL}	0.57+2.9f_{TL}	-0.57-2.9f_{TL}
	a_{roll-y}	C_{YR}	0.51-3f_{TL}	3f_{TL}-0.51	3f_{TL}-0.51	0.51-3f_{TL}
	gsinθ	C_{YG}	-0.22	0.22	0.22	-0.22
Vertical accelerations	a_{heave}	C_{ZH}	1	-1	1	-1
	a_{roll-z}	C_{ZR}	0.51-3f_{TL}	3f_{TL}-0.51	3f_{TL}-0.51	0.51-3f_{TL}
	$a_{pitch-z}$	C_{ZP}	0	0	0	0

Load combinations factors, LCFs for ~~OST, OHM, OHS and OVA~~ OSTf, OHM, OHS, OSA and OVA load cases - Strength assessment

Table 2.2.1(3)

Load component		LCF	OSTf-1P	OSTf-2P	OSTf-1S	OSTf-2S
Hull girder loads	M_{wv}	C_{WV}	0.6-1.06C_{W-LC}	1.06C_{W-LC}-0.60	0.6-1.06C_{W-LC}	1.06C_{W-LC}-0.60
	Q_{wv}	C_{QW}	(0.6-1.06C_{W-LC})f_{lp}	(1.06C_{W-LC}-0.60)f_{lp}	(0.6-1.06C_{W-LC})f_{lp}	(1.06C_{W-LC}-0.60)f_{lp}
	M_{wh}	C_{WH}	-1	1	1	-1
	Q_{wh}	C_{QH}	f_{lp}	-f_{lp}	-f_{lp}	f_{lp}
	M_{wt}	C_{WT}	-f_{lp}	f_{lp}	f_{lp}	-f_{lp}
Longitudinal accelerations	a_{surge}	C_{XS}	-0.07-2.93f_{TL}	2.93f_{TL}+0.07	-0.07-2.93f_{TL}	2.93f_{TL}+0.07
	$a_{pitch-x}$	C_{XP}	0.74-6.3f_{TL}	6.3f_{TL}-0.74	0.74-6.3f_{TL}	6.3f_{TL}-0.74
	gsinφ	C_{XG}	0.12-0.66C_{b-LC}	0.66C_{b-LC}-0.12	0.12-0.66C_{b-LC}	0.66C_{b-LC}-0.12
Transverse accelerations	a_{sway}	C_{YS}	0.33-3.89f_{TL}	3.89f_{TL} -0.33	3.89f_{TL}-0.33	0.33-3.89f_{TL}
	a_{roll-y}	C_{YR}	11.7f_{TL}-0.69	0.69-11.7f_{TL}	0.69-11.7f_{TL}	11.7f_{TL}-0.69
	gsinθ	C_{YG}	0.63-10.2f_{TL}	10.2f_{TL}-0.63	10.2f_{TL}-0.63	0.63-10.2f_{TL}
Vertical accelerations	a_{heave}	C_{ZH}	1.8f_{TL}+0.1	-0.1-1.8f_{TL}	1.8f_{TL}+0.1	-0.1-1.8f_{TL}
	a_{roll-z}	C_{ZR}	11.7f_{TL}-0.69	0.69-11.7f_{TL}	0.69-11.7f_{TL}	11.7f_{TL}-0.69
	$a_{pitch-z}$	C_{ZP}	0.74-6.3f_{TL}	6.3f_{TL}-0.74	0.74-6.3f_{TL}	6.3f_{TL}-0.74

Continue

Load component		LCF	OHM-1P	OHM-2P	OHM-1S	OHM-2S
Hull girder loads	M_{wv}	C_{WV}	$7.1f_{TL}$-0.63	0.63-$7.1f_{TL}$	$7.1f_{TL}$-0.63	0.63-$7.1f_{TL}$
	Q_{wv}	C_{QW}	$(7.1f_{TL}$-0.63$)f_{lp}$	$(0.63$-$7.1f_{TL})f_{lp}$	$(7.1f_{TL}$-0.63$)\ f_{lp}$	$(0.63$-$7.1f_{TL})\ f_{lp}$
	M_{wh}	C_{WH}	-1	1	1	-1
	Q_{wh}	C_{QH}	f_{lp}	$-f_{lp}$	$-f_{lp}$	f_{lp}
	M_{wt}	C_{WT}	$-f_{lp}$	f_{lp}	f_{lp}	$-f_{lp}$
Longitudinal accelerations	a_{surge}	C_{XS}	0.2	-0.2	0.2	-0.2
	$a_{pitch\text{-}x}$	C_{XP}	$10f_{TL}$-0.7	0.7-$10f_{TL}$	$10f_{TL}$-0.7	0.7-$10f_{TL}$
	$g\sin\varphi$	C_{XG}	0.37	-0.37	0.37	-0.37
Transverse accelerations	a_{sway}	C_{YS}	0.27	-0.27	-0.27	0.27
	$a_{roll\text{-}y}$	C_{YR}	$8.5f_{TL}$-0.86	0.86-$8.5f_{TL}$	0.86-$8.5f_{TL}$	$8.5f_{TL}$-0.86
	$g\sin\theta$	C_{YG}	0.7-$10.5f_{TL}$	$10.5f_{TL}$-0.7	$10.5f_{TL}$-0.7	0.7-$10.5f_{TL}$
Vertical accelerations	a_{heave}	C_{ZH}	0.19	-0.19	0.19	-0.19
	$a_{roll\text{-}z}$	C_{ZR}	$8.5f_{TL}$-0.86	0.86-$8.5f_{TL}$	0.86-$8.5f_{TL}$	$8.5f_{TL}$-0.86
	$a_{pitch\text{-}z}$	C_{ZP}	$10f_{TL}$-0.7	0.7-$10f_{TL}$	$10f_{TL}$-0.7	0.7-$10f_{TL}$

Continue

Load component		LCF	OHS-1P	OHS-2P	OHS-1S	OHS-2S
Hull girder loads	M_{wv}	C_{WV}	0.86-$1.34C_{W\text{-}LC}$	$1.34C_{W\text{-}LC}$-0.86	0.86-$1.34C_{W\text{-}LC}$	$1.34C_{W\text{-}LC}$-0.86
	Q_{wv}	C_{QW}	$(0.86$-$1.34C_{W\text{-}LC})f_{lp}$	$(1.34C_{W\text{-}LC}$-0.86$)f_{lp}$	$(0.86$-$1.34C_{W\text{-}LC})f_{lp}$	$(1.34C_{W\text{-}LC}$ -0.86$)f_{lp}$
	M_{wh}	C_{WH}	-1	1	1	-1
	Q_{wh}	C_{QH}	f_{lp}	$-f_{lp}$	$-f_{lp}$	f_{lp}
	M_{wt}	C_{WT}	$-f_{lp}$	f_{lp}	f_{lp}	$-f_{lp}$
Longitudinal accelerations	a_{surge}	C_{XS}	$3f_{TL}$-0.38	0.38-$3f_{TL}$	$3f_{TL}$-0.38	0.38-$3f_{TL}$
	$a_{pitch\text{-}x}$	C_{XP}	0.2+$6.24f_{TL}$	-0.2-$6.24f_{TL}$	0.2+$6.24f_{TL}$	-0.2-$6.24f_{TL}$
	$g\sin\varphi$	C_{XG}	$1.28C_{b\text{-}LC}$-1.13	1.13-$1.28C_{b\text{-}LC}$	$1.28C_{b\text{-}LC}$-1.13	1.13-$1.28C_{b\text{-}LC}$
Transverse accelerations	a_{sway}	C_{YS}	$0.55f_{TL}$+0.08	-0.08-$0.55f_{TL}$	-0.08-$0.55f_{TL}$	$0.55f_{TL}$+0.08
	$a_{roll\text{-}y}$	C_{YR}	$11.6f_{TL}$-0.69	0.69-$11.6f_{TL}$	0.69-$11.6f_{TL}$	$11.6f_{TL}$-0.69
	$g\sin\theta$	C_{YG}	0.66-$10.5f_{TL}$	$10.5f_{TL}$-0.66	$10.5f_{TL}$-0.66	0.66-$10.5f_{TL}$

Vertical accelerations	a_{heave}	C_{ZH}	0.23	-0.23	0.23	-0.23
	a_{roll-z}	C_{ZR}	$11.6f_{TL}$-0.69	0.69-$11.6f_{TL}$	0.69-$11.6f_{TL}$	$11.6f_{TL}$-0.69
	$a_{pitch-z}$	C_{ZP}	0.2+$6.24f_{TL}$	-0.2-$6.24f_{TL}$	0.2+$6.24f_{TL}$	-0.2-$6.24f_{TL}$

Continue

Load component		LCF	OSA-1P	OSA-2P	OSA-1S	OSA-2S
Hull girder loads	M_{wv}	C_{WV}	0.65-$3.18f_{TL}$	$3.18f_{TL}$-0.65	0.65-$3.18f_{TL}$	$3.18f_{TL}$-0.65
	Q_{wv}	C_{QW}	(0.55-$1.7f_{TL}$)f_{lp}	($1.7f_{TL}$-0.55)f_{lp}	(0.55-$1.7f_{TL}$)f_{lp}	($1.7f_{TL}$-0.55)f_{lp}
	M_{wh}	C_{WH}	1.37-$1.26C_{b-LC}$	$1.26C_{b-LC}$-1.37	$1.26C_{b-LC}$-1.37	1.37-$1.26C_{b-LC}$
	Q_{wh}	C_{QH}	/	/	/	/
	M_{wt}	C_{WT}	-$0.7f_{lp-OSA}$	$0.7f_{lp-OSA}$	$0.7f_{lp-OSA}$	-$0.7f_{lp-OSA}$
Longitudinal accelerations	a_{surge}	C_{XS}	$5.25f_{TL}$-0.57	0.57-$5.25f_{TL}$	$5.25f_{TL}$-0.57	0.57-$5.25f_{TL}$
	$a_{pitch-x}$	C_{XP}	1	-1	1	-1
	gsinφ	C_{XG}	-0.68	0.68	-0.68	0.68
Transverse accelerations	a_{sway}	C_{YS}	-0.19-$1.9f_{TL}$	0.19+$1.9f_{TL}$	0.19+$1.9f_{TL}$	-0.19-$1.9f_{TL}$
	a_{roll-y}	C_{YR}	0.15	-0.15	-0.15	0.15
	gsinθ	C_{YG}	-0.1	0.1	0.1	-0.1
Vertical accelerations	a_{heave}	C_{ZH}	$1.53C_{b-LC}$-1.38	1.38-$1.53C_{b-LC}$	$1.53C_{b-LC}$-1.38	1.38-$1.53C_{b-LC}$
	a_{roll-z}	C_{ZR}	0.15	-0.15	-0.15	0.15
	$a_{pitch-z}$	C_{ZP}	1	-1	1	-1

Continue

Load component		LCF	OVA-1P	OVA-2P	OVA-1S	OVA-2S
Hull girder loads	M_{wv}	C_{WV}	0.7-$2.28f_{TL}$	$2.28f_{TL}$-0.7	0.7-$2.28f_{TL}$	$2.28f_{TL}$-0.7
	Q_{wv}	C_{QW}	(0.7-$2.28f_{TL}$)f_{lp}	($2.28f_{TL}$-0.7) f_{lp}	(0.7-$2.28f_{TL}$)f_{lp}	($2.28f_{TL}$-0.7)f_{lp}
	M_{wh}	C_{WH}	0.47	-0.47	-0.47	0.47
	Q_{wh}	C_{QH}	-$0.47f_{lp}$	$0.47f_{lp}$	$0.47f_{lp}$	-$0.47f_{lp}$
	M_{wt}	C_{WT}	$0.47f_{lp}$	-$0.47f_{lp}$	-$0.47f_{lp}$	$0.47f_{lp}$
Longitudinal accelerations	a_{surge}	C_{XS}	$6.9f_{TL}$-0.67	0.67-$6.9f_{TL}$	$6.9f_{TL}$-0.67	0.67-$6.9f_{TL}$
	$a_{pitch-x}$	C_{XP}	1	-1	1	-1
	gsinφ	C_{XG}	-0.66	0.66	-0.66	0.66

Transverse accelerations	a_{sway}	C_{YS}	-0.28	0.28	0.28	-0.28
	$a_{roll\text{-}y}$	C_{YR}	0.6-1.2ω_R	1.2ω_R-0.6	1.2ω_R-0.6	0.6-1.2ω_R
	$g\sin\theta$	C_{YG}	1.2ω_R-0.6	0.6-1.2ω_R	0.6-1.2ω_R	1.2ω_R-0.6
Vertical accelerations	a_{heave}	C_{ZH}	-6f_{TL}	6f_{TL}	-6f_{TL}	6f_{TL}
	$a_{roll\text{-}z}$	C_{ZR}	0.6-1.2ω_R	1.2ω_R-0.6	1.2ω_R-0.6	0.6-1.2ω_R
	$a_{pitch\text{-}z}$	C_{ZP}	1	-1	1	-1

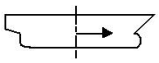
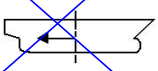
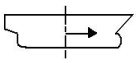
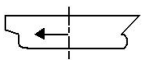
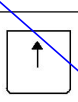
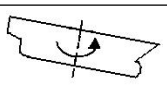
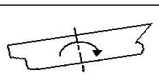
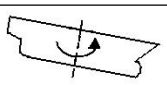
3 Dynamic load cases for fatigue assessment

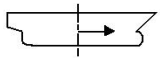
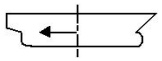
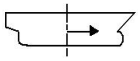
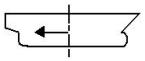
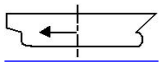
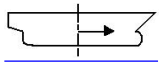
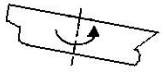
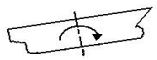
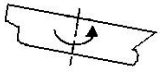
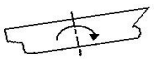
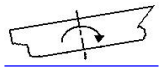
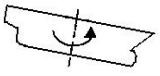
3.1 Description of dynamic load cases

3.1.1 Table 3.1.1(1) to Table 3.1.1(3) describe the ship motions responses and the global loads corresponding to each dynamic load case to be considered for the fatigue assessment.

Ship responses for ~~HVM and HVS~~ HVM, HVS and FVM load cases - Fatigue assessment

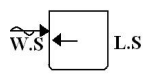
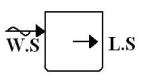
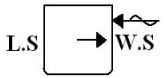
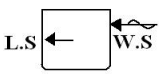
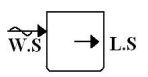
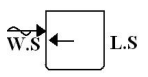
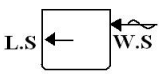
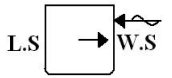
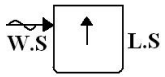
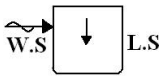
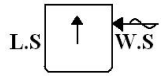
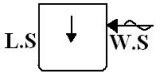
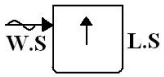
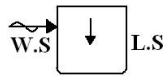
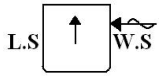
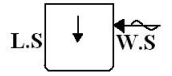
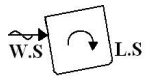
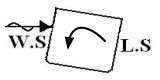
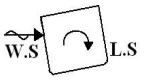
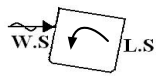
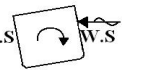
Table 3.1.1(1)

~~Load case~~	~~HVM-1~~	~~HVM-2~~	~~HVS-1~~	~~HVS-2~~
~~EDW~~	~~HVM~~		~~HVS~~	
~~Heading~~	~~Head~~		~~Head~~	
~~Effect~~	~~Max. vertical bending moment~~		~~Max. vertical shear force~~	
~~VWBM~~	~~Sagging~~	~~Hogging~~	~~Sagging~~	~~Hogging~~
~~VWSF~~	~~Negative aft Positive fore~~	~~Positive aft Negative fore~~	~~Negative aft Positive fore~~	~~Positive aft Negative fore~~
~~HWBM~~	-	-	-	-
~~HWSF~~	-	-	-	-
~~TM~~	-	-	-	-
~~Surge~~	~~To stern~~	~~To bow~~	~~To stern~~	~~To bow~~
~~a_{surge}~~				
~~Sway~~	-	-	-	-
~~a_{sway}~~	-	-	-	-
~~Heave~~	~~Down~~	~~Up~~	~~Down~~	~~Up~~
~~a_{heave}~~				
~~Roll~~	-	-	-	-
~~a_{roll}~~	-	-	-	-
~~Pitch~~	~~Bow down~~	~~Bow up~~	~~Bow down~~	~~Bow up~~
~~a_{pitch}~~				

Load case	HVM-1	HVM-2	HVS-1	HVS-2	FVM-1	FVM-2
EDW	HVM		HVS		FVM	
Heading	Head		Head		Following	
Effect	Max. vertical bending moment		Max. vertical shear force		Max. vertical bending moment	
VWBM	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging
VWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	-	-	-	-	-	-
HWSF	-	-	-	-		
TM	-	-	-	-	-	-
Surge	To stern	To bow	To stern	To bow	To bow	To stern
a_{surge}						
Sway	-	-	-	-	-	-
a_{sway}	-	-	-	-	-	-
Heave	Down	Up	Down	Up	Down	Up
a_{heave}						
Roll	-	-	-	-	-	-
a_{roll}	-	-	-	-	-	-
Pitch	Bow down	Bow up	Bow down	Bow up	Bow up	Bow down
a_{pitch}						

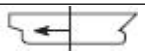
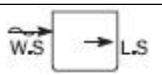
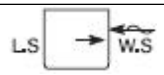
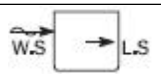
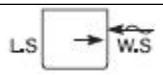
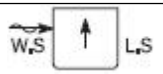
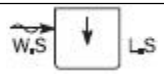
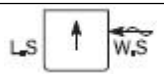
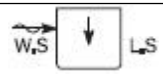
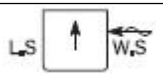
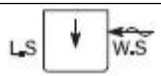
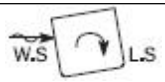
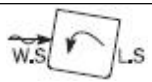
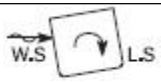
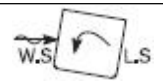
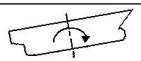
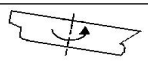
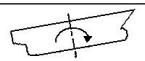
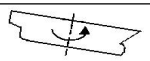
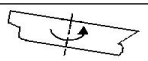
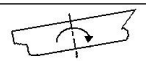
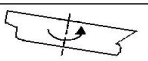
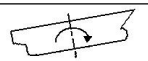
Ship responses for BSR and BSP load cases - Fatigue assessment

Table 3.1.1(2)

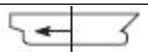
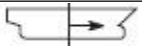
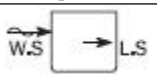
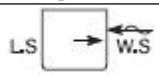
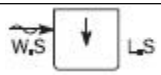
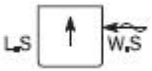
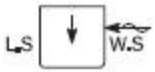
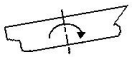
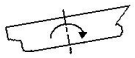
Load case	BSR-1P	BSR-2P	BSR-1S	BSR-2S	BSP-1P	BSP-2P	BSP-1S	BSP-2S
EDW	BSR		BSR		BSP		BSP	
Heading	Beam				Beam			
Effect	Max. roll				Max.pressure at waterline			
VWBM	-	-	-	-	Sagging	Hogging	Sagging	Hogging
VWSF	-	-	-	-	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	Stbd tensile	Port tensile	Port tensile	Stbd tensile	Stbd tensile	Port tensile	Port tensile	Stbd tensile
HWSF	-	-	-	-	-	-	-	-
TM	-	-	-	-	-	-	-	-
Surge	-	-	-	-	-	-	-	-
a_{surge}	-	-	-	-	-	-	-	-
Sway	To starboard	To portside	To portside	To starboard	To portside	To starboard	To starboard	To portside
a_{sway}								
Heave	Down	Up	Down	Up	Down	Up	Down	Up
a_{heave}								
Roll	Portside down	Portside up	Starboard down	Starboard up	Portside down	Portside up	Starboard down	Starboard up
a_{roll}								
Pitch	-	-	-	-	-	-	-	-
a_{pitch}	-	-	-	-	-	-	-	-

Ship responses for OSTf, OHM and OHS load cases - Fatigue assessment

Table 3.1.1(3)

Load case	OSTf-1P	OSTf-2P	OSTf-1S	OSTf-2S	OHM-1P	OHM-2P	OHM-1S	OHM-2S
EDW	OST				OHM			
Heading	Oblique				Oblique			
Effect	Max. torsional moment				Max. horizontal bending moment			
VWBM	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging	Sagging	Hogging
VWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	Port tensile	Stbd tensile	Stbd tensile	Port tensile	Port tensile	Stbd tensile	Stbd tensile	Port tensile
HWSF	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore
TM	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore
Surge	To bow	To stern	To bow	To stern	To stern	To bow	To stern	To bow
a_{surge}								
Sway	To starboard	To portside	To portside	To starboard	To starboard	To portside	To portside	To starboard
a_{sway}								
Heave	Down	Up	Down	Up	Down	Up	Down	Up
a_{heave}								
Roll	Portside down	Portside up	Starboard down	Starboard up	Portside down	Portside up	Starboard down	Starboard up
a_{roll}								
Pitch	Bow up	Bow down	Bow up	Bow down	Bow down	Bow up	Bow down	Bow up
a_{pitch}								

Continue

Load case	OHS-1P	OHS-2P	OHS-1S	OHS-2S
EDW	OHS			
Heading	Oblique			
Effect	Max. horizontal shear force			
VWBM	Sagging	Hogging	Sagging	Hogging
VWSF	Negative-aft Positive -fore	Positive-aft Negative-fore	Negative-aft Positive -fore	Positive-aft Negative-fore
HWBM	Port tensile	Stbd tensile	Stbd tensile	Port tensile
HWSF	Positive-aft Negative-fore	Negative-aft Positive -fore	Negative-aft Positive -fore	Positive-aft Negative-fore
TM	Negative-aft Positive -fore	Positive-aft Negative-fore	Positive-aft Negative-fore	Negative-aft Positive -fore
Surge	To bow	To stern	To bow	To stern
a_{surge}				
Sway	To starboard	To portside	To portside	To starboard
a_{sway}				
Heave	Down	Up	Down	Up
a_{heave}				
Roll	Portside down	Portside up	Starboard down	Starboard up
a_{roll}				
Pitch	Bow up	Bow down	Bow up	Bow down
a_{pitch}				

3.2 Load combination factors

3.2.1 The load combinations factors, LCFs for the global loads and inertia load components for fatigue assessment are defined in:

Table 3.2.1(1): LCFs for ~~HVM and HVS~~ HVM, HVS and FVM load cases.

Table 3.2.1(2): LCFs for BSR and BSP load cases.

Table 3.2.1(3): LCFs for OSTf, OHM and OHS load cases.

Load combinations factors, LCFs for ~~HVM and HVS~~ HVM, HVS and FVM load cases - Fatigue assessment **Table 3.2.1(1)**

~~Load component~~		~~LCF~~	~~HVM-1~~	~~HVM-2~~	~~HVS-1~~	~~HVS-2~~
~~Hull girder loads~~	~~M_{wv}~~	~~C_{WV}~~	~~-1~~	~~1~~	~~-1~~	~~1~~
	~~Q_{wv}~~	~~C_{QW}~~	~~$-f_{lp}$~~	~~f_{lp}~~	~~$-f_{lp}$~~	~~f_{lp}~~
	~~M_{wh}~~	~~C_{WH}~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~Q_{wh}~~	~~C_{QH}~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~M_{wt}~~	~~C_{WT}~~	~~0~~	~~0~~	~~0~~	~~0~~
~~Longitudinal accelerations~~	~~a_{surge}~~	~~C_{XS}~~	~~$0.74-8.1f_{TL}$~~	~~$8.1f_{TL}-0.74$~~	~~$0.76-8.58f_{TL}$~~	~~$8.58f_{TL}-0.76$~~
	~~$a_{pitch-x}$~~	~~C_{XP}~~	~~$-0.55-7.6f_{TL}$~~	~~$0.55+7.6f_{TL}$~~	~~$-0.62-6.36f_{TL}$~~	~~$0.62+6.36f_{TL}$~~
	~~gsinφ~~	~~C_{XG}~~	~~$0.5+4.45f_{TL}$~~	~~$-0.5-4.45f_{TL}$~~	~~$0.43+7.5f_{TL}$~~	~~$-0.43-7.5f_{TL}$~~
~~Transverse accelerations~~	~~a_{sway}~~	~~C_{YS}~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~a_{roll-y}~~	~~C_{YR}~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~gsinθ~~	~~C_{YG}~~	~~0~~	~~0~~	~~0~~	~~0~~
~~Vertical accelerations~~	~~a_{heave}~~	~~C_{ZH}~~	~~$0.16+6.49f_{TL}$~~	~~$-0.16-6.49f_{TL}$~~	~~$0.1+9.6f_{TL}$~~	~~$-0.1-9.6f_{TL}$~~
	~~a_{roll-z}~~	~~C_{ZR}~~	~~0~~	~~0~~	~~0~~	~~0~~
	~~$a_{pitch-z}$~~	~~C_{ZP}~~	~~$-0.55-7.6f_{TL}$~~	~~$0.55+7.6f_{TL}$~~	~~$-0.62-6.36f_{TL}$~~	~~$0.62+6.36f_{TL}$~~

Load component		LCF	HVM-1	HVM-2	HVS-1	HVS-2
Hull girder loads	M_{wv}	C_{WV}	-1	1	-1	1
	Q_{wv}	C_{QW}	$-f_{lp}$	f_{lp}	$-f_{lp}$	f_{lp}
	M_{wh}	C_{WH}	0	0	0	0
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0

Longitudinal accelerations	a_{surge}	C_{XS}	$0.68-8.13f_{TL}$	$8.13f_{TL}-0.68$	$0.76-8.58f_{TL}$	$8.58f_{TL}-0.76$
	$a_{pitch-x}$	C_{XP}	$-0.6-6f_{TL}$	$0.6+6f_{TL}$	$-0.62-6.36f_{TL}$	$0.62+6.36f_{TL}$
	$g\sin\varphi$	C_{XG}	$0.5+4.45f_{TL}$	$-0.5-4.45f_{TL}$	$0.43+7.5f_{TL}$	$-0.43-7.5f_{TL}$
Transverse accelerations	a_{sway}	C_{YS}	0	0	0	0
	a_{roll-y}	C_{YR}	0	0	0	0
	$g\sin\theta$	C_{YG}	0	0	0	0
Vertical accelerations	a_{heave}	C_{ZH}	$0.15+7.7f_{TL}$	$-0.15-7.7f_{TL}$	$0.1+9.6f_{TL}$	$-0.1-9.6f_{TL}$
	a_{roll-z}	C_{ZR}	0	0	0	0
	$a_{pitch-z}$	C_{ZP}	$-0.6-6f_{TL}$	$0.6+6f_{TL}$	$-0.62-6.36f_{TL}$	$0.62+6.36f_{TL}$

Continue

Load component		LCF	FVM-1	FVM-2
Hull girder loads	M_{wv}	C_{WV}	-1	1
	Q_{wv}	C_{QW}	$-f_{lp}$	f_{lp}
	M_{wh}	C_{WH}	0	0
	Q_{wh}	C_{QH}	0	0
	M_{wt}	C_{WT}	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	$0.1-3.58f_{TL}$	$3.58f_{TL}-0.1$
	$a_{pitch-x}$	C_{XP}	0.1	-0.1
	$g\sin\varphi$	C_{XG}	-0.12	0.12
Transverse accelerations	a_{sway}	C_{YS}	0	0
	a_{roll-y}	C_{YR}	0	0
	$g\sin\theta$	C_{YG}	0	0
Vertical accelerations	a_{heave}	C_{ZH}	0.08	-0.08
	a_{roll-z}	C_{ZR}	0	0
	$a_{pitch-z}$	C_{ZP}	0.1	-0.1

Load combinations factors, LCFs for BSR and BSP load cases - Fatigue assessment

Table 3.2.1(2)

Load component		LCF	BSR-1P	BSR-2P	BSR-1S	BSR-2S
Hull girder loads	M_{wv}	C_{WV}	0	0	0	0
	Q_{wv}	C_{QW}	0	0	0	0
	M_{wh}	C_{WH}	$1.3-16f_{TL}$	$16f_{TL}-1.3$	$16f_{TL}-1.3$	$1.3-16f_{TL}$
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch-x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	$0.74-1.72\omega_R$	$1.72\omega_R-0.74$	$1.72\omega_R-0.74$	$0.74-1.72\omega_R$
	a_{roll-y}	C_{YR}	1	-1	-1	1
	gsinθ	C_{YG}	-1	1	1	-1
Vertical accelerations	a_{heave}	C_{ZH}	$0.8-11.8f_{TL}$	$11.8f_{TL}-0.8$	$0.8-11.8f_{TL}$	$11.8f_{TL}-0.8$
	a_{roll-z}	C_{ZR}	1	-1	-1	1
	$a_{pitch-z}$	C_{ZP}	0	0	0	0

Load component		LCF	BSR-1P	BSR-2P	BSR-1S	BSR-2S
Hull girder loads	M_{wv}	C_{WV}	0	0	0	0
	Q_{wv}	C_{QW}	0	0	0	0
	M_{wh}	C_{WH}	$3.1-3.05C_{W\text{-}LC}$	$3.05C_{W\text{-}LC}-3.1$	$3.05C_{W\text{-}LC}-3.1$	$3.1-3.05C_{W\text{-}LC}$
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch-x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	$0.67C_{b\text{-}LC}-0.29$	$0.29-0.67C_{b\text{-}LC}$	$0.29-0.67C_{b\text{-}LC}$	$0.67C_{b\text{-}LC}-0.29$
	a_{roll-y}	C_{YR}	1	-1	-1	1
	gsinθ	C_{YG}	-1	1	1	-1

Vertical accelerations	a_{heave}	C_{ZH}	$0.8\text{-}11.8f_{TL}$	$11.8f_{TL}\text{-}0.8$	$0.8\text{-}11.8f_{TL}$	$11.8f_{TL}\text{-}0.8$
	$a_{roll\text{-}z}$	C_{ZR}	1	-1	-1	1
	$a_{pitch\text{-}z}$	C_{ZP}	0	0	0	0

Continue

Load component		LCF	BSP-1P	BSP-2P	BSP-1S	BSP-2S
Hull girder loads	M_{wv}	C_{WV}	-0.22	0.22	-0.22	0.22
	Q_{wv}	C_{QW}	$-0.22f_{lp}$	$0.22f_{lp}$	$-0.22f_{lp}$	$0.22f_{lp}$
	M_{wh}	C_{WH}	$0.88\text{-}11.8f_{TL}$	$11.8f_{TL}\text{-}0.88$	$11.8f_{TL}\text{-}0.88$	$0.88\text{-}11.8f_{TL}$
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudinal accelerations	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch\text{-}x}$	C_{XP}	0	0	0	0
	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	$-0.56\text{-}6.2f_{TL}$	$0.56\text{+}6.2f_{TL}$	$0.56\text{+}6.2f_{TL}$	$-0.56\text{-}6.2f_{TL}$
	$a_{roll\text{-}y}$	C_{YR}	$0.95\text{-}0.15T_R$	$0.15T_R\text{-}0.95$	$0.15T_R\text{-}0.95$	$0.95\text{-}0.15T_R$
	gsinθ	C_{YG}	-0.3	0.3	0.3	-0.3
Vertical accelerations	a_{heave}	C_{ZH}	1	-1	1	-1
	$a_{roll\text{-}z}$	C_{ZR}	$0.95\text{-}0.15T_R$	$0.15T_R\text{-}0.95$	$0.15T_R\text{-}0.95$	$0.95\text{-}0.15T_R$
	$a_{pitch\text{-}z}$	C_{ZP}	0	0	0	0

Load component		LCF	BSP-1P	BSP-2P	BSP-1S	BSP-2S
Hull girder loads	M_{wv}	C_{WV}	$0.09\text{-}7.82f_{TL}$	$7.82f_{TL}\text{-}0.09$	$0.09\text{-}7.82f_{TL}$	$7.82f_{TL}\text{-}0.09$
	Q_{wv}	C_{QW}	$(0.09\text{-}7.82f_{TL})f_{lp}$	$(7.82f_{TL}\text{-}0.09)f_{lp}$	$(0.09\text{-}7.82f_{TL})f_{lp}$	$(7.82f_{TL}\text{-}0.09)f_{lp}$
	M_{wh}	C_{WH}	$0.77\text{-}10.9f_{TL}$	$10.9f_{TL}\text{-}0.77$	$10.9f_{TL}\text{-}0.77$	$0.77\text{-}10.9f_{TL}$
	Q_{wh}	C_{QH}	0	0	0	0
	M_{wt}	C_{WT}	0	0	0	0
Longitudi	a_{surge}	C_{XS}	0	0	0	0
	$a_{pitch\text{-}x}$	C_{XP}	0	0	0	0

nal accelerations	gsinφ	C_{XG}	0	0	0	0
Transverse accelerations	a_{sway}	C_{YS}	-0.62-4.5f_{TL}	0.62+4.5f_{TL}	0.62+4.5f_{TL}	-0.62-4.5f_{TL}
	a_{roll-y}	C_{YR}	0.4	-0.4	-0.4	0.4
	gsinθ	C_{YG}	4.5f_{TL}-0.5	0.5-4.5f_{TL}	0.5-4.5f_{TL}	4.5f_{TL}-0.5
Vertical accelerations	a_{heave}	C_{ZH}	1	-1	1	-1
	a_{roll-z}	C_{ZR}	0.4	-0.4	-0.4	0.4
	$a_{pitch-z}$	C_{ZP}	0	0	0	0

Load combinations factors, LCFs for OSTf, OHM and OHS load cases - Fatigue assessment

Table 3.2.1(3)

Load component		LCF	OSTf-1P	OSTf-2P	OSTf-1S	OSTf-2S
Hull girder loads	M_{wv}	C_{WV}	0.75C_{W-LC}-0.99	0.99-0.75C_{W-LC}	0.75C_{W-LC}-0.99	0.99-0.75C_{W-LC}
	Q_{wv}	C_{QW}	(0.75C_{W-LC}-0.99)f_{lp}	(0.99-0.75C_{W-LC})f_{lp}	(0.75C_{W-LC}-0.99)f_{lp}	(0.99-0.75C_{W-LC})f_{lp}
	M_{wh}	C_{WH}	-1	1	1	-1
	Q_{wh}	C_{QH}	f_{lp}	-f_{lp}	-f_{lp}	f_{lp}
	M_{wt}	C_{WT}	-f_{lp}	f_{lp}	f_{lp}	-f_{lp}
Longitudinal accelerations	a_{surge}	C_{XS}	0.2C_{b-LC}-0.31	0.31-0.2C_{b-LC}	0.2C_{b-LC}-0.31	0.31-0.2C_{b-LC}
	$a_{pitch-x}$	C_{XP}	0.41	-0.41	0.41	-0.41
	gsinφ	C_{XG}	1.13C_{b-LC}-1.04	1.04-1.13C_{b-LC}	1.13C_{b-LC}-1.04	1.04-1.13C_{b-LC}
Transverse accelerations	a_{sway}	C_{YS}	0.25	-0.25	-0.25	0.25
	a_{roll-y}	C_{YR}	11.7f_{TL}-0.72	0.72-11.7f_{TL}	0.72-11.7f_{TL}	11.7f_{TL}-0.72
	gsinθ	C_{YG}	0.65-10.2f_{TL}	10.2f_{TL}-0.65	10.2f_{TL}-0.65	0.65-10.2f_{TL}
Vertical accelerations	a_{heave}	C_{ZH}	0.18	-0.18	0.18	-0.18
	a_{roll-z}	C_{ZR}	11.7f_{TL}-0.72	0.72-11.7f_{TL}	0.72-11.7f_{TL}	11.7f_{TL}-0.72
	$a_{pitch-z}$	C_{ZP}	0.41	-0.41	0.41	-0.41

Continue

Load component		LCF	OHM-1P	OHM-2P	OHM-1S	OHM-2S
Hull girder loads	M_{wv}	C_{WV}	11.18f_{TL}-0.77	0.77-11.18f_{TL}	11.18f_{TL}-0.77	0.77-11.18f_{TL}
	Q_{wv}	C_{QW}	（11.18f_{TL}-0.77）f_{lp}	（0.77-11.18f_{TL}）f_{lp}	（11.18f_{TL}-0.77）f_{lp}	（0.77-11.18f_{TL}）f_{lp}
	M_{wh}	C_{WH}	-1	1	1	-1
	Q_{wh}	C_{QH}	f_{lp}	-f_{lp}	-f_{lp}	f_{lp}
	M_{wt}	C_{WT}	-f_{lp}	f_{lp}	f_{lp}	-f_{lp}
Longitudinal accelerations	a_{surge}	C_{XS}	0.21	-0.21	0.21	-0.21
	$a_{pitch-x}$	C_{XP}	-0.38	0.38	-0.38	0.38
	gsinφ	C_{XG}	0.3	-0.3	0.3	-0.3
Transverse accelerations	a_{sway}	C_{YS}	0.32	-0.32	-0.32	0.32
	a_{roll-y}	C_{YR}	12f_{TL}-0.9	0.9-12f_{TL}	0.9-12f_{TL}	12f_{TL}-0.9
	gsinθ	C_{YG}	0.7-10.5f_{TL}	10.5f_{TL}-0.7	10.5f_{TL}-0.7	0.7-10.5f_{TL}
Vertical accelerations	a_{heave}	C_{ZH}	0.18	-0.18	0.18	-0.18
	a_{roll-z}	C_{ZR}	12f_{TL}-0.9	0.9-12f_{TL}	0.9-12f_{TL}	12f_{TL}-0.9
	$a_{pitch-z}$	C_{ZP}	-0.38	0.38	-0.38	0.38

Continue

Load component		LCF	OHS-1P	OHS-2P	OHS-1S	OHS-2S
Hull girder loads	M_{wv}	C_{WV}	$0.2C_{W\text{-}LC}$-0.52	0.52-$0.2C_{W\text{-}LC}$	$0.2C_{W\text{-}LC}$-0.52	0.52-$0.2C_{W\text{-}LC}$
	Q_{wv}	C_{QW}	$(0.2C_{W\text{-}LC}\text{-}0.52)f_{lp}$	$(0.52\text{-}0.2C_{W\text{-}LC})f_{lp}$	$(0.2C_{W\text{-}LC}\text{-}0.52)f_{lp}$	$(0.52\text{-}0.2C_{W\text{-}LC})f_{lp}$
	M_{wh}	C_{WH}	-1	1	1	-1
	Q_{wh}	C_{QH}	f_{lp}	$-f_{lp}$	$-f_{lp}$	f_{lp}
	M_{wt}	C_{WT}	$-f_{lp}$	f_{lp}	f_{lp}	$-f_{lp}$
Longitudinal accelerations	a_{surge}	C_{XS}	-0.17	0.17	-0.17	0.17
	$a_{pitch\text{-}x}$	C_{XP}	$0.73\text{-}10.8f_{TL}$	$10.8f_{TL}$-0.73	$0.73\text{-}10.8f_{TL}$	$10.8f_{TL}$-0.73
	gsinφ	C_{XG}	-0.31	0.31	-0.31	0.31
Transverse accelerations	a_{sway}	C_{YS}	0.2	-0.2	-0.2	0.2
	$a_{roll\text{-}y}$	C_{YR}	$11.7f_{TL}$-0.72	$0.72\text{-}11.7f_{TL}$	$0.72\text{-}11.7f_{TL}$	$11.7f_{TL}$-0.72
	gsinθ	C_{YG}	$0.65\text{-}10.2f_{TL}$	$10.2f_{TL}$-0.65	$10.2f_{TL}$-0.65	$0.65\text{-}10.2f_{TL}$
Vertical accelerations	a_{heave}	C_{ZH}	0.2	-0.2	0.2	-0.2
	$a_{roll\text{-}z}$	C_{ZR}	$11.7f_{TL}$-0.72	$0.72\text{-}11.7f_{TL}$	$0.72\text{-}11.7f_{TL}$	$11.7f_{TL}$-0.72
	$a_{pitch\text{-}z}$	C_{ZP}	$0.73\text{-}10.8f_{TL}$	$10.8f_{TL}$-0.73	$0.73\text{-}10.8f_{TL}$	$10.8f_{TL}$-0.73

Section 3 SHIP MOTIONS AND ACCELERATIONS

2 Ship motions and accelerations

2.1 Ship motions

2.1.1 Roll motion

The roll period T_θ, in s, to be taken as:

$$T_\theta = \frac{2.3\pi k_r}{\sqrt{gGM}}$$

The roll angle θ, in deg, to be taken as:

$$\theta = \frac{9000(1.25-0.025T_\theta)f_p f_{BK}}{(B+75)\pi}$$

where:

f_p—Coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment.

~~$f_p = f_{fa}(0.24 - 5.56 f_T B\times 10^{-4})$~~ $f_p = f_{fa}(0.208-0.77 f_T B\times 10^{-4})$ for fatigue assessment.

2.1.2 Pitch motion

The pitch period T_φ, in s, to be taken as:

$$T_\varphi = \sqrt{\frac{2\pi\lambda_\varphi}{g}}$$

where:— $\lambda_\varphi = 0.6(1+f_T)L$

The pitch angle φ, in deg, to be taken as:

$$\varphi = 1350 f_{nl} f_p f_\varphi L^{-0.94}\left\{1.0 + \left(\frac{2.57}{\sqrt{gL}}\right)^{1.2}\right\}$$

where:

f_p—coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = f_{fa}$ [(0.34-0.05f_T) (3.7-2.59f_T)Lx10^{-4}]~~ $f_p = f_{fa}$ [(0.27-0.02f_T)-(13-5f_T)$L\times 10^{-5}$] for fatigue assessment

$f\varphi$—coefficient to be taken as:

~~$f\varphi$=1.69-0.67$C_{W\text{-}LC}$ for strength assessment~~

~~$f\varphi$=2.27-1.38$C_{W\text{-}LC}$ for fatigue assessment~~

$f\varphi$=1.94-0.69$L^{0.1}C_{b\text{-}LC}$ for strength assessment

$f\varphi$=1.96-0.68$L^{0.1}C_{b\text{-}LC}$ for fatigue assessment

2.2 Ship accelerations at the centre of gravity

2.2.1 Surge acceleration

The longitudinal acceleration due to surge, in m/s^2, is to be taken as:

$$a_{surge} = 0.2 f_p f_{s1} f_{nl} a_0 g$$

where:

f_p—coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = f_{fa}(0.26-1.11 f_T L \times 10^{-4})$ for fatigue assessment~~

$f_p = f_{fa}[0.26-(15+4f_T)L \times 10^{-5}]$ for fatigue assessment

f_{s1}—coefficient to be taken as:

~~$f_{s1}=20.59 f_{TL}+0.44$ for full load condition and full load minus draught condition of strength assessment~~

~~$f_{s1}=25.88 f_{TL}+1.07$ for ballast condition of strength assessment~~

~~$f_{s1}=22.3 f_{TL}+0.3$ for full load condition and full load minus draught condition of fatigue assessment~~

~~$f_{s1}=35.2 f_{TL}+0.81$ for ballast condition of fatigue assessment~~

$f_{s1}=2.64-0.093 L^{0.5} C_{b\text{-}LC}$ for strength assessment

$f_{s1}=2.83-0.1 L^{0.5} C_{b\text{-}LC}$ for fatigue assessment

2.2.2 Sway acceleration

The transverse acceleration due to sway, in m/s^2, is to be taken as:

$$a_{sway} = 0.3 f_p f_{s2} f_{nl} a_0 g$$

where:

f_p—coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = f_{fa}[(0.28-0.02 f_T)-(9.6-5.1 f_T)B \times 10^{-4}]$ for fatigue assessment~~

$f_p = f_{fa}[0.24-(5-2f_T)B \times 10^{-4}]$ for fatigue assessment

f_{s2}—coefficient to be taken as:

~~$f_{s2}=2.23-6.92 f_{TL}$ for strength assessment~~

~~$f_{s2}=2.16-5.98 f_{TL}$ for fatigue assessment~~

$f_{s2}=1.87$ for strength assessment

$f_{s2}=2.36-0.42 f_{TL} L^{0.5} C_{W\text{-}LC}^{-2}$ for fatigue assessment

2.2.3 Heave acceleration

The vertical acceleration due to heave, in m/s^2, is to be taken as:

$$a_{heave} = f_p f_{s3} f_{nl} a_0 g$$

where:

f_p—coefficient to be taken as:

$f_p = f_{ps}$, for strength assessment

~~$f_p = f_{fa}[(0.34+0.09 f_T)-(1.86+2.59 f_T)L \times 10^{-4}]$, for fatigue assessment~~

$f_p = f_{fa}[(0.17+0.2 C_{W\text{-}LC})-28 f_T L \times 10^{-5}]$ for fatigue assessment

f_{s3}—coefficient to be taken as:

~~$f_{s3}=1.45-2.89 f_{BL}$, for strength assessment~~

~~$f_{s3}=1.25-1.62f_{BL}$, for fatigue assessment~~

$f_{s3}=4.85-4.65f_{BL}^{0.1}$ for strength assessment

$f_{s3}=0.28+0.35f_{BL}^{-0.5}C_{b\text{-}LC}^{0.5}$ for fatigue assessment

2.2.4 Roll acceleration

The roll acceleration, a_{roll}, in rad/s^2, is to be taken as:

$$a_{roll} = f_p f_{s4} \theta \frac{\pi}{180}\left(\frac{2\pi}{T_\theta}\right)^2$$

where:

θ —Roll angel using f_p equal to 1.0

f_p —coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = f_{fa}\left(0.24-6.67f_T B\times 10^{-4}\right)$ for fatigue assessment~~

$f_p = f_{fa}(0.224\text{-}2.79f_T B\times 10^{-4})$ for fatigue assessment

f_{s4}—coefficient to be taken as:

$f_{s4}=1.0$ for strength assessment

$f_{s4}=1.0$ for fatigue assessment

2.2.5 Pitch acceleration

The pitch acceleration, a_{pitch}, in rad/s^2, is to be taken as:

$$a_{pitch} = f_p f_{s5} f_{nl}\left(\frac{3.1}{\sqrt{gL}}+1.0\right)\varphi\frac{\pi}{180}\left(\frac{2\pi}{T_\varphi}\right)^2$$

where:

φ —Pitch angle using f_p equal to 1.0, $f\varphi$ equal to $1.94\text{-}0.69L^{0.1}C_{b\text{-}LC}$

f_p —coefficient to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = f_{fa}\left[(0.42-0.05f_T)-(9+2f_T)L\times 10^{-5}\right]$ for fatigue assessment~~

$f_p = f_{fa}[(0.3+0.06f_T)\text{-}23.61f_T L\times 10^{-5}]$ for fatigue assessment

f_{s5}—coefficient to be taken as:

~~$f_{s5}=2.19\text{-}5.81f_{TL}^{0.6}C_{W\text{-}LC}^{0.9}$ for full load condition and full load minus draught condition of strength assessment~~

~~$f_{s5}=1.56\text{-}3.37f_{BL}^{0.9}C_{W\text{-}LC}^{1.6}$ for ballast condition of strength assessment~~

~~$f_{s5}=5.75\text{-}6.87f_{BL}^{0.2}C_{b\text{-}LC}^{0.2}$ for full load condition and full load minus draught condition of fatigue assessment~~

~~$f_{s5}=3.72\text{-}4.75f_{BL}^{0.2}C_{b\text{-}LC}^{0.5}$ for ballast condition of fatigue assessment~~

$f_{s5}=2.1\text{-}2.41f_{BL}^{0.5}C_{W\text{-}LC}^{0.2}$ for ballast condition of strength assessment

$f_{s5}=0.91+0.013L^{0.6}$ for other condition of strength assessment

$f_{s5}=3.72\text{-}4.75f_{BL}^{0.2}C_{b\text{-}LC}^{0.5}$ for ballast condition of fatigue assessment, when $C_{b\text{-}LC}<0.67$

$f_{s5}=0.91+1.96L\times 10^{-3}$ for ballast condition of fatigue assessment,when $0.67\le C_{b\text{-}LC}\le 0.77$

$f_{s5}=0.9+6.34f_{TL}$ for ballast condition of fatigue assessment, when $0.77<C_{b\text{-}LC}$

$f_{s5}=0.77+0.133B^{0.3}C_{b\text{-}LC}^{-1}$ for other condition of fatigue assessment

Section 4 HULL GIRDER LOADS

3 Dynamic hull girder loads

3.2 Vertical wave bending moment

3.2.1 Distribution of vertical wave bending moment M_{wv}, in kN·m, along the ship's length is shown in Figure 3.2.1(2), where:

$$M_{wv-h} = +1.5 f_R f_p L^3 C_d C_W \left(\frac{B}{L}\right)^{0.8} f_{NL-Hog}$$

$$M_{wv-s} = -1.5 f_R f_p L^3 C_d C_W \left(\frac{B}{L}\right)^{0.8} f_{NL-Sag}$$

where: f_R—reduction factor, to be taken as:

$f_R = 0.85$

f_p—coefficient, to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = 0.9[0.29-(19.5-14f_T)L\times10^{-5}]$ for fatigue assessment~~

$f_p = 0.9\ [\ 0.28-(14.85f_T-0.5)\ L\times10^{-5}]$ for fatigue assessment

3.3 Vertical wave shear force

3.3.1 The distribution of the vertical wave induced shear forces, Q_{wv} in kN, along the ship length is shown in Figure 3.3.1, where:

$$Q_{wvHog}^{Aft} = +5.2 f_R f_p L^2 C_d C_W \left(\frac{B}{L}\right)^{0.8} \left(0.3+0.7 f_{NL-Hog}\right)$$

$$Q_{wvHog}^{Fore} = -5.7 f_R f_p L^2 C_d C_W \left(\frac{B}{L}\right)^{0.8} f_{NL-Hog}$$

$$Q_{wvSag}^{Aft} = -5.2 f_R f_p L^2 C_d C_W \left(\frac{B}{L}\right)^{0.8} \left(0.3+0.7 f_{NL-Sag}\right)$$

$$Q_{wvSag}^{Fore} = +5.7 f_R f_p L^2 C_d C_W \left(\frac{B}{L}\right)^{0.8} \left(0.25+0.75 f_{NL-Sag}\right)$$

$$Q_{wv}^{Mid} = +4.0 f_R f_p L^2 C_d C_W \left(\frac{B}{L}\right)^{0.8}$$

where: f_p—coefficient, to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = 0.9[0.29 - (27.2 - 25f_T)L \times 10^{-5}]$ for fatigue assessment~~

$f_p = 0.9[0.262-(6.58f_T-0.07)L\times10^{-5}]$ for fatigue assessment

3.4 Horizontal wave bending moment

3.4.1 The horizontal wave bending moment M_{wh} at any longitudinal position, in kN·m, is to be taken as:

$$M_{\text{wh}} = 2.6 \cdot f_{mz} f_R f_P C_d L^3 C_b^{0.3} (\frac{T_{SC}}{L})^{0.8}$$

where: f_p—coefficient, to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = 0.9[0.25 + (5 - 2.8f_T)L \times 10^{-5}]$ for fatigue assessment~~

$f_p=0.9(0.23+2.24f_TL\times10^{-5})$ for fatigue assessment

3.5 Wave torsional moment

3.5.1 The wave torsional moment M_{wt} at any longitudinal position, in kN·m, is to be taken as:

$$M_{\text{wt}} = f_R f_P (M_{x0} + M_T)$$

where:

M_{x0} —torsional moment irrelevant to the vertical position of torsional centre, in kN·m;

M_T —torsional moment relevant to the vertical position of torsional centre, in kN·m;

$$M_{x0} = 2.66 \cdot f_{t1} \cdot C_{\text{d}} \cdot \sqrt{\frac{L}{T_{SC}}} \cdot B^2 \cdot D \cdot C_b$$

$$M_T = f_{t2} \cdot F_y \cdot \left| f_Z D - Z_{SC} \right|$$

f_p: coefficient, to be taken as:

$f_p = f_{ps}$ for strength assessment

~~$f_p = 0.9[0.25 + (7.8 - 5.6f_T)L \times 10^{-5}]$ for fatigue assessment~~

$f_p=0.9(0.237-0.44f_TB\times10^{-4})$ for fatigue assessment

3.7 Hull girder loads for dynamic load cases

3.7.6 Horizontal wave shear force

The horizontal wave shear force, $Q_{wh\text{-}LC}$, in kN, to be used for each dynamic load case in Ch 4, Sec 2, is to be taken as:

$$Q_{\text{wh-LC}} = f_\beta C_{QH} Q_{wh}$$

where:

C_{QH} — Load combination factor for ~~wave torsional moment~~ horizontal wave shear force, to be taken as specified in Ch 4, Sec 2.

Q_{wh} — Wave torsional moment taking account of the appropriate design load scenario, as defined in [3.6.1].

4 Bi-moment loads

4.1 General requirements

4.1.1 As a guiding value, if the calculation of hull girder warping stress based on the thin-walled beam model or the direct calculation of whole ship of Chapter 8 of the Rules has not been performed, the bi-moment specified in [4.2] may be used for the calculation of hull girder warping stress.

4.1.2 This bi-moment load is applicable to container ships of aft-island type and twin-island type. For container ships of other configurations, the hull girder warping stress is to be calculated either based on the thin-walled beam model or by means of direct calculation of whole ship, subject to the agreement of CCS.

4.2 Bi-moment

4.2.1 The bi-moment B_i at any longitudinal position, in kN·m^2, is to be taken as:

$$B_i = \frac{M_{t_LC}}{k} f(x)$$

where: M_{t_LC} — total torsional moment amidships applied to the oblique wave dynamic load cases defined in Section 2 of this Chapter, in kN·m, see [4.2.2];

k — bending-torsion characteristic coefficient of the transverse section amidships, see [4.2.3];

$f(x)$ — distribution coefficient, see [4.2.4] and [4.2.5].

4.2.2 Total torsional moment amidships applied to the oblique wave dynamic load cases M_{t_LC}, in kN·m, is to be taken as:

$$M_{t_LC} = M_{st} + M_{wt_LC}$$

where: M_{st} — still water bending moment amidships, in kN·m, to be calculated in accordance with [2.4.1] of this Chapter and with the same symbol as M_{wt_LC};

M_{wt_LC} — wave bending moment amidships, in kN·m, to be calculated in accordance with [3.7.5] of this Chapter, where f_{lp} is taken as 1.0.

4.2.3 Bending-torsion characteristic coefficient of the transverse section amidships k, in m^{-1}, is to be taken as:

$$k=\sqrt{\frac{GI_{t-n50}}{EI_{\omega-n50}}}$$

where: G—shear modulus, in MPa, to be taken as 8×10^4;

I_{t-n50}—net torsional moment of inertia of the transverse section amidships, in m^4;

E—modulus of elasticity, in MPa, to be taken as 2.06×10^5;

$I_{\omega-n50}$—net sectorial moment of inertia of the transverse section amidships, in m^6.

4.2.4 For container ships of aft-island type, distribution coefficient $f(x)$ is to be taken as:

$$f(x)=\begin{cases}0 & 0\le x\le 0.1\\ \dfrac{0.29}{x_A-0.1}x-\dfrac{0.029}{x_A-0.1} & 0.1<x\le x_A\\ 0.29 & x_A<x\le x_A+a\\ \dfrac{-0.5}{0.77-2a-x_A}(x-x_A-a)+0.29 & x_A+a<x\le 0.77-a\\ -0.21 & 0.77-a<x\le 0.77\\ 0.91x-0.91 & 0.77<x\le 1\end{cases}$$

where: x—to be taken as $\frac{X}{L}$, where X is the distance from the aft end of ship length L, in m;

x_A—to be taken as $\frac{X_A}{L}$, where X_A is the distance from forward bulkhead of the engine room to the aft end of ship length L, in m, see Figure 4.2.5;

a—to be taken as $\frac{12.6}{L}$.

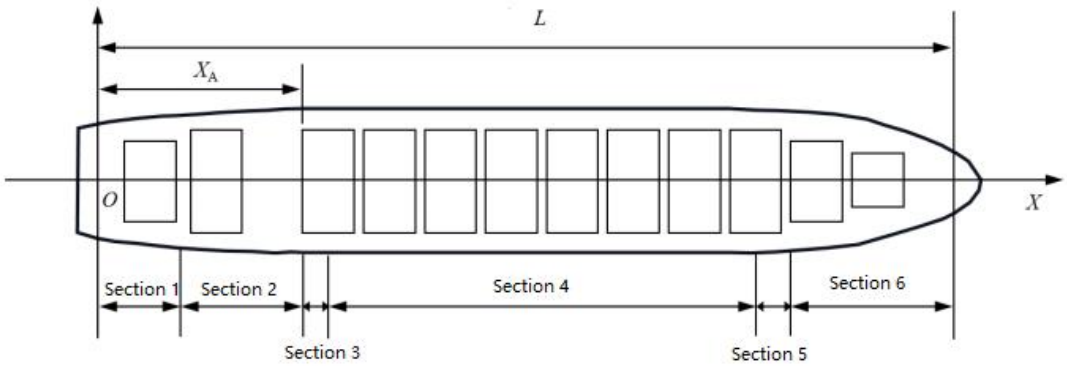


Figure 4.2.4 Value of X_A

4.2.5 For container ships of twin-island type, distribution coefficient $f(x)$ is to be taken as:

$$f(x)=\begin{cases}0 & 0<x\le 0.1\\ \dfrac{0.21}{x_{A3}-0.1}x-\dfrac{0.021}{x_{A3}-0.1} & 0.1<x\le x_{A3}\\ 0.21 & x_{A3}<x\le x_{A3}+a\\ \dfrac{0.43(x_{A3}+a-x)}{x_{A4}-x_{A3}-a}+0.21 & x_{A3}+a<x\le x_{A4}\\ -0.22 & x_{A4}<x\le x_{A5}\\ \dfrac{0.22}{1-x_{A5}}x-\dfrac{0.22}{1-x_{A5}} & x_{A5}<x\le 1\end{cases}$$

where: x—to be taken as $\frac{X}{L}$, where X is the distance from the aft end of ship length L, in m;

x_{A3}, x_{A4}, x_{A5}—to be taken as $\frac{X_{A3}}{L}$, $\frac{X_{A4}}{L}$, $\frac{X_{A5}}{L}$, where X_{A3}, X_{A4}, X_{A5} are the distances from the forward bulkhead of the engine room, the aft bulkhead of the forward island and the forward bulkhead of the forward island to the aft end of ship length L, in m, see Figure 4.2.5;

a—to be taken as $\frac{12.6}{L}$.

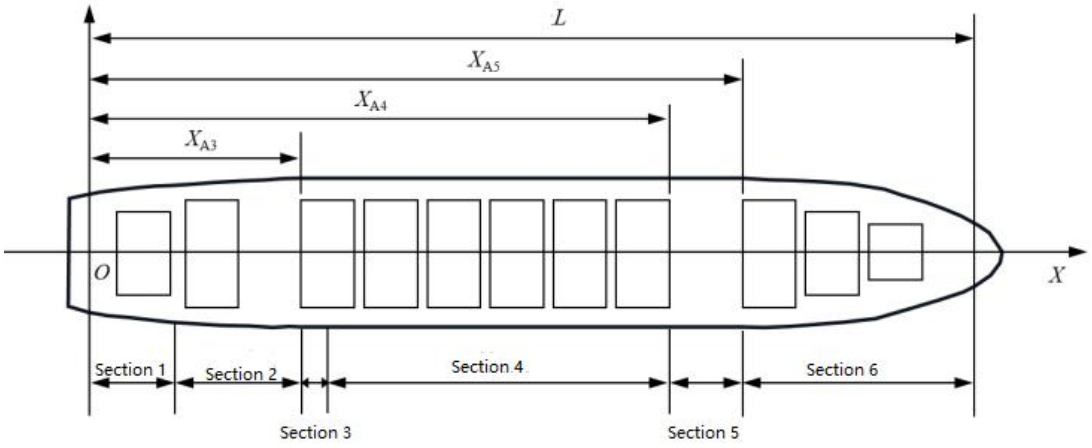


Figure 4.2.5 Value of X_{A3}, X_{A4}, X_{A5}

Section 5 EXTERNAL LOADS

Symbols

f_{yB}—Ratio between Y-coordinate of the load point and B_x, to be taken as:

$$f_{yB} = \frac{|2y|}{B_x}$$, but not greater than 1.0, and when $B_x = 0.0$ ~~f_{yB}=0.0~~ f_{yB}=1.0.

1 Sea pressure

1.3 External dynamic pressures for strength assessment

1.3.4 Hydrodynamic pressures for FVM load cases

The hydrodynamic pressures, P_W, for FVM-1 and FVM-2 load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.4(1). See also Figure 1.3.2(1) and Figure 1.3.2(2).

Hydrodynamic pressures for FVM load cases Table 1.3.4(1)

Load case	Hydrodynamic pressure, kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
FVM-1	$P_W = \max(-P_{FVM}, \rho g(z-T_{LC}))$	$P_W = P_{W,WL} - \rho g(z-T_{LC})$	$P_W = 0.0$
FVM-2	$P_W = \max(P_{FVM}, \rho g(z-T_{LC}))$		

where:

$$P_{FVM} = f_\beta f_{ps} f_{nl} f_h k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{nl}—Coefficient considering non-linear effects, to be taken as:

f_{nl} = 0.9 for extreme sea loads design load scenario;

f_{nl} = 0.95 for ballast water exchange design load scenario;

f_{yz}—Girth distribution coefficient, to be taken as:

$$f_{yz} = \frac{z}{T_{LC}} + f_{yB} + 1$$

f_h—Coefficient to be taken as:

f_h=2.6

k_a—Amplitude coefficient in the longitudinal direction of the ship, to be taken as:

$k_a = 1 + (3.75 - 2f_T)(1 - 5f_{xL})(1 - f_{yB})$ for $f_{xL} < 0.2$;

k_a=1.0 for $0.2 \le f_{xL} < 0.9$;

$k_a = 1 + 20(1 - f_{yB})(f_{xL} - 0.9)$ for $f_{xL} \ge 0.9$;

λ— Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.6(1 + 2/3 f_T) L$$

k_p—Phase coefficient to be obtained from Table 1.3.4(2). Intermediate values are to be interpolated.

k_p values for FVM load cases **Table 1.3.4(2)**

f_{xL}	0	0.35-0.1f_T	0.5-0.2f_T	0.75	0.8	1.0
k_p	-0.75-0.25f_{yB}	-1	1	1	-1	-0.75-0.25f_{yB}

1.3.4-5 Hydrodynamic pressures for FVMf load cases

The hydrodynamic pressures, P_W, for FVMf-1 and FVMf-2 load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.45(1). See also Figure 1.3.2(1) and Figure 1.3.2(2)

Hydrodynamic pressures for FVM load cases **Table 1.3.4-5(1)**

	Hydrodynamic pressure, in kN/m^2		
Load case	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
FVMf-1	$P_W = \max\left(-P_{\text{FVMf}}, \rho g\left(z - T_{LC}\right)\right)$	$P_W = P_{W,WL} - \rho g(z - T_{LC})$	$P_W = 0$
FVMf-2	$P_W = \max\left(P_{\text{FVMf}}, \rho g\left(z - T_{LC}\right)\right)$		

where:

$$P_{\text{FVMf}} = f_{ps} f_{nl} f_h k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{nl}— Coefficient considering non-linear effects, to be taken as:

$f_{nl} = 0.9$ for extreme sea loads design load scenario

$f_{nl} = 0.95$ for ballast water exchange design load scenario

f_{yz}— Girth distribution coefficient, to be taken as:

$$f_{yz} = 2.08\frac{z}{T_{LC}} + 1.44 f_{yB} + 3.2$$

f_h— Coefficient to be taken as:

$$f_h = 0.78$$

k_a—Amplitude coefficient in the longitudinal direction of the ship, to be taken as:

$$k_a = 1 + \left(3.96 - 3.56\, f_T\right)\left(1 - f_{xL}\,/(0.27 - 0.22\, f_T)\right)\left(2 - f_{yB}\right) \quad \text{for}$$

$f_{xL} < 0.27 - 0.22 f_T$

$$k_a = 1.0 \quad \text{for} \quad 0.27 - 0.22 f_T \le f_{xL} < 0.8$$

$$k_a = 1 + 10\left(1.75 - f_{yB}\right)\left(f_{xL} - 0.8\right) \quad \text{for} \quad f_{xL} \ge 0.8$$

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.6\left(1 + 2/3\, f_T\right)L$$

k_p— Phase coefficient to be obtained from Table 1.3.45(2). Intermediate values are to be interpolated.

k_p values for FVMf load cases **Table ~~1.3.4~~1.3.5(2)**

f_{xL}	0	0.32 – 0.22 f_T	0.52 – 0.22 f_T	0.72 – 0.22 f_T	0.69 + 0.11 f_T	1.0
k_p	–0.76–0.44f_T	– 0.76 – 0.44 f_T	1.0	1.0	– 0.76 – 0.44 f_T	-0.4

1.3.~~5~~6 Hydrodynamic pressures for BSR load cases

The hydrodynamic pressures, P_W, for BSR-1 and BSR-2 load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.~~5~~6. See also Figure 1.3.~~5~~6(1) and Figure 1.3.~~5~~6(2).

Hydrodynamic pressures for BSR load cases **Table 1.3.~~5~~6**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
BSR-1P	P_W = max (P_{BSR} , $\rho g(z\text{-}T_{LC})$)	$P_W = P_{W,WL} - \rho g(z\text{-}T_{LC})$	$P_W = 0$
BSR-2P	P_W = max (-P_{BSR} , $\rho g(z\text{-}T_{LC})$)		
BSR-1S	P_W = max (P_{BSR} , $\rho g(z\text{-}T_{LC})$)		
BSR-2S	P_W = max (-P_{BSR} , $\rho g(z\text{-}T_{LC})$)		

where:

For BSR-1P and BSR-2P

$$P_{BSR} = f_\beta f_{nl}\left(10\,y\sin\theta + 0.88\,f_{ps}C_s\sqrt{\frac{L_0+\lambda-125}{L}}\left(f_{yB1}+1\right)\right)$$

For BSR-1S and BSR-2S

$$P_{BSR} = f_\beta f_{nl}\left(-10\,y\sin\theta + 0.88\,f_{ps}C_s\sqrt{\frac{L_0+\lambda-125}{L}}\left(f_{yB1}+1\right)\right)$$

f_{nl}— Coefficient considering non-linear effects, to be taken as:

f_{nl} = 1.0 for extreme sea loads design load scenario

f_{nl} = 1.0 for ballast water exchange design load scenario

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = \frac{g}{2\pi}T_\theta^2$$

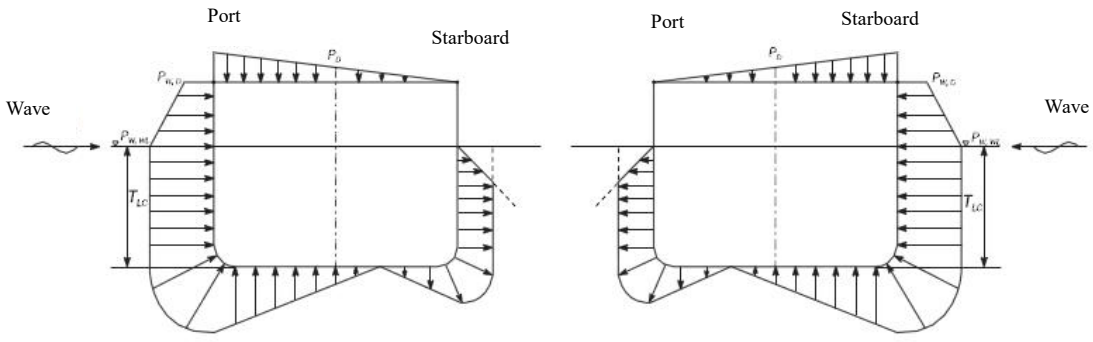


Figure 1.3.~~5~~6(1) Transverse distribution of dynamic pressure for BSR-1P (left) and BSR-1S (right) load cases

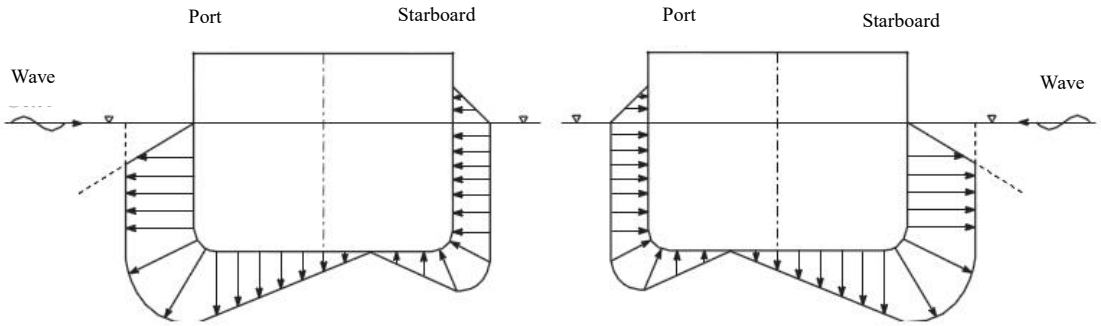


Figure 1.3.~~5~~6(2) Transverse distribution of dynamic pressure for BSR-2P (left) and BSR-2S (right) load cases

1.3.~~6~~7 Hydrodynamic pressures for BSP load cases

The hydrodynamic pressures, P_W, for BSP-1 and BSP-2 load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.~~6~~7(1). See also Figure 1.3.~~6~~7(1) and Figure 1.3.~~6~~7(2).

Hydrodynamic pressures for BSP load cases **Table 1.3.~~6~~7(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
BSP-1P	$P_W = \max(P_{BSP}, \rho g(z\text{-}T_{LC}))$	$P_W = P_{W,WL} - \rho g(z\text{-}T_{LC})$	$P_W = 0$
BSP-2P	$P_W = \max(-P_{BSP}, \rho g(z\text{-}T_{LC}))$		
BSP-1S	$P_W = \max(P_{BSP}, \rho g(z\text{-}T_{LC}))$		
BSP-2S	$P_W = \max(-P_{BSP}, \rho g(z\text{-}T_{LC}))$		

where:

~~$P_{BSP} = 0.8 f_\beta f_{ps} f_{nl} f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$~~

$$P_{BSP} = 4.5 f_{BSP} f_\beta f_{ps} f_{nl} f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.2(1 + 2 f_T) L$$

f_{BSP} — Correction coefficient, to be taken as:

$$f_{BSP} = 5.35(C_b f_T)^3 - 9.92(C_b f_T)^2 + 6.04(C_b f_T) - 0.43$$

f_{yz} — Girth distribution coefficient, to be obtained from Table 1.3.~~6~~7(2).

Girth distribution coefficient f_{yz} for BSP load cases **Table 1.3.67(2)**

~~Transverse position~~	~~BSP-1P, BSP-2P~~	~~BSP-1S, BSP-2S~~
~~$y \geq 0$~~	~~$9\frac{z}{T_{LC}} + 11 f_{yB1} + 2$~~	~~$3\frac{z}{T_{LC}} + 2 f_{yB1} + 2$~~
~~$y < 0$~~	~~$3\frac{z}{T_{LC}} + 2 f_{yB1} + 2$~~	~~$9\frac{z}{T_{LC}} + 11 f_{yB1} + 2$~~

Transverse position	BSP-1P, BSP-2P	BSP-1S, BSP-2S
$y \geq 0$	$f_{yz} = 2\frac{z}{T_{LC}} + 2.5 f_{yB1} + 0.5$	$f_{yz} = \frac{2}{3}\frac{z}{T_{LC}} + \frac{1}{2} f_{yB1} + 0.5$
$y < 0$	$f_{yz} = \frac{2}{3}\frac{z}{T_{LC}} + \frac{1}{2} f_{yB1} + 0.5$	$f_{yz} = 2\frac{z}{T_{LC}} + 2.5 f_{yB1} + 0.5$

f_{nl}— Coefficient considering non-linear effects, to be taken as:

- For extreme sea loads and ballast water exchange design load scenario

  $f_{nl} = 0.6$ at $f_{XL} = 0.0$

  $f_{nl} = 0.8$ at $f_{XL} = 0.3$

  $f_{nl} = 0.8$ at $f_{XL} = 0.7$

  $f_{nl} = 0.6$ at $f_{XL} = 1.0$

  Intermediate values are obtained by linear interpolation.

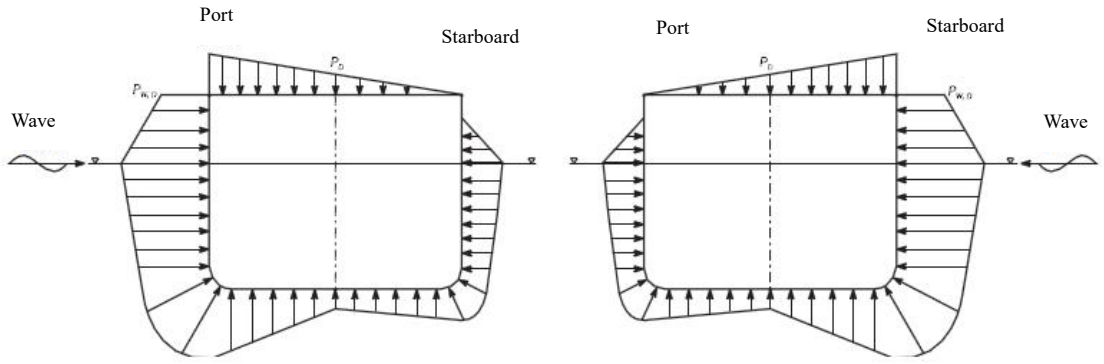


Figure 1.3.67(1) Transverse distribution of dynamic pressure for BSP-1P (left) and BSP-1S (right) load cases

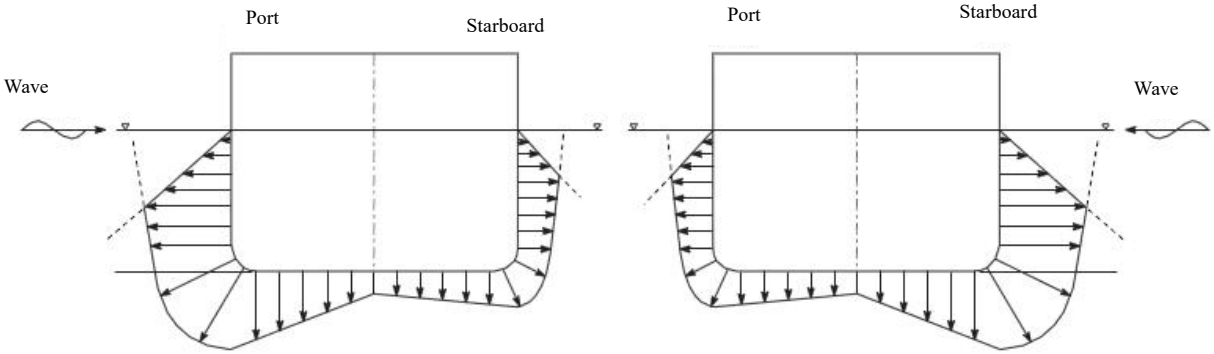


Figure 1.3.67(2) Transverse distribution of dynamic pressure for BSP-2P (left) and BSP-2S (right) load cases

1.3.~~7~~8 Hydrodynamic pressures for OSTf load cases

The hydrodynamic pressures, P_W, for OSTf -1P, OSTf-2P, OSTf-1S and OSTf-2S load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.~~7~~8(1).

Hydrodynamic pressures for OSTf load cases **Table 1.3.~~7~~8(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
OSTf-1P	P_W = max (-P_{OSTf}, $\rho g(z-T_{LC})$)	$P_W = P_{W,WL} - \rho g(z-T_{LC})$	$P_W = 0$
OSTf-2P	P_W = max (P_{OSTf}, $\rho g(z-T_{LC})$)		
OSTf-1S	P_W = max (-P_{OSTf}, $\rho g(z-T_{LC})$)		
OSTf-2S	P_W = max (P_{OSTf}, $\rho g(z-T_{LC})$)		

where:

$$P_{OSTf} = 0.69 f_{ps} f_{nl} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.3.~~7~~8(2).

f_{nl}— Coefficient considering non-linear effects, to be taken as:

f_{nl} = 0.8 for extreme sea loads design load scenario

f_{nl} = 0.9 for ballast water exchange design load scenario

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.45L$$

Girth distribution coefficient f_{yz} for OSTf load cases **Table 1.3.~~7~~8(2)**

Transverse position	OSTf-1P, OSTf-2P	OSTf -1S, OSTf -2S
$y \ge 0$	$12\frac{z}{T_{LC}} + 9f_{yB} + 3$	$(12 - 10.5f_T)(\frac{z}{T_{LC}} + f_{yB}) + 3$
$y < 0$	$(12 - 10.5f_T)(\frac{z}{T_{LC}} + f_{yB}) + 3$	$12\frac{z}{T_{LC}} + 9f_{yB} + 3$

k_a—Amplitude coefficient in the longitudinal direction of the ship to be obtained from Table 1.3.~~7~~8(3). Intermediate values are to be interpolated.

k_a values for OSTf load cases **Table 1.3.78(3)**

Transverse position	Longitudinal position f_{xL}	OSTf-1P, OSTf-2P	OSTf -1S, OSTf -2S
$y \geq 0$	0	$2.16-1.66f_T+11(1-f_{yB}^{0.1})(2.21-2.11f_T)$	$2.16-1.66f_T+11(1-f_{yB}^{0.1})(2.21-2.11f_T)$
	0.1	$1.0+2.33(5-5.5f_{yB}^{0.1})(1-f_T)+(0.67-1.17f_T)f_{yB}$	$1.0+2.33(5-5.5f_{yB}^{0.1})(1-f_T)$
	0.2	$1+(0.67-1.17f_T)f_{yB}$	1.0
	0.5	1.0	1.0
	0.8	$1.0+2.33(1-1.5f_{yB}^{0.1})(1-f_T)+(0.66-1.16f_T)f_{yB}$	$1.0+2.33(1-1.5f_{yB}^{0.1})(1-f_T)$
	1.0	$-2.98+21(1-f_{yB}^{0.1})(1-f_T)+6.98f_T+(3.96-6.96f_T)f_{yB}$	$-2.98+21(1-f_{yB}^{0.1})(1-f_T)+6.98f_T$
$y < 0$	0	$2.16-1.66f_T+11(1-f_{yB}^{0.1})(2.21-2.11f_T)$	$2.16-1.66f_T+11(1-f_{yB}^{0.1})(2.21-2.11f_T)$
	0.1	$1.0+2.33(5-5.5f_{yB}^{0.1})(1-f_T)$	$1.0+2.33(5-5.5f_{yB}^{0.1})(1-f_T)+(0.67-1.17f_T)f_{yB}$
	0.2	1.0	$1+(0.67-1.17f_T)f_{yB}$
	0.5	1.0	1.0
	0.8	$1.0+2.33(1-1.5f_{yB}^{0.1})(1-f_T)$	$1.0+2.33(1-1.5f_{yB}^{0.1})(1-f_T)+(0.66-1.16f_T)f_{yB}$
	1.0	$-2.98+21(1-f_{yB}^{0.1})(1-f_T)+6.98f_T$	$-2.98+21(1-f_{yB}^{0.1})(1-f_T)+6.98f_T+(3.96-6.96f_T)f_{yB}$

k_p— Phase coefficient to be obtained from Table 1.3.78(4). Intermediate values are to be interpolated.

k_p values for OSTf load cases **Table 1.3.78(4)**

Transverse position	f_{xL}	OSTf-1P; OSTf-2P	OSTf-1S; OSTf-2S
$y \geq 0$	0.0	-0.5	-0.5
	0.2	$-0.5(1-f_{yB})-Af_{yB}$	$-0.5(1-f_{yB})+(1.5A-0.6)f_{yB}$
	0.5+0.1A	$1+0.5A(1-f_{yB})$	$1+0.5A(1-f_{yB})+(2.33f_T-2.93)f_{yB}$
	0.8	$-0.5A$	$A(0.9f_{yB}-0.5)$
	0.9	$0.4-0.2f_{yB}-A(0.7+0.5f_{yB})$	$0.4-0.2f_{yB}+A(0.9f_{yB}-0.7)$
	1.0	$0.8-A(0.5+0.3f_{yB})$	$0.8-A(0.5+0.3f_{yB})+0.4Af_{yB}$
$y < 0$	0.0	-0.5	-0.5
	0.2	$-0.5(1-f_{yB})+(1.5A-0.6)f_{yB}$	$-0.5(1-f_{yB})-Af_{yB}$
	0.5+0.1A	$1+0.5A(1-f_{yB})+(2.33f_T-2.93)f_{yB}$	$1+0.5A(1-f_{yB})$
	0.8	$A(0.9f_{yB}-0.5)$	$-0.5A$
	0.9	$0.4-0.2f_{yB}+A(0.9f_{yB}-0.7)$	$0.4-0.2f_{yB}-A(0.7+0.5f_{yB})$
	1.0	$0.8-A(0.5+0.3f_{yB})+0.4Af_{yB}$	$0.8-A(0.5+0.3f_{yB})$
where: $A=2.33f_T-1.33$			

1.3.89 Hydrodynamic pressures for OHM load cases

The hydrodynamic pressures, P_W, for OHM -1P, OHM-2P, OHM-1S and OHM-2S load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.89(1).

Hydrodynamic pressures for OHM load cases **Table 1.3.89(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \leq T_{LC}$	$T_{LC} < z \leq h_W + T_{LC}$	$z > h_W + T_{LC}$
OHM-1P	P_W = max (-P_{OHM}, $\rho g(z-T_{LC})$)	$P_W = P_{W,WL} - \rho g(z-T_{LC})$	$P_W = 0$
OHM-2P	P_W = max (P_{OHM}, $\rho g(z-T_{LC})$)		
OHM-1S	P_W = max (-P_{OHM}, $\rho g(z-T_{LC})$)		
OHM-2S	P_W = max (P_{OHM}, $\rho g(z-T_{LC})$)		

where:

$$P_{OHM} = -0.66 f_{ps} f_{nl} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

λ —Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = (1 - 0.5 f_T) L$$

f_{nl}—Coefficient considering non-linear effects, to be taken as:

$f_{nl} = 0.8$ for extreme sea loads design load scenario

$f_{nl} = 0.9$ for ballast water exchange design load scenario

Intermediate values are obtained by linear interpolation.

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.3.8(2).

Girth distribution coefficient f_{yz} for OHM load cases **Table 1.3.89(2)**

Transverse position	OHM-1P, OHM-2P	OHM -1S, OHM -2S
$y \geq 0$	$(1.58-0.58f_T)(10\frac{z}{T_{LC}}+6f_{yB})+2$	$(4.5-3.5f_T)(\frac{z}{T_{LC}}+f_{yB})+2$
$y < 0$	$(4.5-3.5f_T)(\frac{z}{T_{LC}}+f_{yB})+2$	$(1.58-0.58f_T)(10\frac{z}{T_{LC}}+6f_{yB})+2$

k_a—Amplitude coefficient to be obtained from Table 1.3.89(3). Intermediate values are to be interpolated.

k_p— Phase coefficient to be obtained from Table 1.3.89(4). Intermediate values are to be interpolated.

k_a values for OHM load cases **Table 1.3.89(3)**

Transverse position	Longitudinal position f_{xL}	OHM-1P, OHM-2P	OHM -1S, OHM -2S
$y \geq 0$	0	$0.6+4(1-f_{yB})-A(3.1-2.9f_{yB})$	$0.6+4(1-f_{yB})-A(3.1-2.9f_{yB})+1.4f_{yB}$
	0.1	$0.2+2.8(1-f_{yB})+A(3f_{yB}-2.6)$	$0.2+2.8(1-f_{yB})+A(3f_{yB}-2.6)+0.4f_{yB}$
	0.2	$0.4+1.5(1-f_{yB})+A(1.5f_{yB}-1.1)$	$0.4+1.5(1-f_{yB})+A(1.5f_{yB}-1.1)$
	0.4	1.0	$1-0.3f_{yB}$
	0.6	$0.8+0.2(1-f_{yB})+0.2A$	$0.8+0.2(1-f_{yB})+0.2A+0.2f_{yB}$
	0.8	$0.6+0.2(1-f_{yB})+A(1.6f_{yB}-1.1)$	$0.6+0.2(1-f_{yB})+A(1.6f_{yB}-1.1)+0.4f_{yB}$
	0.9	$1.2+(5.13-2.33f_T)(1-f_{yB})$	$1.2+(5.13-2.33f_T)(1-f_{yB})$ $+(5.825f_T-2.825)f_{yB}$
	1.0	$1.6+6.4(1-f_{yB})+A(1.7f_{yB}-2)$	$1.6+6.4(1-f_{yB})+A(1.7f_{yB}-2)$ $+(9.786f_T-4.086)f_{yB}$
$y < 0$	0	$0.6+4(1-f_{yB})-A(3.1-2.9f_{yB})+1.4f_{yB}$	$0.6+4(1-f_{yB})-A(3.1-2.9f_{yB})$
	0.1	$0.2+2.8(1-f_{yB})+A(3f_{yB}-2.6)+0.4f_{yB}$	$0.2+2.8(1-f_{yB})+A(3f_{yB}-2.6)$
	0.2	$0.4+1.5(1-f_{yB})+A(1.5f_{yB}-1.1)$	$0.4+1.5(1-f_{yB})+A(1.5f_{yB}-1.1)$
	0.4	$1-0.3f_{yB}$	1.0
	0.6	$0.8+0.2(1-f_{yB})+0.2A+0.2f_{yB}$	$0.8+0.2(1-f_{yB})+0.2A$
	0.8	$0.6+0.2(1-f_{yB})+A(1.6f_{yB}-1.1)+0.4f_{yB}$	$0.6+0.2(1-f_{yB})+A(1.6f_{yB}-1.1)$
	0.9	$1.2+(5.13-2.33f_T)(1-f_{yB})$ $+(5.825f_T-2.825)f_{yB}$	$1.2+(5.13-2.33f_T)(1-f_{yB})$
	1.0	$1.6+6.4(1-f_{yB})+A(1.7f_{yB}-2)$ $+(9.786f_T-4.086)f_{yB}$	$1.6+6.4(1-f_{yB})+A(1.7f_{yB}-2)$
where: $A=2.33f_T-1.33$			

k_p values for OHM load cases **Table 1.3.89(4)**

Transverse position	f_{xL}	OHM-1P; OHM-2P	OHM-1S; OHM-2S
$y \geq 0$	0.0	$-1.0 + A(0.5 + f_{yB})$	$-1.0 + A(0.5 - 0.5f_{yB})$
	0.1	$-0.9(1-f_{yB}) + A(1.6-0.6f_{yB})$	$-0.9+0.1f_{yB} + A(1.6-1.8f_{yB})$
	0.2	$0.6A$	$A(0.6 - f_{yB})$
	0.3	$-0.5-0.2f_{yB} + A(0.3+0.5f_{yB})$	$-0.5+1.1f_{yB} + A(0.3-0.1f_{yB})$
	For OHM-1P, OHM-2P: $0.6-0.1f_{yB}$ For OHM-1S, OHM-2S: $0.6-0.2f_{yB}$	-1.0	$-1.0+1.8f_{yB}$
	0.8	$0.7-0.4f_{yB}+0.5Af_{yB}$	$0.7+0.2f_{yB}-0.9Af_{yB}$
	0.9	$0.7-0.2f_{yB} + A(0.5f_{yB}-0.1)$	$0.7+0.1f_{yB} - A(0.7f_{yB}+0.1)$
	1.0	$0.6 + 0.2Af_{yB}$	$0.6 - 0.1Af_{yB}$
$y < 0$	0.0	$-1.0 + A(0.5 - 0.5f_{yB})$	$-1.0 + A(0.5 + f_{yB})$
	0.1	$-0.9+0.1f_{yB} + A(1.6-1.8f_{yB})$	$-0.9(1-f_{yB}) + A(1.6-0.6f_{yB})$
	0.2	$A(0.6 - f_{yB})$	$0.6A$
	0.3	$-0.5+1.1f_{yB} + A(0.3-0.1f_{yB})$	$-0.5-0.2f_{yB} + A(0.3+0.5f_{yB})$
	For OHM-1P, OHM-2P: $0.6-0.2f_{yB}$ For OHM-1S, OHM-2S: $0.6-0.1f_{yB}$	$-1.0+1.8f_{yB}$	-1.0
	0.8	$0.7+0.2f_{yB}-0.9Af_{yB}$	$0.7-0.4f_{yB}+0.5Af_{yB}$
	0.9	$0.7+0.1f_{yB} - A(0.7f_{yB}+0.1)$	$0.7-0.2f_{yB} + A(0.5f_{yB}-0.1)$
	1.0	$0.6 - 0.1Af_{yB}$	$0.6 + 0.2Af_{yB}$
where: $A = 2.33f_T - 1.33$			

1.3.~~9~~10 Hydrodynamic pressures for OHS load cases

The hydrodynamic pressures, P_W, for OHS -1P, OHS-2P, OHS-1S and OHS-2S load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.~~9~~10(1).

Hydrodynamic pressures for OHS load cases **Table 1.3.~~9~~10(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
OHS-1P	P_W = max (-P_{OHS}, $\rho g(z-T_{LC})$)	$P_W = P_{W,WL} - \rho g(z-T_{LC})$	$P_W = 0$
OHS-2P	P_W = max (P_{OHS}, $\rho g(z-T_{LC})$)		
OHS-1S	P_W = max (-P_{OHS} , $\rho g(z-T_{LC})$)		
OHS-2S	P_W = max (P_{OHS} , $\rho g(z-T_{LC})$)		

where:

$$P_{OHS} = -0.7 f_{ps} f_{nl} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.3.~~9~~10(2).

f_{nl}—Coefficient considering non-linear effects, to be taken as:

$f_{nl} = 0.8$ for extreme sea loads design load scenario

$f_{nl} = 0.9$ for ballast water exchange design load scenario

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.42L$$

Girth distribution coefficient f_{yz} for OHS load cases **Table 1.3.~~9~~10(2)**

Transverse position	OHS-1P, OHS-2P	OHS-1S, OHS-2S
$y \ge 0$	$10\frac{z}{T_{LC}} + 7f_{yB} + 3.5$	$1.5\frac{z}{T_{LC}} + 1.5f_{yB} + 3.5$
$y < 0$	$1.5\frac{z}{T_{LC}} + 1.5f_{yB} + 3.5$	$10\frac{z}{T_{LC}} + 7f_{yB} + 3.5$

k_a—Amplitude coefficient to be obtained from Table 1.3.~~9~~10(3). Intermediate values are to be interpolated.

k_a values for OHS load cases **Table 1.3.~~9~~10(3)**

Transverse position	Longitudinal position f_{xL}	OHS-1P, OHS-2P	OHS -1S, OHS -2S
$y \ge 0$	0	$1.0 + 7.77(1 - f_T)(1 - f_{yB}) + f_{yB}(0.53 - 0.93 f_T)$	$1.0 + 7.77(1 - f_T)$
	0.1	$1.0 - 0.4 f_{yB}$	1.0
	0.2	$1.0 - 0.4 f_{yB}$	1.0

Transverse position	Longitudinal position f_{xL}	OHS-1P, OHS-2P	OHS -1S, OHS -2S
	0.5	1.0	1.0
	0.6	1.0	1.0
	0.8	$1.0-0.5f_{yB}$	1.0
	1.0	$1.0+3(1-0.91f_{yB}^{0.1})$	4.0
$y<0$	0	$1.0+7.77(1-f_T)$	$1.0+7.77(1-f_T)(1-f_{yB})+f_{yB}(0.53-0.93f_T)$
	0.1	1.0	$1.0-0.4f_{yB}$
	0.2	1.0	$1.0-0.4f_{yB}$
	0.5	1.0	1.0
	0.6	1.0	1.0
	0.8	1.0	$1.0-0.5f_{yB}$
	1.0	4.0	$1.0+3(1-0.91f_{yB}^{0.1})$

k_p— Phase coefficient to be obtained from Table 1.3.~~9~~10(4). Intermediate values are to be interpolated.

k_p values for OHS load cases **Table 1.3.~~9~~10(4)**

Transverse position	f_{xL}	OHS-1P; OHS-2P	OHS-1S; OHS-2S
$y\geq 0$	0.0	$0.9-0.3A$	$0.9-0.3A$
	0.2	$0.9-0.1f_{yB}+A(0.6f_{yB}-0.4)$	$0.9-0.7f_{yB}-A(0.6f_{yB}+0.4)$
	0.3	$0.8-0.5f_{yB}+A(1.5f_{yB}-1.3)$	$0.8-0.4f_{yB}+A(0.3f_{yB}-1.3)$
	0.4	$0.3f_{yB}-0.8$	$1.6f_{yB}-0.8-1.7Af_{yB}$
	0.5	-1	$-1+1.7f_{yB}-1.3Af_{yB}$
	0.6	$-1+0.266(1-f_{yB})(1-f_T)$	$-1+0.266(1-f_{yB})(1-f_T)+(1.3-0.7A)f_{yB}$
	$0.8+0.1Af_{yB}$	$0.7+A(0.5f_{yB}-0.4)$	$0.7-A(0.3f_{yB}+0.4)-0.3f_{yB}$
	1.0	$0.2f_{yB}-0.5+0.2A$	$-0.5+0.2A$
$y<0$	0.0	$0.9-0.3A$	$0.9-0.3A$
	0.2	$0.9-0.7f_{yB}-A(0.6f_{yB}+0.4)$	$0.9-0.1f_{yB}+A(0.6f_{yB}-0.4)$
	0.3	$0.8-0.4f_{yB}+A(0.3f_{yB}-1.3)$	$0.8-0.5f_{yB}+A(1.5f_{yB}-1.3)$
	0.4	$1.6f_{yB}-0.8-1.7Af_{yB}$	$0.3f_{yB}-0.8$
	0.5	$-1+1.7f_{yB}-1.3Af_{yB}$	-1
	0.6	$-1+0.266(1-f_{yB})(1-f_T)+(1.3-0.7A)f_{yB}$	$-1+0.266(1-f_{yB})(1-f_T)$

	$0.8+0.1Af_{yB}$	$0.7-A(0.3f_{yB}+0.4)-0.3f_{yB}$	$0.7+A(0.5f_{yB}-0.4)$
	1.0	$-0.5+0.2A$	$0.2f_{yB}-0.5+0.2A$
where: $A=2.33f_T-1.33$			

1.3.~~10~~11 Hydrodynamic pressures for OVA load cases

The hydrodynamic pressures, P_W, for OVA -1P, OVA-2P, OVA-1S and OVA-2S load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.~~10~~11(1).

Hydrodynamic pressures for OVA load cases **Table 1.3.~~10~~11(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
OVA-1P	P_W = max (-P_{OVA}, $\rho g(z-T_{LC})$)	$P_W = P_{W,WL} - \rho g(z-T_{LC})$	$P_W = 0$
OVA-2P	P_W = max (P_{OVA}, $\rho g(z-T_{LC})$)		
OVA-1S	P_W = max (-P_{OVA} , $\rho g(z-T_{LC})$)		
OVA-2S	P_W = max (P_{OVA}, $\rho g(z-T_{LC})$)		

where:

$$P_{OVA} = 0.61 f_{ps} f_{nl} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

λ —Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.7L$$

f_{nl}— Coefficient considering non-linear effects, to be taken as:

- For extreme sea loads design load scenario:
  - f_{nl} = 0.5 at f_{XL}= 0.0
  - f_{nl} = 0.8 at f_{XL}= 0.3
  - f_{nl} = 0.8 at f_{XL}= 0.7
  - f_{nl} = 0.6 at f_{XL}= 1.0
- For ballast water exchange design load scenario:
  - f_{nl} = 0.75 at f_{XL}= 0.0
  - f_{nl} = 0.90 at f_{XL}= 0.3
  - f_{nl} = 0.90 at f_{XL}= 0.7
  - f_{nl} = 0.80 at f_{XL}= 1.0

  Intermediate values are obtained by linear interpolation.

f_{yz}—Girth distribution coefficient, to be obtained from Table 1.3.~~10~~11(2).

Girth distribution coefficient f_{yz} for OVA load cases **Table 1.3.~~10~~11(2)**

Transverse position	OVA-1P, OVA-2P	OVA -1S, OVA -2S
$y \ge 0$	$7\frac{z}{T_{LC}}+5f_{yB}+2.5$	$2\frac{z}{T_{LC}}+2f_{yB}+2.5$
$y < 0$	$2\frac{z}{T_{LC}}+2f_{yB}+2.5$	$7\frac{z}{T_{LC}}+5f_{yB}+2.5$

k_a— Amplitude coefficient to be obtained from Table 1.3.~~10~~11(3). Intermediate values are to be interpolated.

k_p—Phase coefficient to be obtained from Table 1.3.~~10~~11(4). Intermediate values are to be interpolated.

k_a values for OVA load cases **Table 1.3.~~10~~11(3)**

Transverse position	Longitudinal position f_{xL}	OVA-1P, OVA-2P	OVA -1S, OVA -2S
$y \geq 0$	0	$1.0+1.5(1.44-0.774f_T)(2.5-2.5f_{yB})+f_{yB}(1.33-2.33f_T)$	$1.0+1.5(1.44-0.774f_T)(2.5-1.5f_{yB})$
	0.222f_T-0.022	1.0	1.0
	0.8	1.0	1.0
	1.0	$1.0+(6.67f_T-0.67)(2-1.7f_{yB})$	$1.0+(6.67f_T-0.67)(2-f_{yB})$
$y < 0$	0	$1.0+1.5(1.44-0.774f_T)(2.5-1.5f_{yB})$	$1.0+1.5(1.44-0.774f_T)(2.5-2.5f_{yB})+f_{yB}(1.33-2.33f_T)$
	0.222f_T-0.022	1.0	1.0
	0.8	1.0	1.0
	1.0	$1.0+(6.67f_T-0.67)(2-f_{yB})$	$1.0+(6.67f_T-0.67)(2-1.7f_{yB})$

k_p values for OVA load cases **Table 1.3.~~10~~11(4)**

Transverse position	f_{xL}	OVA-1P; OVA-2P	OVA-1S; OVA-2S
$y \geq 0$	0	$1.4f_T-1.4$	$1.4f_T-1.4$
	0.2-0.1f_{yB}	$0.7-0.7f_T+(0.5-1.4f_T)(1-f_{yB})$	$0.7-0.7f_T+(0.5-1.4f_T)(1-f_{yB})$
	0.4-0.1f_{yB}	-1.0	$-1.0+(1.9-0.7f_T)f_{yB}$
	0.5	$-1.66+1.16f_T$	$-1.66+1.5f_{yB}+1.16f_T$
	0.7	$1.0+(1.16f_T-1.16)f_{yB}$	$1.0+(1.16f_T-1.16)f_{yB}$
	0.8	1.0	$1.0+(0.58f_T-0.58)f_{yB}$
	1.0	1.0	1.0
$y < 0$	0	$1.4f_T-1.4$	$1.4f_T-1.4$
	0.2-0.1f_{yB}	$0.7-0.7f_T+(0.5-1.4f_T)(1-f_{yB})$	$0.7-0.7f_T+(0.5-1.4f_T)(1-f_{yB})$
	0.4-0.1f_{yB}	$-1.0+(1.9-0.7f_T)f_{yB}$	-1.0
	0.5	$-1.66+1.5f_{yB}+1.16f_T$	$-1.66+1.16f_T$
	0.7	$1.0+(1.16f_T-1.16)f_{yB}$	$1.0+(1.16f_T-1.16)f_{yB}$
	0.8	$1.0+(0.58f_T-0.58)f_{yB}$	1.0
	1.0	1.0	1.0

1.3.12 Hydrodynamic pressures for OSA load cases

The hydrodynamic pressures, P_W, for OSA-1 and OSA-2 load cases, at any load point, in kN/m^2, are to be obtained from Table 1.3.12(1). See also Figure 1.3.12(1) and Figure 1.3.12(2).

Hydrodynamic pressures for OSA load cases **Table 1.3.12(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le h_W + T_{LC}$	$z > h_W + T_{LC}$
OSA -1P	$P_W = \max(P_{OSA}, \rho g(z-T_{LC}))$	$P_W = P_{W,WL} - \rho g(z-T_{LC})$	$P_W = 0.0$
OSA -2P	$P_W = \max(-P_{OSA}, \rho g(z-T_{LC}))$		
OSA -1S	$P_W = \max(P_{OSA}, \rho g(z-T_{LC}))$		
OSA -2S	$P_W = \max(-P_{OSA}, \rho g(z-T_{LC}))$		

where:

$$P_{OSA} = 0.8 f_{ps} f_{nl} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}} (1 + 0.5 f_T)$$

λ—Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.7L$$

f_{nl}—Coefficient considering non-linear effects, to be taken as:

For extreme sea loads design load scenario:

$f_{nl} = 0.5$ at $f_{XL} = 0.0$

$f_{nl} = 0.8$ at $f_{XL} = 0.3$

$f_{nl} = 0.8$ at $f_{XL} = 0.7$

$f_{nl} = 0.6$ at $f_{XL} = 1.0$

For ballast water exchange design load scenario:

$f_{nl} = 0.75$ at $f_{XL} = 0.0$

$f_{nl} = 0.9$ at $f_{XL} = 0.3$

$f_{nl} = 0.9$ at $f_{XL} = 0.7$

$f_{nl} = 0.8$ at $f_{XL} = 1.0$

Intermediate values are obtained by linear interpolation.

f_{yz}—Girth distribution coefficient, to be obtained from Table 1.3.12(2).

k_a—Amplitude coefficient in the longitudinal direction of the ship, to be obtained from Table 1.3.12(3).

k_p—Phase coefficient to be obtained from Table 1.3.12(4). Intermediate values are to be interpolated.

Girth distribution coefficient f_{yz} for OSA load cases **Table 1.3.12(2)**

Transverse position	OSA-1P, OSA-2P	OSA -1S, OSA -2S
$y \ge 0$	$5.5\frac{z}{T_{LC}} + 5.3 f_{yB} + 2.2$	$0.9\frac{z}{T_{LC}} + 0.4 f_{yB} + 2.2$
$y < 0$	$0.9\frac{z}{T_{LC}} + 0.4 f_{yB} + 2.2$	$5.5\frac{z}{T_{LC}} + 5.3 f_{yB} + 2.2$

k_a values for OSA load cases **Table 1.3.12(3)**

Transverse position	Longitudinal position	OSA-1P, OSA-2P	OSA-1S, OSA -2S
$y \geq 0$	$f_{xL} \leq 0.2$	$1.0+3(2-f_T)(1-5f_{xL})(1-f_{yB})$	$\frac{1.0+3(2-f_T)(1-5f_{xL})+\{(28f_{xL}-5)+3f_T(1-5f_{xL})\}f_{yB}}{}$
	$0.2<f_{xL} \leq 0.5$	1.0	$1.0+(1-2f_{xL})f_{yB}$
	$0.5<f_{xL} \leq 0.8$	1.0	$1.0+1.5(2f_{xL}-1)f_{yB}$
	$f_{xL} > 0.8$	$1.0+(f_{xL}-0.8)(1-f_{yB})A$	$\frac{1.0+\{1.5(2f_{xL}-1)-(f_{xL}-0.8)A\}f_{yB}}{+(f_{xL}-0.8)A}$
$y<0$	$f_{xL} \leq 0.2$	$\frac{1.0+3(2-f_T)(1-5f_{xL})+\{(28f_{xL}-5)+3f_T(1-5f_{xL})\}f_{yB}}{}$	$1.0+3(2-f_T)(1-5f_{xL})(1-f_{yB})$
	$0.2<f_{xL} \leq 0.5$	$1.0+(1-2f_{xL})f_{yB}$	1.0
	$0.5<f_{xL} \leq 0.8$	$1.0+1.5(2f_{xL}-1)f_{yB}$	1.0
	$f_{xL} > 0.8$	$\frac{1.0+\{1.5(2f_{xL}-1)-(f_{xL}-0.8)A\}f_{yB}}{+(f_{xL}-0.8)A}$	$1.0+(f_{xL}-0.8)(1-f_{yB})A$
where: $A = 22-15f_T+3[22(f_{xL}-0.8)-0.25(2-f_T)]$			

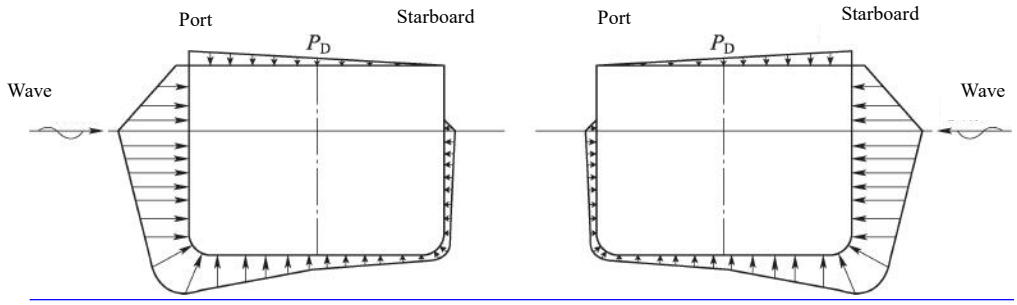


Figure 1.3.12(1) Transverse distribution of dynamic pressure amidships for OSA-1P (left) and OSA-1S (right) load cases

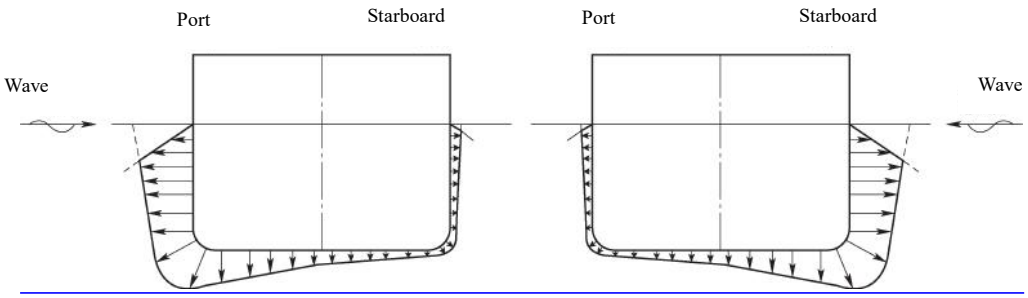


Figure 1.3.12(2) Transverse distribution of dynamic pressure amidships for OSA-2P (left) and OSA-2S (right) load cases

k_p values for OSA load cases **Table 1.3.12(4)**

Transverse position	f_{xL}	OSA-1P; OSA-2P	OSA-1S; OSA-2S
$y \geq 0$	0.0	$0.75-0.5\,f_{yB}$	0.75
	0.2	$f_T-0.25+(1.25-f_T)\,f_{yB}$	$f_T-0.25+(0.35f_T-0.47)\,f_{yB}$
	0.4	1.0	$1.0+(2.7f_T-3.2)\,f_{yB}$
	0.5	$1.25-0.5f_T+(0.5f_T-0.25)\,f_{yB}$	$1.25-0.5f_T+(2.7f_T-3.2)\,f_{yB}$
	0.75	$0.5f_T-1.25+(0.25-0.5f_T)\,f_{yB}$	$0.5f_T-1.25+(0.2-0.1f_T)\,f_{yB}$
	1.0	$0.5f_T-1.25+(0.25-0.5f_T)\,f_{yB}$	$0.5f_T-1.25+(0.2-0.1f_T)\,f_{yB}$
$y<0$	0.0	0.75	$0.75-0.5\,f_{yB}$
	0.2	$f_T-0.25+(0.35f_T-0.47)f_{yB}$	$f_T-0.25+(1.25-f_T)\,f_{yB}$
	0.4	$1.0+(2.7f_T-3.2)f_{yB}$	1.0
	0.5	$1.25-0.5f_T+(2.7f_T-3.2)\,f_{yB}$	$1.25-0.5f_T+(0.5f_T-0.25)\,f_{yB}$
	0.75	$0.5f_T-1.25+(0.2-0.1f_T)\,f_{yB}$	$0.5f_T-1.25+(0.25-0.5f_T)\,f_{yB}$
	1.0	$0.5f_T-1.25+(0.2-0.1\,f_T)\,f_{yB}$	$0.5f_T-1.25+(0.25-0.5f_T)\,f_{yB}$

1.4 External dynamic pressures for fatigue assessments

1.4.4 Hydrodynamic pressures for FVM load cases

The hydrodynamic pressures, P_W, for FVM-1 and FVM-2 load cases, at any load point, in kN/m^2, see 1.4.4(1).

Hydrodynamic pressures for FVM load cases **Table 1.4.4(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \leq T_{LC}$	$T_{LC} < z \leq 2h_W + T_{LC}$	$z > 2h_W + T_{LC}$
FVM-1	$P_W = \max(-P_{FVM}, \rho g(z-T_{LC}))$	$P_W = P_{W,WL} - \frac{1}{2}\rho g(z-T_{LC})$	$P_W = 0$
FVM-2	$P_W = \max(P_{FVM}, \rho g(z-T_{LC}))$		

where:

$$P_{FVM} = f_p f_h k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{yz}—Girth distribution coefficient, to be taken as:

$$f_{yz} = \frac{z}{T_{LC}} + f_{yB} + 1$$

f_h—Coefficient, to be taken as:

$$f_h = 2.6$$

f_p—Coefficient, to be taken as:

$f_p = f_{fa}[(0.21 + 0.02 f_T) + (6 - 4 f_T) L \times 10^{-5}]$

k_a—Amplitude coefficient in the longitudinal direction of the ship, to be taken as:

$k_a = 1 + (3.5 - 2 f_T)(1 - 5 f_{xL})(1 - f_{yB})$ for $f_{xL} < 0.2$

$k_a = 1.0$ for $0.2 \le f_{xL} < 0.9$

$k_a = 1 + 15(1 - f_{yB})(f_{xL} - 0.9)$ for $f_{xL} \ge 0.9$

λ—Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.6\left(1 + \frac{2}{3} f_T\right) L$$

k_p—Phase coefficient to be obtained from Table 1.4.4(2). Intermediate values are to be interpolated.

k_p values for FVM load cases **Table 1.4.4(2)**

f_{xL}	k_p
0	$-0.75 - 0.25 f_{yB}$
$0.35 - 0.1 f_T$	-1
$0.5 - 0.2 f_T$	1
0.75	1
$0.9 - 0.1 f_T$	-1
1.0	$-0.5 - 0.5 f_{yB}$

1.4.4-5 Hydrodynamic pressures for BSR load cases

The hydrodynamic pressures, P_W, for load cases BSR-1 and BSR-2, at any load point, in kN/m^2, are to be obtained from Table 1.4.4-5.

Hydrodynamic pressures for BSR load cases **Table 1.4.4-5**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le 2h_W + T_{LC}$	$z > 2h_W + T_{LC}$
BSR-1P	$P_W = \max(P_{BSR}, \rho g(z - T_{LC}))$	$P_W = P_{W,WL} - \frac{1}{2}\rho g(z - T_{LC})$	$P_W = 0$
BSR-2P	$P_W = \max(-P_{BSR}, \rho g(z - T_{LC}))$		
BSR-1S	$P_W = \max(P_{BSR}, \rho g(z - T_{LC}))$		
BSR-2S	$p_W = \max(-P_{BSR}, \rho g(z - T_{LC}))$		

where:

For BSR-1P and BSR-2P

$$P_{BSR} = 10 y \sin\theta + 0.88 f_p C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}(f_{yB1} + 1)$$

For BSR-1S and BSR-2S

$$P_{BSR} = -10 y \sin\theta + 0.88 f_p C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}(f_{yB1} + 1)$$

f_p— Coefficient to be taken as:

$$f_p = f_{fa}\left[(0.21+0.04f_T)-(12f_T-2)B\times10^{-4}\right]$$

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = \frac{g}{2\pi}T_\theta^2$$

1.4.~~5~~ 6 Hydrodynamic pressures for BSP load cases

The hydrodynamic pressures, P_W, for load cases BSP-1 and BSP-2, at any load point, in kN/m^2, are to be obtained from Table 1.4.~~5~~ 6(1).

Hydrodynamic pressures for BSP load cases **Table 1.4.~~5~~ 6(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le 2h_W + T_{LC}$	$z > 2h_W + T_{LC}$
BSP-1P	P_W = max (P_{BSP}, $\rho g(z\text{-}T_{LC})$)	$P_W = P_{W,WL} - \frac{1}{2}\rho g(z-T_{LC})$	$P_W = 0$
BSP-2P	P_W = max (-P_{BSP}, $\rho g(z\text{-}T_{LC})$)		
BSP-1S	P_W = max (P_{BSP}, $\rho g(z\text{-}T_{LC})$)		
BSP-2S	P_W = max (-P_{BSP}, $\rho g(z\text{-}T_{LC})$)		

where:

~~$P_{BSP} = 0.8 f_p f_{yz} C_s \sqrt{\frac{L_0+\lambda-125}{L}}$~~

$$P_{BSP} = 4.5 f_p f_{yz} C_s \sqrt{\frac{L_0+\lambda-125}{L}}$$

λ —Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.2(1+2f_T)L$$

f_p— Coefficient to be taken as:

$$f_p = f_{fa}\left[0.2+(8+16f_T)\times10^{-3}\right]$$

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.4.~~5~~ 6(2).

Girth distribution coefficient f_{yz} for BSP load cases **Table 1.4.~~5~~ 6(2)**

~~Transverse position~~	~~BSP-1P, BSP-2P~~	~~BSP-1S, BSP-2S~~
~~$y \ge 0$~~	~~$9\frac{z}{T_{LC}}+11f_{yB1}+2$~~	~~$3\frac{z}{T_{LC}}+2f_{yB1}+2$~~
~~$y < 0$~~	~~$3\frac{z}{T_{LC}}+2f_{yB1}+2$~~	~~$9\frac{z}{T_{LC}}+11f_{yB1}+2$~~

Transverse position	BSP-1P, BSP-2P	BSP-1S, BSP-2S
$y \geq 0$	$f_{yz} = 2\frac{z}{T_{LC}} + 2.5 f_{yB1} + 0.5$	$f_{yz} = \frac{2}{3}\frac{z}{T_{LC}} + \frac{1}{2} f_{yB1} + 0.5$
$y < 0$	$f_{yz} = \frac{2}{3}\frac{z}{T_{LC}} + \frac{1}{2} f_{yB1} + 0.5$	$f_{yz} = 2\frac{z}{T_{LC}} + 2.5 f_{yB1} + 0.5$

1.4.67 Hydrodynamic pressures for OSTf load cases

The hydrodynamic pressures, P_W, for load cases OSTf-1 and OSTf-2, at any load point, in kN/m^2, are to be obtained from Table 1.4.67(1).

Hydrodynamic pressures for OSTf load cases **Table 1.4.67(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \leq T_{LC}$	$T_{LC} < z \leq 2h_W + T_{LC}$	$z > 2h_W + T_{LC}$
OSTf-1P	P_W = max ($-P_{OSTf}$, $\rho g(z-T_{LC})$)	$P_W = P_{W,WL} - \frac{1}{2}\rho g(z - T_{LC})$	$P_W = 0$
OSTf-2P	P_W = max (P_{OSTf}, $\rho g(z-T_{LC})$)		
OSTf-1S	P_W = max ($-P_{OSTf}$, $\rho g(z-T_{LC})$)		
OSTf-2S	P_W = max (P_{OSTf}, $\rho g(z-T_{LC})$)		

where:

$$P_{OSTf} = 0.18 f_{fa} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.4.67(2).

Girth distribution coefficient f_{yz} for OSTf load cases **Table 1.4.67(2)**

~~Transverse position~~	~~OST-1P, OST-2P~~	~~OST-1S, OST-2S~~
~~$y \geq 0$~~	~~$(16.16 - 8.16 f_T)\frac{z}{T_{LC}} + (17.15 - 15.15 f_T) f_{yB} + 4$~~	~~$(25.8 - 23.3 f_T)\frac{z}{T_{LC}} + (14.32 - 9.32 f_T) f_{yB} + 4$~~
~~$y < 0$~~	~~$(25.8 - 23.3 f_T)\frac{z}{T_{LC}} + (14.32 - 9.32 f_T) f_{yB} + 4$~~	~~$(16.16 - 8.16 f_T)\frac{z}{T_{LC}} + (17.15 - 15.15 f_T) f_{yB} + 4$~~

Transverse position	OSTf-1P, OSTf-2P	OSTf-1S, OSTf-2S
$y \geq 0$	$(12.16 - 4.16 f_T)\frac{z}{T_{LC}} + (9.15 - 7.15 f_T) f_{yB} + 4$	$(13.8 - 11.3 f_T)\frac{z}{T_{LC}} + (10.32 - 5.32 f_T) f_{yB} + 4$
$y < 0$	$(13.8 - 11.3 f_T)\frac{z}{T_{LC}} + (10.32 - 5.32 f_T) f_{yB} + 4$	$(12.16 - 4.16 f_T)\frac{z}{T_{LC}} + (9.15 - 7.15 f_T) f_{yB} + 4$

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.45L$$

k_a— Amplitude coefficient to be obtained from Table 1.4.67(3). Intermediate values are to be interpolated.

k_a values for OSTf load cases **Table 1.4.67(3)**

Transverse position	Longitudinal position f_{xL}	OST-1P, OST-2P	OST-1S, OST-2S
$y \geq 0$	0	$4.03-2.7f_{yB}-0.93f_T+A(2-2.4f_{yB})$	$4.03-2.9f_{yB}-0.93f_T+2A(1-f_{yB})$
	0.1	$0.84-0.9f_{yB}+1.16f_T+A(1-0.8f_{yB})$	$0.84-1.3f_{yB}+1.16f_T+A(1-f_{yB})$
	0.2	$0.7f_T-0.2Af_{yB}$	$0.7f_T$
	0.3	$0.87-0.47f_T-0.3f_{yB}-0.8Af_{yB}$	$0.87-0.47f_T$
	$0.41+0.23f_T$	$0.87+0.23f_T+0.2f_{yB}+0.4Af_{yB}$	$0.87+0.23f_T$
	0.8	$0.73-0.6f_{yB}+0.47f_T+A(0.5-0.9f_{yB})$	$0.73-0.8f_{yB}+0.47f_T+0.5A(1-f_{yB})$
	1.0	$3.17-4f_{yB}+2.33f_T+A(1-1.2f_{yB})$	$3.17-3.9f_{yB}+2.33f_T+A(1-f_{yB})$
$y < 0$	0	$4.03-2.9f_{yB}-0.93f_T+2A(1-f_{yB})$	$4.03-2.7f_{yB}-0.93f_T+A(2-2.4f_{yB})$
	0.1	$0.84-1.3f_{yB}+1.16f_T+A(1-f_{yB})$	$0.84-0.9f_{yB}+1.16f_T+A(1-0.8f_{yB})$
	0.2	$0.7f_T$	$0.7f_T-0.2Af_{yB}$
	0.3	$0.87-0.47f_T$	$0.87-0.47f_T-0.3f_{yB}-0.8Af_{yB}$
	$0.41+0.23f_T$	$0.87+0.23f_T$	$0.87+0.23f_T+0.2f_{yB}+0.4Af_{yB}$
	0.8	$0.73-0.8f_{yB}+0.47f_T+0.5A(1-f_{yB})$	$0.73-0.6f_{yB}+0.47f_T+A(0.5-0.9f_{yB})$
	1.0	$3.17-3.9f_{yB}+2.33f_T+A(1-f_{yB})$	$3.17-4f_{yB}+2.33f_T+A(1-1.2f_{yB})$
where: $A=-2.33f_T+1.33$			

Transverse position	Longitudinal position f_{xL}	OSTf-1P, OSTf-2P	OSTf-1S, OSTf -2S
$y \geq 0$	0	$4.03-2.7f_{yB}-0.93f_T+A(2-2.4f_{yB})$	$4.03-2.9f_{yB}-0.93f_T+2A(1-f_{yB})$
	0.1	$0.84-0.9f_{yB}+1.16f_T+A(1-0.8f_{yB})$	$0.84-1.3f_{yB}+1.16f_T+A(1-f_{yB})$
	0.2	$0.7f_T-0.2Af_{yB}$	$0.7f_T$
	0.3	$0.87-(0.47-0.3f_{yB})f_T-0.1f_{yB}-0.3Af_{yB}$	$0.87-0.47f_T$
	$0.41+0.23f_T$	$0.27+(0.47+0.16f_{yB})f_T+0.2f_{yB}+0.2Af_{yB}$	$0.27+(0.47+0.36f_{yB})f_T$
	0.8	$0.73-0.6f_{yB}+0.47f_T+A(0.5-0.9f_{yB})$	$0.73-0.8f_{yB}+0.47f_T+0.5A(1-f_{yB})$
	1.0	$3.67-4f_{yB}+2.33f_T+A(1-1.2f_{yB})$	$3.67-3.4f_{yB}+2.33f_T+A(1-f_{yB})$
$y < 0$	0	$4.03-2.9f_{yB}-0.93f_T+2A(1-f_{yB})$	$4.03-2.7f_{yB}-0.93f_T+A(2-2.4f_{yB})$
	0.1	$0.84-1.3f_{yB}+1.16f_T+A(1-f_{yB})$	$0.84-0.9f_{yB}+1.16f_T+A(1-0.8f_{yB})$
	0.2	$0.7f_T$	$0.7f_T-0.2Af_{yB}$
	0.3	$0.87-0.47f_T$	$0.87-(0.47-0.3f_{yB})f_T-0.1f_{yB}-0.3Af_{yB}$
	$0.41+0.23f_T$	$0.27+(0.47+0.36f_{yB})f_T$	$0.27+(0.47+0.16f_{yB})f_T+0.2f_{yB}+0.2Af_{yB}$
	0.8	$0.73-0.8f_{yB}+0.47f_T+0.5A(1-f_{yB})$	$0.73-0.6f_{yB}+0.47f_T+A(0.5-0.9f_{yB})$
	1.0	$3.67-3.4f_{yB}+2.33f_T+A(1-f_{yB})$	$3.67-4f_{yB}+2.33f_T+A(1-1.2f_{yB})$
where: $A=-2.33f_T+1.33$			

k_p values for OSTf load cases **Table 1.4.67(4)**

Transverse position	f_{xL}	OST-1P; OST-2P	OST-1S; OST-2S
$y \geq 0$	0.0	$0.6-0.1f_{yB}-A(0.3+0.2f_{yB})$	$0.6-0.1f_{yB}-0.3A(1-f_{yB})$
	0.1	$0.6-A(0.5f_{yB}+0.2)$	$0.6-1.6f_{yB}+A(1.9f_{yB}-0.2)$
	0.2	$0.6+0.2f_{yB}-A(1.1f_{yB}+0.4)$	$-0.6-1.1f_{yB}+A(1.9f_{yB}-0.4)$
	0.35	$-0.8+1.1f_{yB}-1.3Af_{yB}$	$-0.8-0.2f_{yB}$
	0.65	$1-0.1f_{yB}+0.2Af_{yB}$	$1-1.5f_{yB}+0.8Af_{yB}$
	0.8	$-0.4+0.4f_{yB}-0.2A$	$-0.4-0.2f_{yB}+A(1.5f_{yB}-0.2)$
	0.9	$-0.8+0.6f_{yB}-0.7Af_{yB}$	$-0.8+0.1Af_{yB}$
	1.0	$-1+0.6f_{yB}+A(0.1-0.4f_{yB})$	$-1+0.1A$
$y < 0$	0.0	$0.6-0.1f_{yB}-0.3A(1-f_{yB})$	$0.6-0.1f_{yB}-A(0.3+0.2f_{yB})$
	0.1	$0.6-1.6f_{yB}+A(1.9f_{yB}-0.2)$	$0.6-A(0.5f_{yB}+0.2)$
	0.2	$0.6-1.1f_{yB}+A(1.9f_{yB}-0.4)$	$0.6+0.2f_{yB}-A(1.1f_{yB}+0.4)$
	0.35	$-0.8-0.2f_{yB}$	$-0.8+1.1f_{yB}-1.3Af_{yB}$
	0.65	$1-1.5f_{yB}+0.8Af_{yB}$	$1-0.1f_{yB}+0.2Af_{yB}$
	0.8	$-0.4-0.2f_{yB}+A(1.5f_{yB}-0.2)$	$-0.4+0.4f_{yB}-0.2A$
	0.9	$-0.8+0.1Af_{yB}$	$-0.8+0.6f_{yB}-0.7Af_{yB}$
	1.0	$-1+0.1A$	$-1+0.6f_{yB}+A(0.1-0.4f_{yB})$
where: $A=-2.33f_T+1.33$			

Transverse position	f_{xL}	OSTf-1P; OSTf-2P	OSTf-1S; OSTf-2S
$y \geq 0$	0.0	$0.3-0.2f_{yB}-A(0.2f_{yB}-0.1)$	$0.3+0.2f_{yB}-A(0.2-0.1f_{yB})$
	0.1	$0.1-0.7f_{yB}+A(0.5f_{yB}-0.4)$	$0.1+0.5f_{yB}+A(5f_{yB}-0.4)$
	0.2	$-0.1-0.5f_{yB}-A(1.1f_{yB}-1)$	$-0.1+f_{yB}-A(1.1f_{yB}-1)$
	0.3+0.2f_T	$1.2-0.1f_{yB}-A\left(1.1f_{yB}-1\right)$	$1.2-2.1f_{yB}$
	0.65	$1.1-0.1f_{yB}+0.1Af_{yB}$	$1.1-0.9f_{yB}+0.1Af_{yB}$
	0.8	$-0.5+0.4f_{yB}-0.1A$	$-0.5+0.1f_{yB}-0.1A$
	0.9	$-1.4+0.6f_{yB}-0.1Af_{yB}$	$-1.4+0.7f_{yB}$
	1.0	$-1+0.6f_{yB}+A(0.1-0.4f_{yB})$	$-1+0.1A$
$y < 0$	0.0	$0.3+0.2f_{yB}-A(0.2-0.1f_{yB})$	$0.3-0.2f_{yB}-A(0.2f_{yB}-0.1)$
	0.1	$0.1+0.5f_{yB}+A(5f_{yB}-0.4)$	$0.1-0.7f_{yB}+A(0.5f_{yB}-0.4)$
	0.2	$-0.1+f_{yB}-A(1.1f_{yB}-1)$	$-0.1-0.5f_{yB}-A(1.1f_{yB}-1)$
	0.3+0.2f_T	$1.2-2.1f_{yB}$	$1.2-0.1f_{yB}-A\left(1.1f_{yB}-1\right)$
	0.65	$1.1-0.9f_{yB}+0.1Af_{yB}$	$1.1-0.1f_{yB}+0.1Af_{yB}$
	0.8	$-0.5+0.1f_{yB}-0.1A$	$-0.5+0.4f_{yB}-0.1A$
	0.9	$-1.4+0.7f_{yB}$	$-1.4+0.6f_{yB}-0.1Af_{yB}$
	1.0	$-1+0.1A$	$-1+0.6f_{yB}+A(0.1-0.4f_{yB})$
where: $A=-2.33f_T+1.33$			

1.4.~~7~~8 Hydrodynamic pressures for OHM load cases

The hydrodynamic pressures, P_W, for load cases OHM-1 and OHM-2, at any load point, in kN/m^2, are to be obtained from Table 1.4.~~7~~8(1).

Hydrodynamic pressures for OHM load cases **Table 1.4.~~7~~8(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le 2h_W + T_{LC}$	$z > 2h_W + T_{LC}$
OHM-1P	P_W = max (-P_{OHM} , $\rho g(z\text{-}T_{LC})$)	$P_W = P_{W,WL} - \frac{1}{2}\rho g(z - T_{LC})$	$P_W = 0$
OHM-2P	P_W = max (P_{OHM} , $\rho g(z\text{-}T_{LC})$)		
OHM-1S	P_W = max (-P_{OHM} , $\rho g(z\text{-}T_{LC})$)		
OHM-2S	p_W = max (P_{OHM} , $\rho g(z\text{-}T_{LC})$)		

where:

$$P_{OHM} = \text{-}0.16 f_{fa} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.4.~~7~~8(2).

Girth distribution coefficient f_{yz} for OHM load cases **Table 1.4.~~7~~8(2)**

Transverse position	OHM-1P, OHM-2P	OHM -1S, OHM -2S
$y \geqslant 0$	$(18.64 f_T - 6.64)\frac{z}{T_{LC}} + (22.14 - 18.64 f_T) f_{yB} + 2.5$	$\frac{z}{T_{LC}} + (8 - 7 f_T) f_{yB} + 2.5$
$y < 0$	$\frac{z}{T_{LC}} + (8 - 7 f_T) f_{yB} + 2.5$	$(18.64 f_T - 6.64)\frac{z}{T_{LC}} + (22.14 - 18.64 f_T) f_{yB} + 2.5$

λ — Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = (1 - 0.5 f_T) L$$

k_a— Amplitude coefficient to be obtained from Table 1.4.~~7~~8(3). Intermediate values are to be interpolated.

k_p— Phase coefficient to be obtained from Table 1.4.~~7~~8(4). Intermediate values are to be interpolated.

k_a values for OHM load cases **Table 1.4.~~78~~8(3)**

Transverse position	Longitudinal position f_{xL}	OHM-1P, OHM-2P	OHM -1S, OHM -2S
$y \geqslant 0$	0	$2.73+0.47f_T-2.4f_{yB}+A(0.7f_{yB}-1)$	$1.13+0.47f_T+(2.33f_T-2.93)(f_{yB}-1)$
	0.1	$1.2-0.7f_{yB}+0.3A(2f_{yB}-1)$	$1.2-0.7f_{yB}+0.3A(f_{yB}-1)$
	0.2	$-0.46+1.86f_T-0.1f_{yB}+A(0.3f_{yB}-0.7)$	$-0.46+1.86f_T+0.7A(f_{yB}-1)$
	$0.53-0.23f_T$	$-0.33+2.33f_T+0.1f_{yB}+A(0.2f_{yB}-1.3)$	$-0.33+2.33f_T+1.3A(f_{yB}-1)$
	$0.83-0.23f_T$	$0.5+0.5f_{yB}-0.1Af_{yB}$	0.5
	0.9	$4-2.6f_{yB}+A(f_{yB}-1)$	$4-1.5f_{yB}+A(2f_{yB}-1)$
	1.0	$6-4.6f_{yB}+A(2.1f_{yB}-2)$	$6-3.5f_{yB}+2A(f_{yB}-1)$
$y<0$	0	$1.13+0.47f_T+(2.33f_T-2.93)(f_{yB}-1)$	$2.73+0.47f_T-2.4f_{yB}+A(0.7f_{yB}-1)$
	0.1	$1.2-0.7f_T+0.3A(f_{yB}-1)$	$1.2-0.7f_T+0.3A(2f_{yB}-1)$
	0.2	$-0.46+1.86f_T+0.7A(f_{yB}-1)$	$-0.46+1.86f_T-0.1f_{yB}+A(0.3f_{yB}-0.7)$
	$0.53-0.23f_T$	$-0.33+2.33f_T+1.3A(f_{yB}-1)$	$-0.33+2.33f_T+0.1f_{yB}+A(0.2f_{yB}-1.3)$
	$0.83-0.23f_T$	0.5	$0.5+0.5f_{yB}-0.1Af_{yB}$
	0.9	$4-1.5f_{yB}+A(2f_{yB}-1)$	$4-2.6f_{yB}+A(f_{yB}-1)$
	1.0	$6-3.5f_{yB}+2A(f_{yB}-1)$	$6-4.6f_{yB}+A(2.1f_{yB}-2)$
where: $A=2.33f_T-1.33$			

k_p values for OHM load cases **Table 1.4.~~78~~8(4)**

Transverse position	f_{xL}	OHM-1P; OHM-2P	OHM-1S; OHM-2S
$y \geqslant 0$	0.0	$-1+A(0.4+f_{yB})$	$-1+0.4A(1-f_{yB})$
	0.1	$-0.5+f_{yB}+A(1.3-0.8f_{yB})$	$-0.5+1.3A(1-f_{yB})$
	0.2	$0.5-0.3f_{yB}+0.7A$	$0.5-0.4f_{yB}+0.7A$
	0.3	$-0.5+0.2f_{yB}+A(0.7-0.1f_{yB})$	$-0.5+1.5f_{yB}+A(0.7-0.8f_{yB})$
	$0.6-0.1f_{yB}$	-1	$-1+1.8f_{yB}$
	0.75	$0.7-0.1A$	$0.7-A(0.1+1.6f_{yB})$
	0.9	$0.7+0.1f_{yB}+A(0.1f_{yB}-0.1)$	$0.7-0.1f_{yB}-A(0.1+0.4f_{yB})$
	1.0	$0.8+A(0.1f_{yB}-0.2)$	$0.8-0.5f_{yB}-0.2A(1-f_{yB})$
$y<0$	0.0	$-1+0.4A(1-f_{yB})$	$-1+A(0.4+f_{yB})$
	0.1	$-0.5+1.3A(1-f_{yB})$	$-0.5+f_{yB}+A(1.3-0.8f_{yB})$

	0.2	$0.5-0.4f_{yB}+0.7A$	$0.5-0.3f_{yB}+0.7A$
	0.3	$-0.5+1.5f_{yB}+A(0.7-0.8f_{yB})$	$-0.5+0.2f_{yB}+A(0.7-0.1f_{yB})$
	$0.6-0.1f_{yB}$	$-1+1.8f_{yB}$	-1
	0.75	$0.7-A(0.1+1.6f_{yB})$	$0.7-0.1A$
	0.9	$0.7-0.1f_{yB}-A(0.1+0.4f_{yB})$	$0.7+0.1f_{yB}+A(0.1f_{yB}-0.1)$
	1.0	$0.8-0.5f_{yB}-0.2A(1-f_{yB})$	$0.8+A(0.1f_{yB}-0.2)$
where: $A=2.33f_T-1.33$			

1.4.89 Hydrodynamic pressures for OHS load cases

The hydrodynamic pressures, P_W, for load cases OHS-1 and OHS-2, at any load point, in kN/m^2, are to be obtained from Table 1.4.89(1).

Hydrodynamic pressures for OHS load cases **Table 1.4.89(1)**

Load case	Hydrodynamic pressure, in kN/m^2		
	$z \le T_{LC}$	$T_{LC} < z \le 2h_W + T_{LC}$	$z > 2h_W + T_{LC}$
OHS-1P	P_W = max (-P_{OHS}, $\rho g(z\text{-}T_{LC})$)	$P_W = P_{W,WL} - \frac{1}{2}\rho g(z-T_{LC})$	$P_W = 0$
OHS-2P	P_W = max (P_{OHS}, $\rho g(z\text{-}T_{LC})$)		
OHS-1S	P_W = max (-P_{OHS}, $\rho g(z\text{-}T_{LC})$)		
OHS-2S	p_W = max (P_{OHS}, $\rho g(z\text{-}T_{LC})$)		

where:

$$P_{OHS} = \text{-}0.17 f_{fa} k_a k_p f_{yz} C_s \sqrt{\frac{L_0 + \lambda - 125}{L}}$$

f_{yz}— Girth distribution coefficient, to be obtained from Table 1.4.89(2).

Girth distribution coefficient f_{yz} for OHS load cases **Table 1.4.89(2)**

Transverse position	OHS-1P, OHS-2P	OHS-1S, OHS-2S
$y \ge 0$	$(13.66-4.66f_T)\frac{z}{T_{LC}}+(13.32-9.32f_T)f_{yB}+4$	$(0.17+2.33f_T)\frac{z}{T_{LC}}+(19-14f_T)f_{yB}+4$
$y < 0$	$(0.17+2.33f_T)\frac{z}{T_{LC}}+(19-14f_T)f_{yB}+4$	$(13.66-4.66f_T)\frac{z}{T_{LC}}+(13.32-9.32f_T)f_{yB}+4$

λ —Wave length of the dynamic load case, in m, to be taken as:

$$\lambda = 0.42L$$

k_a—Amplitude coefficient to be obtained from Table 1.4.89(3). Intermediate values are to be interpolated.

k_a values for OHS load cases **Table 1.4.89(3)**

Transverse position	Longitudinal position f_{xL}	OHS-1P, OHS-2P	OHS -1S, OHS -2S
$y \geq 0$	0	$3.7-2.9f_{yB}+2.5A(f_{yB}-1)$	$3.7-2.9f_{yB}+A(2f_{yB}-2.5)$
	0.1	$1.5-0.9f_{yB}+A(0.6f_{yB}-0.4)$	$1.5-1.3f_{yB}+A(f_{yB}-0.4)$
	0.2	$0.8-0.3f_{yB}+A(0.7f_{yB}-0.4)$	$0.8-0.4f_{yB}+A(0.7f_{yB}-0.4)$
	0.3	$0.2+0.3f_{yB}+A(0.1+0.3f_{yB})$	$0.2+0.5f_{yB}+A(0.1-0.4f_{yB})$
	0.5	1	1
	0.6	$1-0.1f_{yB}$	$1-0.2f_{yB}+0.3Af_{yB}$
	0.8	$1-0.4f_{yB}+A(1.2f_{yB}-0.8)$	$1-0.8f_{yB}+A(f_{yB}-0.8)$
	1.0	$4.8-3.8f_{yB}+A(1.8f_{yB}-1.1)$	$4.8-4f_{yB}+A(1.8f_{yB}-1.1)$
$y < 0$	0	$3.7-2.9f_{yB}+A(2f_{yB}-2.5)$	$3.7-2.9f_{yB}+2.5A(f_{yB}-1)$
	0.1	$1.5-1.3f_{yB}+A(f_{yB}-0.4)$	$1.5-0.9f_{yB}+A(0.6f_{yB}-0.4)$
	0.2	$0.8-0.4f_{yB}+A(0.7f_{yB}-0.4)$	$0.8-0.3f_{yB}+A(0.7f_{yB}-0.4)$
	0.3	$0.2+0.5f_{yB}+A(0.1-0.4f_{yB})$	$0.2+0.3f_{yB}+A(0.1+0.3f_{yB})$
	0.5	1	1
	0.6	$1-0.2f_{yB}+0.3Af_{yB}$	$1-0.1f_{yB}$
	0.8	$1-0.8f_{yB}+A(f_{yB}-0.8)$	$1-0.4f_{yB}+A(1.2f_{yB}-0.8)$
	1.0	$4.8-4f_{yB}+A(1.8f_{yB}-1.1)$	$4.8-3.8f_{yB}+A(1.8f_{yB}-1.1)$
where: $A=2.33f_T-1.33$			

k_p — Phase coefficient to be obtained from Table 1.4.89(4). Intermediate values are to be interpolated.

k_p values for OHS load cases **Table 1.4.89(4)**

Transverse position	f_{xL}	OHS-1P, OHS-2P	OHS-1S, OHS-2S
$y \geq 0$	0.0	$0.5 + A(0.2 f_{yB} - 0.3)$	$0.5 - A(f_{yB} + 0.3)$
	0.1	$0.5 - 0.7A(1 - f_{yB})$	$0.5 - A(0.7 + 0.6 f_{yB}) - 0.3 f_{yB}$
	0.2	$0.5 + A(0.8 f_{yB} - 0.3)$	$0.5 - A(0.5 f_{yB} + 0.3) - 0.7 f_{yB}$
	For OHS-1P, OHS-2P: 0.3 For OHS-1S, OHS-2S:$0.3+0.1 f_{yB}$	$0.5 + 0.3 A f_{yB}$	$0.5 + (0.2A + 0.4) f_{yB}$
	For OHS-1P, OHS-2P: $0.6+0.1A(1-f_{yB})$ For OHS-1S, OHS-2S: $0.6+0.1A(1-f_{yB})+0.1f_{yB}$	$-1 + 0.3A(1 - f_{yB})$	$-1 + A(0.3 - 0.6 f_{yB}) + f_{yB}$
	0.8	$0.7 + 0.2A(1 - f_{yB})$	$0.7 + A(0.2 - 0.9 f_{yB}) - 0.4 f_{yB}$
	0.9	$0.8 + 0.2A$	$0.8 + 0.2A - 0.2 f_{yB}$
	1.0	$0.4 + A(0.4 - 0.3 f_{yB})$	$0.4 + A(0.4 - 0.1 f_{yB}) + 0.2 f_{yB}$
$y < 0$	0.0	$0.5 - A(f_{yB} + 0.3)$	$0.5 + A(0.2 f_{yB} - 0.3)$
	0.1	$0.5 - A(0.7 + 0.6 f_{yB}) - 0.3 f_{yB}$	$0.5 - 0.7A(1 - f_{yB})$
	0.2	$0.5 - A(0.5 f_{yB} + 0.3) - 0.7 f_{yB}$	$0.5 + A(0.8 f_{yB} - 0.3)$
	For OHS-1P, OHS-2P: $0.3+0.1f_{yB}$ For OHS-1S, OHS-2S:0.3	$0.5 + (0.2A + 0.4) f_{yB}$	$0.5 + 0.3 A f_{yB}$
	For OHS-1P, OHS-2P: $0.6+0.1A(1-f_{yB})+0.1f_{yB}$ For OHS-1S、OHS-2S: $0.6+0.1A(1-f_{yB})$	$-1 + A(0.3 - 0.6 f_{yB}) + f_{yB}$	$-1 + 0.3A(1 - f_{yB})$
	0.8	$0.7 + A(0.2 - 0.9 f_{yB}) - 0.4 f_{yB}$	$0.7 + 0.2A(1 - f_{yB})$
	0.9	$0.8 + 0.2A - 0.2 f_{yB}$	$0.8 + 0.2A$
	1.0	$0.4 + A(0.4 - 0.1 f_{yB}) + 0.2 f_{yB}$	$0.4 + A(0.4 - 0.3 f_{yB})$
where: $A = 2.33 f_T - 1.33$			

2 External pressures on exposed decks

2.1 Application

2.1.1 The external pressures and forces on exposed decks are only to be applied for strength assessment.

2.1.2 The green sea pressures for exposed decks are to be considered independently of the pressures due to distributed cargo or other equipment loads and any concentrated forces due to cargo or other unit equipment loads.

2.2 Green sea loads

2.2.1 Pressure on exposed deck

The external dynamic pressure due to green sea loading, P_D, at any point of an exposed deck, in kN/m^2, for the static plus dynamic (S+D) design load scenarios is to be derived for each dynamic load case and is to be taken as defined in [2.2.3] to [2.2.4]. The external dynamic pressure due to green sea loading, P_D, at any point of an exposed deck for the static (S) design load scenarios is zero.

2.2.2 If a breakwater is fitted on the exposed deck, no reduction in the green sea pressure is allowed for the area of the exposed deck located aft of the breakwater.

2.2.3 ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVM and FVMf load cases

The external pressure, P_D, for ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVM and FVMf load cases, at any load point of an exposed deck is to be obtained, in kN/m^2, from the following formula, see Figure 1.3.2(1) and Figure 1.3.2(2):

$$P_D = \chi P_W$$

where:

$P_W = P_{W,D}$, but not to be taken less than $P_{D\text{-}min}$.

$P_{W,D}$— Pressure, in kN/m^2, obtained at side of the exposed deck for ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVM and FVMf load cases as defined in [1.3].

$P_{D\text{-}min}$— Minimum exposed deck pressure calculated from the formula in Table 2.2.3(1), in kN/m^2, to be taken as:

- For cargo hold analysis according to Ch 7: $P_{D\text{-}min}$=0.0
- For other cases: $P_{D\text{-}min}$ as defined in Table 2.2.3(1).

χ — Coefficient defined in Table 2.2.3(2).

Minimum pressures on exposed decks for ~~HVM, HVS and FVM~~ HVM, HVS, HSA, FVM and FVMf load cases

Table 2.2.3(1)

Location	Minimum pressure on exposed deck $P_{D\text{-}min}$, kN/m²	
	$L_{LL} \geq 100$m	$L_{LL} < 100$m
$x_{LL} / L_{LL} \leq 0.75$	34.3	$14.9 + 0.195\, L_{LL}$
$x_{LL} / L_{LL} > 0.75$	$34.3 + (14.8 + a(L_{LL} - 100))\left(4\frac{x_{LL}}{L_{LL}} - 3\right)$	$12.2 + \frac{L_{LL}}{9}\left(5\frac{x_{LL}}{L_{LL}} - 2\right) + 3.6\frac{x_{LL}}{L_{LL}}$

where:

a— Coefficient taken equal to:

a=0.0726

x_{LL}— X-coordinate of the load point measured from the aft end of the freeboard length L_{LL}.

Coefficient for pressure on exposed decks

Table 2.2.3(2)

Exposed deck location	χ
Freeboard deck	1.00
Superstructure deck including forecastle deck	0.75
1st tier of deckhouse	0.56
2nd tier of deckhouse	0.42
3rd tier of deckhouse	0.32
4th tier of deckhouse	0.25
5th tier of deckhouse	0.20
6th tier of deckhouse	0.15
7th tier of deckhouse and above	0.10

2.2.4 BSR, BSP, OSTf, OHM, OHS, OSA and OVA load cases

The external pressure, P_D, for BSR, BSP, OSTf, OHM, OHS, OSA and OVA load cases at any load point of an exposed deck is to be obtained, in kN/m^2, by linear interpolation between the pressures at the port and starboard deck edges:

$$P_{D,stb} = \chi P_{W,D-stb}$$

$$P_{D,pt} = \chi P_{W,D-pt}$$

where:

$P_{W,D\text{-}stb}$— Pressure obtained at starboard deck edge for BSR, BSP, OSTf, OHM, OHS, OSA and OVA load cases as defined in [1.3], as appropriate.

$P_{W,D\text{-}pt}$— Pressure obtained at port deck edge for BSR, BSP, OSTf, OHM, OHS, OSA and OVA load cases as defined in [1.3], as appropriate.

χ— Coefficient defined in Table 2.2.3(2).

3 External impact pressures for the bow and stern areas

3.1 Application

3.1.1 The impact pressures for the bow and stern areas are only applicable to strength assessment.

3.2 Bow bottom slamming pressure

~~3.2.1 Extreme value of slamming pressures~~

~~The section at $0.85L_{PP}$ from the aft perpendicular is selected as the transverse section for calculation, where L_{PP} is defined in Ch 1, Sec 4, [2.1.1]. The extreme value of slamming pressures, P_{SE}, in kN/m², is calculated in accordance with the following formula:~~

$$P_{SE}(\alpha) = \frac{1}{2}\rho k_1 C_{ps}\left\{V_0^2 - 2E_v \ln\left[1-(1-\alpha)^{1/n}\right]\right\}$$

~~where: ρ — density of seawater, in t/m³, taken as 1.025;~~

~~k_1 — slamming coefficient, obtained according to Table 3.2.1, the intermediate value may be obtained from interpolation:~~

~~**Slamming coefficient k_1 — Table 3.2.1**~~

b_1/d_1	1.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0
k_1	4.0	9.5	20.0	26.0	29.5	32.0	33.0	34.2	35.3	36.2

~~where: d_1 — $T_{SC}/10$ draught, in m;~~

~~b_1 — half breadth of the waterline for the transverse section concerned under draught d_1, in m;~~

~~C_{ps} — coefficient, taken as 0.44;~~

~~V_0 — critical slamming speed, in m/s, obtained from the following formulae:~~

$$V_0 = 0.0925\sqrt{L}$$

~~α — assurance rate, taken as 0.01;~~

~~n — number of impacts, to be taken as the mean number of impacts N within t_n, obtained from the following formula:~~

$$N = 3600\frac{t_n}{2\pi}\sqrt{\frac{E_v}{E_r}}\exp\left\{-\left(\frac{T_f^2}{2E_r}+\frac{V_0^2}{2E_v}\right)\right\}$$

~~where:~~

~~t_n — the calculated navigation time, in h, obtained according to the following formulae:~~

t_n =41, for L ≤ 77 m

t_n =35, for L ≥160 m

~~The intermediate value of t_n may be obtained by linear interpolation.~~

~~T_f — draught of transverse section concerned in navigation condition with minimum draught at bow, in m;~~

~~E_r, E_v — Variance of vertical relative motions for the hull and wave surface of transverse section concerned and variance of vertical relative velocities for the hull and wave surface of transverse section concerned are obtained from the following formula:~~

$$E_r = 0.25\left(C_{pc}M_r\right)^2/f_r$$

$$E_v = 0.25\left(\omega_e C_{pc} M_r\right)^2 / f_v$$

where: C_{pc} — correction factor of vertical relative motion probability, taken as 1.2;

ω_e — encounter frequency, in rad/s, obtained from the following formula:

$$\omega_e = \omega\left(1 + \frac{0.4\omega V_c}{g}\right)$$

ω - effective wave frequency based on 80% length L of the ship, in rad/s, obtained from the following formula:

$$\omega = \sqrt{\frac{2\pi g}{0.8L}}$$

V_c — considered ship speed, in m/s, obtained from the following formula:

$$V_c = 0.5144V$$

where: M_r - vertical relative motions for the hull and wave surface of the considered section, in m, obtained from the following formula:

$$M_r = H_{\min}\left[1 + \frac{4.5}{C_b + 0.2}\left(\frac{x_a}{L} - x_m\right)^2\right]$$

$H_{\min}$ — minimum wave height for calculation, in m, obtained from the following formula:

$$H_{\min} = \frac{0.0545}{k_m} L\left(C_b + 0.2\right)^{0.3} \exp\left(-0.0044L\right)$$

x_a — longitudinal position from the considered section to the after perpendicular, in m;

x_m — coefficient, obtained from the following formula, to be taken not less than 0.2;

$$x_m = 0.45 - \frac{0.309V}{\sqrt{gL}}$$

k_m — coefficient, calculated in accordance with the following formulae:

$$k_m = 1 + \frac{4.5\left(0.5 - x_m\right)^2}{C_b + 0.2}$$

f_r, f_v — coefficient, calculated in accordance with the following formulae:

$$f_r = -0.00411L + 4.1$$

$$f_v = -0.011L + 5.1$$

3.2.2 Section slamming pressures

The slamming pressure P_{SL} for each section is calculated in accordance with the following formula:

$$P_{SL} = eP_{SE}$$

where: e — slamming pressure longitudinal correction coefficient, see Table 3.2.2;

P_{SE} - extreme value of bottom slamming pressures, in kPa, see [3.2.1] of this Section;

Correction coefficient *e* **Table 3.2.2**

Position	*e*
Between $X-0.125L$ to X from F.P.	$\dfrac{2f-1}{0.05-C_b}$
Between F.P. and $X-0.2L$ from F.P.	$0.5+\dfrac{f}{0.9-C_b}$
Others	1

Note: C_b — block coefficient, C_b=0.7 for C_b<0.7, C_b=0.7 for C_b>0.8;

f — ratio of distance between the section position and forward perpendicular to ship length L;

X — bow bottom slamming strengthening scope, see Ch 7, Sec 7, [3.1.1].

3.2.1 Section slamming pressures

The slamming pressure P_{SL} for each section, in kN/m^2, is calculated in accordance with the following formula:

$$P_{SL} = eP_{SE}$$

where: P_{SE} — extreme value of bottom slamming pressures, in kN/m^2, see [3.2.2];

e — slamming pressure longitudinal correction coefficient, see Table 3.2.1 and Figure 3.2.1.

Correction coefficient *e* **Table 3.2.1**

Position	*e*
Between $X-0.125L$ to X from F.P.	$\dfrac{2f-1}{0.05-C_b}$
Between F.P. and $X-0.2L$ from F.P.	$0.5+\dfrac{f}{0.9-C_b}$
Others	1

Note: C_b — block coefficient, C_b=0.7 for C_b<0.7, C_b=0.8 for C_b>0.8;

f — ratio of distance between the section position and forward perpendicular to ship length L;

X — bow bottom slamming strengthening scope, see Ch 6, Sec 7, [3.1.1].

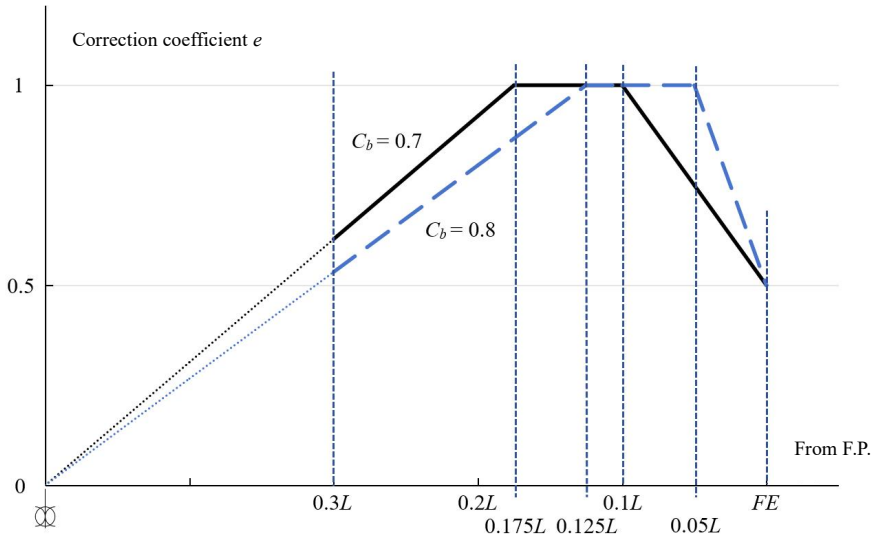


Figure 3.2.1 Correction Coefficient *e*

3.2.2 Extreme value of bottom slamming pressures

Extreme value of bottom slamming pressures P_{SE}, in kN/m^2, is to be calculated for each frame transverse section at the corresponding position where e = 1, and the maximum value is to be taken in accordance with the following formula:

$$P_{SE}(\alpha) = \frac{1}{2}\rho k_1 C_{ps}\left\{V_0^2 - 2E_v \ln\left[1-(1-\alpha)^{1/n}\right]\right\}$$

where: ρ — density of seawater, in t/m^3, taken as 1.025;

k_1 — slamming coefficient, obtained according to Table 3.2.2(1), the intermediate value may be obtained from interpolation:

Slamming coefficient k_1 **Table 3.2.2(1)**

b_1/d_1	1.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0
$C_b \le 0.73$	4.0	9.5	20.0	26.0	29.5	32.0	33.0	34.2	35.3	36.2
$C_b > 0.73$	4.0	9.5	20.0	26.0	28.5	29.6	30.0	29.6	28.8	28.0

Note: $d_1 = T_{SC}/10$ draught, in m;

b_1 — half breadth of the waterline for the transverse section concerned under draught d_1, in m;

C_{ps} — coefficient, taken as 0.44;

V_0 — critical slamming speed, in m/s, obtained from the following formulae:

$$V_0 = \begin{cases} 0.0925\sqrt{gL}, & C_b \le 0.73 \\ 0.07\sqrt{gL}, & C_b > 0.73 \end{cases}$$

α — assurance rate, taken as 0.01;

n — number of impacts, to be taken as the mean number of impacts N within t_n, obtained from the following formula:

$$N = 3600\frac{t_n}{2\pi}\sqrt{\frac{E_v}{E_r}}\exp\left\{-\left(\frac{T_f^2}{2E_r}+\frac{V_0^2}{2E_v}\right)\right\}$$

where:

t_n — the calculated navigation time, in h, to be taken as t_n =35;

T_f — draught of transverse section concerned in navigation condition with minimum draught at bow, in m;

E_r, E_v — variance of vertical relative motions for the hull and wave surface of transverse section concerned and variance of vertical relative velocities for the hull and wave surface of transverse section concerned are obtained from the following formula:

$$E_r = 0.25\left(C_{pc}M_r\right)^2 / f_r$$

$$E_v = 0.25\left(\omega_e C_{pc}M_r\right)^2 / f_v$$

where: C_{pc} — correction factor of vertical relative motion probability, taken as 1.2;

ω_e — encounter frequency, in rad/s, obtained from the following formula:

$$\omega_e = \omega_L\left(1+\frac{0.4\omega V_c}{g}\right)$$

ω_L — effective wave frequency based on 80% length L of the ship, in rad/s, obtained from the following formula:

$$\omega_L = \sqrt{\frac{2\pi g}{0.8L}}$$

V_c — considered ship speed, in m/s, obtained from the following formula:

$$V_c = 0.5144V$$

M_r — vertical relative motions for the hull and wave surface of the considered section, in m, obtained from the following formula:

$$M_r = H_{\min}\left[1+\frac{4.5}{C_b+0.2}\left(\frac{x_a}{L}-x_m\right)^2\right]$$

$H_{\min}$ — minimum wave height for calculation, in m, obtained from the following formula:

$$H_{\min} = \frac{0.0545}{k_m}L\left(C_b+0.2\right)^{0.3}\exp\left(-0.0044L\right)$$

x_a — longitudinal position from the considered section to the after perpendicular, in m;

x_m — coefficient, obtained from the following formula, to be taken not less than 0.2;

$$x_m = 0.45-\frac{0.309V}{\sqrt{gL}}$$

k_m — coefficient, calculated in accordance with the following formulae:

$$k_m = 1 + \frac{4.5(0.5 - x_m)^2}{C_b + 0.2}$$

f_r, f_v — coefficient distributed along ship length, calculated in accordance with the following formulae:

$f_r, f_v \equiv$ { selected in accordance with Table 3.2.2(2), when $L \leq 200$ m; linear interpolation in accordance with ship lenth, when 200 m $< L <$ 300 m; selected in accordance with Table 3.2.2(3), when $L \geq 300$m }

Coefficient f_r, f_v — Table 3.2.2(2)

x_a / L	0.80	0.85	0.90	0.95
f_r	7.30	5.03	3.86	3.21
f_v	4.08	3.39	3.01	2.70

Coefficient f_r, f_v — Table 3.2.2(3)

x_a / L	0.80	0.85	0.90	0.95
f_r	3.15	2.52	2.21	2.08
f_v	1.00	1.00	1.00	1.00

3.2.3 Bow relative motion direct calculation

In calculation of the section slamming pressures, variance of vertical relative motions for the hull and wave surface of transverse section concerned E_r and vertical relative velocities E_v may be determined by direct calculation according to the requirements of this ~~Section~~ paragraph, namely the zero moment of motion response given respectively by spectrum analysis. In this case, the E_r and E_v of each section concerned are given by direct calculation, the slamming pressure P_{SL} is taken as ~~replaced by~~ the actual calculated value of ~~extreme value of slamming pressures~~ P_{SE}.

Direction calculation is to use the loading condition with the minimum draught at bow in navigation condition which is determined in accordance with the loading manual.

(1) Two-parameter P-M spectrum is adopted to model the wave power spectrum density function, which is given by the following formula:

$$S(\omega) = \frac{124 H_S^2}{T_Z^4} \omega^{-5} \exp\left(-\frac{496}{T_Z^4} \omega^{-4}\right) f_0(\theta)$$

where: H_S — significant wave height, in m;

T_Z — mean zero-crossing period, in s;

ω — angular frequency of wave components, in rad/s;

$f_0(\theta)$ — wave spreading function, obtained from the following formula:

$$f_0(\theta)=\begin{cases}\dfrac{2}{\pi}\cos^2(\theta-\theta_m), & |\theta-\theta_m|<90\\ 0, & \text{Other values}\end{cases}$$

where: θ — extension wave direction, in ~~degree~~(°);

θ_m — main wave direction, in ~~degree~~(°).

(2) The extreme value of slamming pressures is to be determined by short-term prediction approach and the significant wave height *Hs* is obtained from the following formulae:

$$H_S=\begin{cases}8-0.6\left(\dfrac{300-L}{100}\right)^{1.5} & \text{m},\ L<300\text{m}\\ 8+0.6\left(\dfrac{L-300}{100}\right)^{1.5} & \text{m},\ L\geq 300\text{m}\end{cases}$$

The average zero up-crossing wave period T_z ~~and calculated navigation time t_n are~~ is to be selected in accordance with Table 3.2.3 and the intermediate values are to be obtained by interpolation.

Selection of sea wave conditions **Table 3.2.3**

Significant wave height H_S (m)	6.0	7.0	8.0	9.0
Average zero up-crossing wave period T_Z (s)	8.703	9.400	9.990	10.503
~~Calculated navigation time t_n (h)~~	~~41~~	~~35~~	~~35~~	~~35~~

(3) The speed is to be taken as $0.75V$.

(4) The head sea and head oblique sea are to be considered, and interval between wave heading angles is not to be greater than 30 degrees.

(5) The range of wave frequencies is to include 0.2 rad/s to 1.8 rad/s in increments taken as 0.05 rad/s.

(6) Linear rolling damping may be determined by test or empirical formula, if not applicable, 5% of the critical rolling damping value may be taken.

(7) Where direct calculation is adopted for relative motion, the slamming coefficient k_1 in [3.~~1.1~~2.2] of this Section is obtained from the following formula:

$$k_1=\exp\left(1.377+2.419a_1-0.873a_3+9.624a_5\right)$$

where: a_1, a_3, a_5 — the coefficient of three-parameter conformal mapping for the transverse section under draught d_1 to unit circle as follows:

$$Z_0=U(\zeta+a_1\zeta^{-1}+a_3\zeta^{-3}+a_5\zeta^{-5})$$

Z_0 — section coordinate;

ζ — circle coordinate;

U — scale ratio, $U=\dfrac{d_1}{1-a_1+a_3-a_5}$.

3.4 Stern flat bottom slamming pressure

3.4.1 Section slamming pressures

The slamming pressure P_{SL} for each section, in kN/m², is calculated in accordance with the following formula:

$$P_{SL}=\frac{1}{2}\rho k_1\left\{V_0^2-2E_v\ln\left[1-(1-\alpha)^{1/n}\right]\right\}$$

where: ρ — density of seawater, in t/m^3, taken as 1.025;

k_1 — slamming coefficient, to be determined in accordance with [3.4.2](4);

V_0 —critical slamming speed, in m/s, obtained from the following formula:

$$V_0 = 0.0925\sqrt{gL}$$

E_v —variance of vertical relative velocities for the hull and wave surface of transverse section concerned, determined by direct calculation in accordance with [3.4.2];

α — assurance rate, taken as 0.01;

n — number of impacts, to be taken as the mean number of impacts N within t_n, obtained from the following formula:

$$N = 3600\frac{t_n}{2\pi}\sqrt{\frac{E_v}{E_r}}\exp\left\{-\left(\frac{H_a^2}{2E_r}+\frac{V_0^2}{2E_v}\right)\right\}$$

where:

t_n — the calculated navigation time, in h, to be taken as t_n =35;

E_r —variance of vertical relative motions for the hull and wave surface of transverse section concerned, determined by direct calculation in accordance with [3.4.2];

H_a —vertical distance from the bottom of considered transverse section to draught in assessment condition in m.

3.4.2 Stern relative motion direct calculation

For direction calculation method of relative motion of considered transverse section at stern, refer to the method in [3.2.3] and pay attention to the following points:

(1) The maximum stern draught loading condition in ballast navigation determined in accordance with the loading manual is to be used for direct calculation;

(2) The calculated speed is taken as 5 kn;

(3) When calculating heading angles, following sea and quartering sea conditions are to be considered, with the interval of wave direction angles not exceeding 30°;

(4) When calculating the slamming coefficient k_1 in the formula of [3.4.1], the offsets of the transverse section is to be taken within the height d_1 measured upward from the baseline at the stern bottom.

Section 6 INTERNAL LOADS

1 Pressures due to liquids

1.2 Static liquid pressure

1.2.1 Normal operations at sea

The static pressure due to liquid in tanks, P_{ls} during normal operations at sea, in kN/m^2, is to be taken as:

$$P_{ls} = \rho_L g(z_{top} - z) + P_{PV} \quad \text{for tanks fitted with PRV}$$

~~$P_{ls} = \rho_L g(z_{top} - z) + 25$ for ballast tanks in cargo hold area~~

~~$P_{ls} = \rho_L g(z_{top} - z + 0.5h_{air})$ for other cases~~

$P_{ls} = \rho_L g\left(z_{top} - z\right)$ for other cases

1.2.2 Harbour/sheltered water operations

The static pressure due to liquid in tanks,P_{ls} for harbour/sheltered water operations, in kN/m^2, is to be taken as:

$P_{ls} = \rho_L g(z_{top} - z) + P_{PV}$ for tanks fitted with PRV

~~$P_{ls} = \rho_L g(z_{top} - z) + 25$ for ballast tanks in cargo hold area~~

~~$P_{ls} = \rho_L g(z_{top} - z + 0.5h_{air})$ for other cases~~

$P_{ls} = \rho_L g\left(z_{top} - z\right)$ for other cases

1.2.3 Sequential ballast water exchange

The static pressure, P_{ls} due to liquid in ballast tanks associated with sequential ballast water exchange operations, in kN/m^2, is to be taken as:

~~$P_{ls} = \rho_L g(z_{top} - z) + 25$ for ballast tanks in cargo hold area~~

~~$P_{ls} = \rho_L g(z_{top} - z + 0.5h_{air})$ for other cases~~

$P_{ls} = \rho_L g\left(z_{top} - z\right) + P_{PV}$ where pressure release valve is fitted

$P_{ls} = \rho_L g\left(z_{top} - z\right)$ for other cases

Section 8 LOADING CONDITIONS

3 Design loading conditions for block FE strength analysis

3.2 Design loading conditions

3.2.2 Design loading conditions for strength check in fuel oil tank area is shown in Table 3.2.2.

Design loading conditions for strength check in the cargo hold area

Table 3.2.1

Condition	Description	Container weight	Draught	Still water bending moment	Still water shear force	Dynamic load case
LC1	Homogeneous loading of heavy container	40ft heavy container	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2

Condition	Description	Container weight	Draught	Still water bending moment	Still water shear force	Dynamic load case
						FVMf-2/FVM-2 BSR-2P BSP-2P OST-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC2	Homogeneous loading of light container	40ft light container	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P OST-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC3	Homogeneous loading of heavy container minus draught	20ft heavy container. If there is mixed loading on the deck, the maximum mixed loading weight is to be taken on the deck, and the maximum design stack weight of 20ft in the hold is to be taken.	$0.9T_{sc}$	M_{sw-Sag}	Q_{sw}	HVM-1 HVS-1/HSA-1 FVMf-1/FVM-1 BSR-1P BSP-1P OSTf-1P OHM-1S OHS-1P OSA-2S/OVA-2S
LC4-1	Empty within one 40 ft bay and full on hatch covers over the bay; full within other bays and hatch covers	40ft heavy container	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC4-2	Empty within one 40 ft bay and full on hatch covers over the bay; full	20ft heavy container	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2

Condition	Description	Container weight	Draught	Still water bending moment	Still water shear force	Dynamic load case
	within other bays and hatch covers					BSR-2P BSP-2P OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC5	Empty within one 40 ft bay and hatch covers over the bay; full within other bays and hatch covers	40ft heavy container	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC6	Flooded (heeling of ship)	40ft heavy container	T_{dam}	--	--	--

Notes: (1) T_{sc}— Scantling draught, in m;

(2) Heavy container — the weight of a container is to be taken as permissible stack weight divided by the maximum number of tiers;

(3) Light container — the weight of a container is not to be greater than the values taken as follows:

In hold: 55% of the weight of heavy container;

On hatch covers: to be taken as 90% of the permissible stack weight divided by the maximum number of tiers or 17 tons, whichever is the lesser;

(4) where a hold consists of two or more 40 ft bays, then each bay is to be considered as entirely empty;

(5) T_{dam}—when any cargo hold of ship is flooded to the deepest equilibrium waterline, the distance between the waterline at the longitudinal centerline and the baseline is T_{dam};

(6) OHM is only applicable to container ships with C_b less than 0.73.

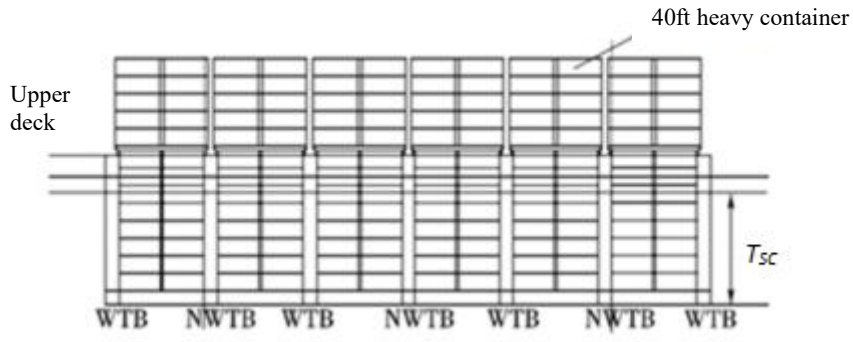


Figure 3.2.1(1) LC 1: Homogeneous loading of heavy container (40ft)

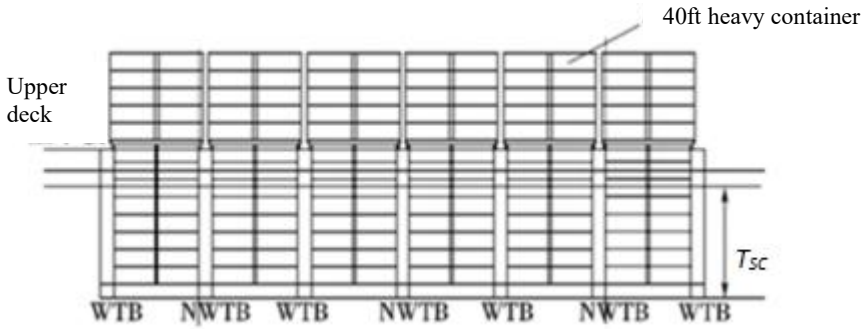


Figure 3.2.1(2) LC 2: Homogeneous loading of light container (40ft)

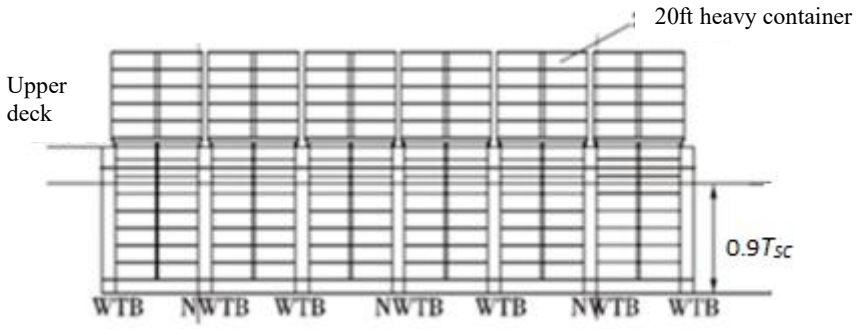


Figure 3.2.1(3) LC 3: Homogeneous loading of heavy container minus draught

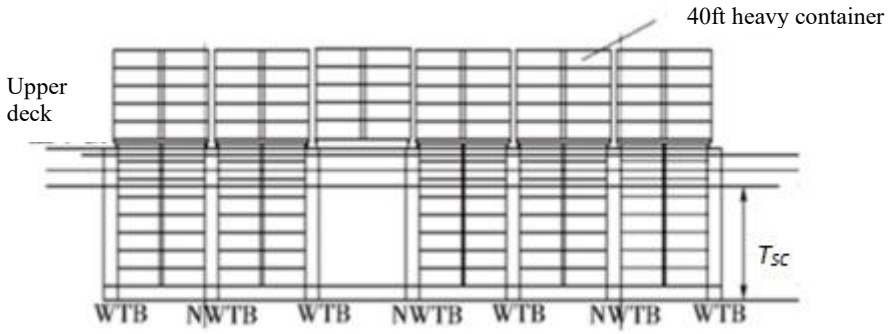


Figure 3.2.1(4) LC 4-1: 40ft heavy container, one bay empty in the hold

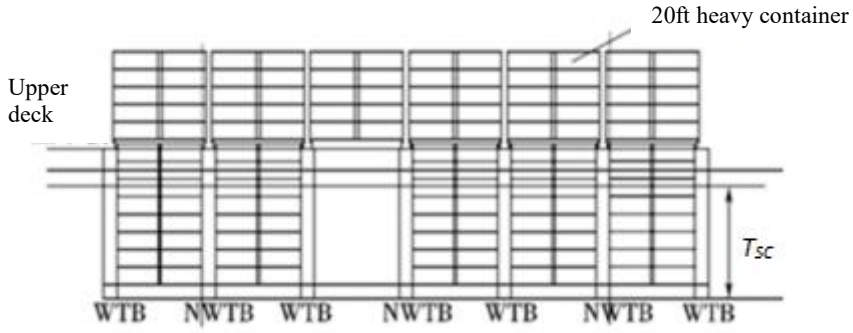


Figure 3.2.1(5) LC 4-2: 20ft heavy container, one bay empty in the hold

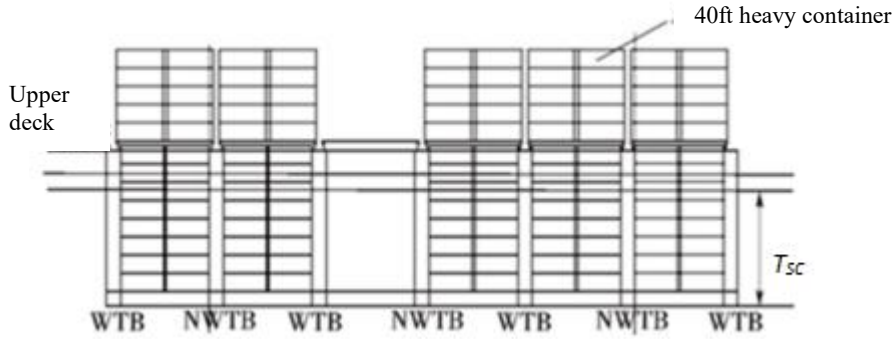


Figure 3.2.1(6) LC 5: 40ft heavy container, one bay empty on the deck and hatch cover

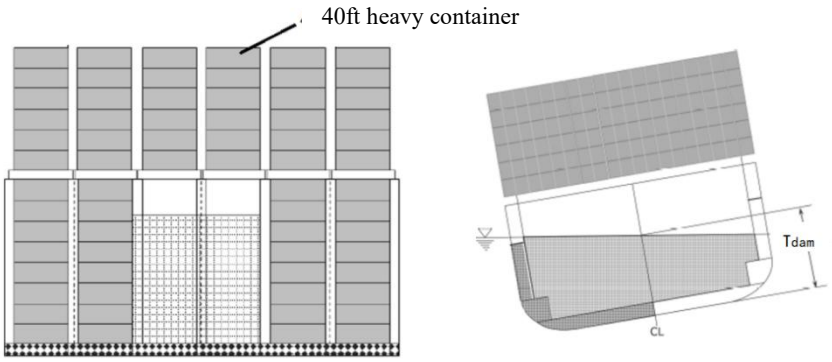


Figure 3.2.1(7) LC 6: Flooded condition

Design loading conditions for strength check in fuel oil tank area

Table 3.2.2

Condition	Description	Container weight	Fuel oil tank	Ballast tank	Draught	Still water bending moment	Still water shear force	Dynamic load case
LC1-1	Cargo hold empty, fuel oil tank and ballast tank fully loaded	-	Full load	Full load	T_{BAL}	From loading manual	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC1-2			Alternate load					
LC2-1	Homogeneous loading of 40 ft heavy	40 ft heavy container	Empty	Empty	T_{sc}	M_{sw-Sag}	Q_{sw}	HVM-1 HVS-1/HSA-1
LC2-2			Full load					
LC2-3			Alternat					

Condition	Description	Container weight	Fuel oil tank	Ballast tank	Draught	Still water bending moment	Still water shear force	Dynamic load case
	container		e load					FVMf-1/FVM-1 BSR-1P BSP-1P OSTf-1P OHM-1S OHS-1P OSA-2S/OVA-2S
LC3-1	Homogeneous loading of 40 ft light container	40 ft light container	Full load	Empty	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC3-2			Alternate load					
LC4-1	Homogeneous loading of 20 ft heavy container	20ft heavy container. If there is mixed loading on the deck, the maximum mixed loading weight is to be taken on the deck, and the maximum design stack weight of 20ft in the hold is to be taken.	Empty	Empty	$0.9T_{sc}$	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC4-2			Full load					
LC4-3			Alternate load					
LC5-1	Empty within one 40 ft bay in the hold and on the hatch cover closed to the fuel	40 ft heavy container	Empty	Empty	T_{sc}	M_{sw-Hog}	Q_{sw}	HVM-2 HVS-2/HSA-2 FVMf-2/FVM-2 BSR-2P BSP-2P
LC5-2			Alternate load					

Condition	Description	Container weight	Fuel oil tank	Ballast tank	Draught	Still water bending moment	Still water shear force	Dynamic load case
	oil tank; full within other bays and hatch covers							OSTf-2P OHM-2S OHS-2P OSA-1S/OVA-1S
LC5-3			Full load			M_{sw-Sag}		HVM-1 HVS-1/HSA-1 FVMf-1/FVM-1 BSR-1P BSP-1P OSTf-1P OHM-1S OHS-1P OSA-2S/OVA-2S

Notes: (1) T_{BAL}— Draught in ballast condition, in m;

(2) Heavy container — the weight of a container is to be taken as permissible stack weight divided by the maximum number of tiers;

(3) Light container — the weight of a container is not to be greater than the values taken as follows:

In hold: 55% of the weight of heavy container;

On hatch covers: to be taken as 90% of the permissible stack weight divided by the maximum number of tiers or 17 tons, whichever is the lesser;

(4) If the fore and aft structure of the fuel oil tank is asymmetrical, the empty 40 ft bay forward and aft the fuel oil tank is to be checked respectively for LC 5 condition. ;

(5) OHM is only applicable to container ships with C_b less than 0.73.

4.2 Wave loading condition

4.2.1 According to the loading conditions selected in [4.1], the hydrodynamic load analysis is carried out to determine the design wave parameters. Each design wave corresponds to a calculation condition in which the wave load control parameters reach the maximum, so as to evaluate the effect of the load on the hull structure strength under the calculation condition. Each calculation condition is based on different combination of still water condition and wave dominant load condition. Generally, the global strength analysis of container ships is to be checked in accordance with the loading conditions in Table 4.2.1. For two-island container ship, the considered condition of the maximum torque at fore and aft ends of the fore island is also to be checked.

Wave dominant load case **Table 4.2.1**

EDW	Dominant load	Extreme position of dominant load	Wave direction	Target value of dominant load
HVM	Vertical wave bending moment	Amidships	Head sea	See Ch 4, Sec 4
HVS	Vertical wave shear force	Near 0.75*L*	Head sea	See Ch 4, Sec 4
FVMf/FVM	Vertical wave bending moment	Near 0.25*L*/near 0.5*L*	Follow sea	See Ch 4, Sec 4
BSR	Roll angle	At center of gravity	Beam sea	See Ch 4, Sec 3
BSP	Hydrodynamic pressure	Waterline amidships	Beam sea	See Ch 4, Sec 5
OSTf	Wave torsional moment	Near 0.75*L*	Oblique sea	See Ch 4, Sec 4
OHM	Horizontal wave bending moment	Amidships	Oblique sea	See Ch 4, Sec 4
OHS	Horizontal wave shear force	Near 0.75*L*	Oblique sea	See Ch 4, Sec 4
(HSA, OSA)/OVA	Vertical acceleration	Near *L* at bow	Head sea/Oblique sea	See Ch 4, Sec 3

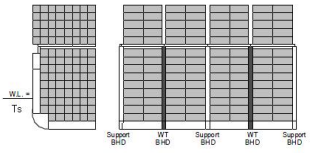
Note: (1) HSA, FVM and OSA are only applicable to container ships with C_b greater than 0.73. HVS, FVMf, OHM and OVA are only applicable to container ships with C_b not greater than 0.73.

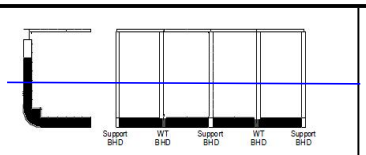
5 Design loading conditions for fatigue assessment

5.1 Design load cases for fatigue assessment of container ships

5.1.1 In accordance with the requirements in Ch 10, Sec 1, [6.2], the design loading conditions for finite element fatigue strength assessment of container ship blocks are shown in Table 5.1.1 of this Section.

Design conditions applicable to fatigue assessment of container ships other than the foremost and aftmost cargo holds **Table 5.1.1**

No.	Description	Loading pattern	Static load		Dynamic load cases
			Draught	$C_{BM\text{-}LC}$: %permissible still water bending moment	
1	Full load		~~T_{SC}~~ max(0.85T_{SC}, T_{design})	90% (Hogging)	HVM, HVS, FVM, BSR, BSP, OSTf, OHM, OHS

~~2~~	~~Normal ballast~~		~~T_{BAL}~~	~~80% (Hogging)~~	~~HVM, HVS, BSR, BSP, OST, OHM, OHS~~

Note: (1) T_{design}—design draught, in m;

(2) For full load, the full load condition where maximum still water bending moment occurs in the loading manual is to be taken. The full load loading pattern may be determined by the designer based on actual operating conditions and submitted to CCS for approval. If no specific data is available, it may be assumed that the side tanks carry ballast water for 70% of the service time and remain empty for 30% of the service time;

(3) FVM is only applicable to container ships with C_b greater than 0.73. HVS and OHM are only applicable to container ships with C_b not greater than 0.73.

5.1.2 In accordance with the requirements in Ch 10, Sec 1, [6.1], the design loading conditions for global finite element fatigue strength assessment are shown in Table 5.1.2 of this Section. The full load condition where maximum still water bending moment occurs in the loading manual is to be taken.

For global fatigue strength analysis, the hydrodynamic load analysis is carried out in accordance with loading to determine the design wave parameters. Each design wave corresponds to a calculation condition in which the wave load control parameters reach the maximum. Each calculation condition is based on different combination of still water load case and wave dominant load case. Generally, the global fatigue strength analysis of container ships is to be checked in accordance with the loading conditions in Table 5.1.2.

Design loading conditions for global fatigue strength assessment

Table 5.1.2

EDW	Dominant load	Extreme position of dominant load	Wave direction	Target value of dominant load
HVM	Vertical wave bending moment	Amidships	Head sea	See Ch 4, Sec 4
HVS	Vertical wave shear force	Near 0.75*L*	Head sea	See Ch 4, Sec 4
FVM	Vertical wave bending moment	Near 0.5*L*	Follow sea	See Ch 4, Sec 4
BSR	Roll angle	At center of gravity	Beam sea	See Ch 4, Sec 3
BSP	Hydrodynamic pressure	Waterline amidships	Beam sea	See Ch 4, Sec 5
OST	Wave torsional moment	Near 0.75*L*	Oblique sea	See Ch 4, Sec 4
OHM	Horizontal wave bending moment	Amidships	Oblique sea	See Ch 4, Sec 4
OHS	Horizontal wave shear force	Near 0.75*L*	Oblique sea	See Ch 4, Sec 4

Note: (1) FVM is only applicable to container ships with C_b greater than 0.73. HVS and OHM are only applicable to container ships with C_b not greater than 0.73.

CHAPTER 5 HULL GIRDER STRENGTH

Section 1 GENERAL

1 Strength characteristics of hull girder transverse sections

1.4 Section modulus

1.4.1 Section modulus at any point, in m^3, is calculated by the following formula:

$$Z_{A-n50} = \frac{I_{y-n50}}{|z - z_n|}$$

1.4.2 Section modulus at the bottom, in m^3, is calculated by the following formula:

$$Z_{B-n50} = \frac{I_{y-n50}}{z_n}$$

1.4.3 Section modulus at the deck, in m^3, is calculated by the following formula:

$$Z_{D-n50} = \frac{I_{y-n50}}{V_D}$$

where: V_D — Vertical distance of equivalent deck line, in m, which is equal to:

Where longitudinal members are not fitted above the line connecting the strength deck side line and the point vertically offset upward from the horizontal neutral axis $(z_D - z_n)/0.9$ at the centreline:

$$V_D = z_D - z_n$$

Where longitudinal members are fitted above the line connecting the strength deck side line and the point vertically offset upward from the horizontal neutral axis $(z_D - z_n)/0.9$ at the centreline:

$$V_D = (z_T - z_n)(0.9 + 0.2\frac{y_T}{B_1}) \geq z_D - z_n$$

where: z_D — Z coordinate of strength deck side line as defined in [1.3.1], in m;

z_T, y_T —Y and Z coordinates of the top of continuous trunks, hatch coamings, longitudinals or girders, in m, which are to be measured to the point giving the maximum value of V_D;

B_1 — breadth of ship at section considered, in m.

Section 2 HULL GIRDER YIELD STRENGTH

1 Section modulus

1.1 Minimum section modulus

1.1.2 Scantlings of all continuous longitudinal members of hull girder based on the minimum midship section modulus W_0 are to be maintained within $0.4L$ amidships. However, in special cases, based on consideration of type of ship, hull form and loading conditions, the scantlings of continuous longitudinal members may be gradually reduced towards the end of the 0.4 L part,

bearing in mind the desire not to inhibit the vessel's loading flexibility. In ships where part of the longitudinal strength material in the deck or bottom area are forming boundaries of tanks for ballast water and such tanks are provided with an effective corrosion protection system, certain reductions in the scantlings of these boundaries are allowed. These reductions, however, should in no case reduce the minimum hull girder section modulus by more than 5%.

2.3 Calculation methods for warping normal and shear stresses

2.3.2 As an alternative, the warping normal stress σ_w and shear stress τ_w may be calculated using the whole ship FE model or other equivalent methods subject to CCS agreement.

CHAPTER 6 HULL LOCAL SCANTLING

Section 1 GENERAL

2 Load combination

2.1 Hull girder

2.1.2 Calculation of warping stress

In general, the warping stress of the hull girder is to be calculated in accordance with the requirements of Ch. 5, Sec. 2, [2.3]. If the calculation of hull girder warping stress based on the thin-walled beam model or the direct calculation of the whole ship is not performed, the hull girder warping stress, in N/mm^2 , may be calculated using the following formula:

$$\sigma_w = \frac{B_i \omega_{n50}}{I_{\omega-n50}} 10^{-3}$$

where: B_i — bi-moment, in kN·m^2, see Ch. 4, Sec. 4, [4];

ω_{n50} — net sectorial coordinate of the member at the considered transverse section, in m^2;

$I_{\omega-n50}$ — Net sectorial moment of inertia of the considered transverse section, in m^6.

Section 2 MINIMUM THICKNESSES

1 PLATING

1.1 Minimum thickness requirements

1.1.1 The net thickness of plating in mm, is to comply with the appropriate minimum thickness requirements given in Table 1.1.1.

Minimum net thickness for plating **Table 1.1.1**

Element	Location	Area	Net thickness
Shell	Keel	-	$6.5+0.035L_2$
	Bottom Bilge	Fore Part Machinery space Aft part	$6.5+0.03L_2$
		Elsewhere	$4.5+0.03L_2$
	Side shell	Fore Part	$5.0+0.03L_2$(1)
		Machinery space Aft part	$4.5+0.03L_2$
		Elsewhere	$4.0+0.03L_2$
Deck	Weather deck, strength deck	-	$4.5+0.02L_2$
	Platform deck, side tank platform plating	Machinery space	$5.0+0.015L_2$
		Elsewhere	$4.5+0.01L_2$
Inner bottom(2)	-	Machinery space	$6.5+0.025L_2$
		Elsewhere	$5.0+0.015L_2$
Bulkheads	Internal tank boundary,Transverse/longitudinal watertight bulkhead	-	$4.0+0.015L_2$
	Non-tight bulkhead, Wash bulkhead, Bulkheads between dry spaces	-	$4.0+0.01L_2$
	Pillar bulkheads in fore and aft peaks	-	7.5
Other members	Engine casing (in the cargo hold region)	Cargo hold region	5.5
	Engine casing (in way of accommodation)	Accommodation	4.0
	Other plates in general	-	$4.0+0.01L_2$

(1) The as-built thickness needs not to be more than 16 mm;

(2) Applicable for both tight and non tight members.

Element	Location	Area	Net thickness
Shell	Keel	-	$6.5+0.03L_2$
	Bottom Bilge	Fore part	$5.0+0.03\ L_2$
		Machinery space, aft part	$4.5+0.03\ L_2$
		Elsewhere	$4.5+0.03\ L_2$
	Side shell	Fore part	$5.0+0.03\ L_2$
		Machinery space, aft part	$4.5+0.03\ L_2$
		Elsewhere below T_{SC}+2.0m	$4.0+0.025\ L_2$
		Elsewhere above T_{SC}+2.0m	$4.5+0.015\ L_2$
Deck	Weather deck②③, strength deck②	-	$4.5+0.02\ L_2$
	Platform deck, cargo deck, internal tank boundary	Machinery space④	$4.5+0.015\ L_2$
		Elsewhere	$4.5+0.01\ L_2$
Inner bottom①	—	Machinery space, cargo hold region⑤	$5.5+0.025\ L_2$
		Elsewhere	$5.0+0.015\ L_2$
Bulkheads	Internal tank boundary, transverse/longitudinal watertight bulkhead, aft peak tank bulkhead	-	$4.0+0.015\ L_2$
	Non-tight bulkhead, wash bulkhead, bulkheads between dry	-	$4.0+0.01\ L_2$
	Pillar bulkheads in fore and aft peaks	-	$4.0+0.01\ L_2$
Other members	Engine casing (in the cargo hold region)	Cargo hold region	5.5
	Engine casing (in way of accommodation)	Accommodation	4.0
	Other plates in general	-	$4.0+0.01\ L_2$

Notes: ① Applicable to tight or non-tight members;

② For ships fitted with two continuous decks, it may be taken as $4.5+0.015\ L_2$; for ships fitted with more than two continuous decks, it may be taken as $4.5+0.01\ L_2$;

③ For decks not contributing to the longitudinal strength, it may be taken as $4.5+0.01\ L_2$;

④ For non-load-bearing non-watertight platform decks, it may be taken as $4.5+0.01\ L_2$;

⑤ Cargo hold of container ship is in accordance with the requirements for minimum net thickness of inner bottom plating of other spaces.

3 Primary supporting members

3.1 Minimum thickness requirements

3.1.1 The net thickness of web plating and flange of primary supporting members in mm, is to comply with the minimum net thickness given in Table 3.1.1.

Minimum net thickness for primary supporting members Table 3.1.1

Element	Location	Net thickness
Double bottom centreline girder	Machinery space	$9.5+0.015L_2$
	Elsewhere	$5.5+0.025L_2$
Other bottom girder	Machinery space	$8.0+0.015L_2$
	Elsewhere	$5.0+0.015L_2$
Bottom floor	Machinery space	$8.0+0.015L_2$
	Fore part	$6.0+0.02L_2$
	Elsewhere	$5.0+0.015L_2$
Aft peak floor	-	$7.0+0.015L_2$
Side transverse web	-	$4.5+0.01L_2$
Other primary supporting member	-	$4.0+0.01L_2$

Element	Location		Net thickness
Double bottom centreline girder①, center keelson	Machinery space		$6.0+0.025L_2$
	Elsewhere		$5.5+0.025L_2$
Other bottom girder, side keelson	Machinery space		$6.0+0.015L_2$
	Fore part		$6.0+0.015L_2$
	Elsewhere		$5.0+0.015L_2$
Bottom floor	Machinery space		$6.0+0.015L_2$
	Fore part		$5.5+0.015L_2$
	Elsewhere		$5.0+0.015L_2$
Aft peak floor②	-		$5.0+0.025L_2$
Other primary supporting member	Aft part/fore part		$4.0+0.015L_2$
	Elsewhere	Watertight boundary, dry cargo hold boundary, shell plating below strength deck③ and freeboard deck	$4.5+0.015L_2$
		Others	$4.0+0.01L_2$

Notes: ① The box-type center girder (pipe tunnel) is in accordance with the minimum net thickness requirements for other bottom girders;

② The minimum net thickness need not be greater than 10 mm;

③ For ships provided with more than two continuous decks, the minimum net thickness of PSM in the region above the continuous deck structure may be taken as $4.5+0.01L_2$, and need not be greater than 6.5 mm.

Section 3 PLATING

1 Plating subjected to lateral pressure

1.1 Yielding check

1.1.1 The net thickness, t in mm, is not to be taken less than the greatest value for all applicable design load sets, as defined in [2.4.3], Section ~~2~~ 1 of this Chapter given by:

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

where:

C_a— Permissible bending stress coefficient for plate taken equal to:

$$C_a = \beta - \alpha\frac{|\sigma_{hg}|}{R_{eH}}, \text{ not to be taken greater than } C_{a\text{-}max};$$

β— Coefficient as defined in Table 1.1.1;

α— Coefficient as defined in Table 1.1.1;

$C_{a\text{-}max}$— Maximum permissible bending stress coefficient as defined in Table 1.1.1.

~~**2.3 Side shell plating**~~

~~2.3.1 Fender contact zone~~

~~The net thickness, t in mm, of the side shell plating within the fender contact zone as specified in [2.3.2] is not to be taken less than:~~

~~$$t = 26\left(\frac{b}{1000} + 0.7\right)\left(\frac{BT_{SC}}{R_{eH}^{\ 2}}\right)^{025}$$~~

~~2.3.2 Application of fender contact zone requirement~~

~~The application extends within the cargo hold region from the ballast draught T_{BAL} to 0.25 T_{SC} (minimum 2.2 m) above TSC.~~

2.4 3 Sheer strake

2.4 3.1 The net thickness of a welded sheer strake is not to be less than the offered net thickness of the adjacent 2 m width side plating.

2.4 3.2 The net thickness of a rounded sheer strake is not to be less than:

(1) The offered net thickness of the adjacent 2 m width deck plating, ~~or~~

(2) The offered net thickness of the adjacent 2 m width side plating,

whichever is greater.

Section 5 PRIMARY SUPPORTING MEMBERS AND PILLARS

2 Primary supporting members within cargo hold region

~~**2.2 Double bottom girder**~~

~~2.2.1 The thickness t of the centre girders within cargo hold region is not to be less than:~~

$$~~t = f_{ab}\left(0.0077h_0 + 2.5\right)\sqrt{K}~~ \text{ ~~mm~~}$$

~~The thickness t of side girder is not to be less than the value obtained from the following formula:~~

$$~~t = f_{ab}\left(0.0077h_0 - 2\right)\sqrt{K}~~ \text{ ~~mm~~}$$

~~where:~~

~~f_{db} — correction factor of height of double bottom, $f_{db} = h_0/h_a$ but not to be less than 0.9; where the longitudinal girder complies with the requirements for direct calculation of global strength of ship in Chapter 8, $f_{db} = h_0/h_a$ but not to be less than 0.85;~~

~~h_0 — considered height of double bottom, in mm, $h_0 = 25B_e + 42T_{se} + 300$, and not less than 760 mm;~~

~~B_e — maximum distance between midpoints of the outer and inner side shells; where the strength of the double bottom complies with the requirements for direct calculation of global strength of ship in Chapter 8, B_e is to be taken as not less than $0.8B$, otherwise B_e is to be taken as not less than $0.9B$;~~

~~h_a — actual height of double bottom, in mm.~~

Section 6 FORE PART, MACHINERY SPACE, AFT PART

3 Aft part

3.3 Stern frames

3.3.2 Propeller posts

(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 3.3.2(1) for single screw ships and Table 3.3.2(2) for twin screw ships.

Scantlings and proportions of the propeller post which differ from Table 3.3.2(1) and Table 3.2.2(2) 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 3.3.2(1) or Table 3.2.2(2), as applicable.

3.3.3 Sole pieces

The structures of sole pieces are to comply with the relevant requirements of 2.14.2.5 to 2.14.2.10, Section 14, Chapter 2, PART TWO of CCS Rules for Classification of Sea-going Steel Ships.

3.3.~~3~~ 4 Connections

(1) Connections with hull structure

Stern frames are to be effectively attached to the aft structure and the required scantling for the lower part of the propeller post is to be extended from the aft end of propeller post, at the centerline of the propeller shaft, to a length not less than $1500+6L_2$ mm, in order to provide an effective connection with the keel. However, the stern frame need not extend beyond the aft peak bulkhead.

(2) Connection with keel plate

The thickness of the lower part of the stern frames is to be gradually tapered to that of the solid bar keel or keel plate.

Where a keel plate is fitted, the lower part of the stern frame is to be designed to ensure an effective connection with the keel.

(3) Connection with transom floors

Rudder posts and propeller posts are to be connected with transom floors having height not less than that of the double bottom height and a net thickness not less than that obtained, in mm, from the following formula:

$$t = 9 + 0.023L_1$$

(4) Connection with centre 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 girder.

Section 7 OTHER SPECIAL REQUIREMENTS

3 Structural strength under slamming load in bow and stern areas

3.1 General

3.1.1 Extent of strengthening for bow bottom ~~forward~~

Where the draught forward in navigation is less than $0.04L$, the flat portion of bottom aft from F.P. is to be strengthened. The transverse extent of strengthening is not to be less than $0.014B$ (B being the breadth of the ship) above the base line, but need not be greater than 0.28 m, and the length X, in m, from the end line of the longitudinal extent of strengthening to F.P. is not to be less than that obtained from the following formula:

$$X = \left(0.65 - \frac{C_b}{2}\right)L$$

where:

C_b — block coefficient, to be taken as 0.7 for $C_b < 0.7$, and 0.8 for $C_b > 0.8$.

3.1.2 Extent of strengthening for bow side structure

The bow (including forecastle) side structure is to be strengthened within $0.1L$ aft of the fore perpendicular above the summer load line. Where the maximum flare angle α at $0.15L$ from forward perpendicular (see Section 5 of Chapter 4) is greater than 40 degrees, the strengthened longitudinal extent is to be extended to $0.15L$ from forward perpendicular. The scantlings of side

members in the strengthened area are to comply with the requirements of this Section.

3.1.3 Extent of strengthening for stern flat bottom

For container ships fitted with large stern flat bottom structures (where the angle between the flat bottom section of the aft peak tank at the centerline plane and the horizontal line is not greater than 10°), strengthening of stern flat bottom against slamming is to be considered, and the longitudinal extent is to cover at least the flat bottom area of the aft peak tank.

3.2 Strengthening of bow bottom ~~forward~~ against slamming

3.2.1 Shell plating

In the area where strengthening is required, the ~~forward~~ bow bottom plating is to be strengthened as follows:：

(1) The net thickness t of the forward bottom plating, in mm, is not to be less than that obtained from the following formula:

$$t = 5.95\sqrt{P_{SL}Kb^2\left[3-\frac{2}{\beta^2}\left(\sqrt{1+3\beta^2}-1\right)\right]\times 10^{-4}}$$

where:

P_{SL} — slamming pressure at the section, in kN/m², see [3.2.~~2~~1], Section 5 of Chapter 4 or obtained from the direct calculation according to [3.2.3] of the Section;

K — material factor;

a — length of the longer side of plating, in mm;

b — length of the shorter side of plating, in mm;

β — aspect radio of plating, $\beta = b/a$.

(2) The strengthened forward bottom plating is to be gradually tapered to adjacent shell plating.

3.2.2 Bottom ~~longitudinals~~ stiffeners

(1)In the extent of strengthening, the net plastic section modulus ~~Z~~ Z_{pl} of shell plating stiffeners of bow bottom~~longitudinals forward~~, in cm^3, is not to be less than that obtained from the following formula:

~~$$Z = 1.86P_{SL}Ksl^2\times 10^{-10}$$~~

$$Z_{pl} = 2.79P_{SL}Ksl_{bdg}^2\times 10^{-4}$$

where:

P_{SL} — slamming pressure at the section, in kN/m², see [3.2.~~2~~1], Section 5 of Chapter 4 or obtained from the direct calculation according to [3.2.3] of the Section;

s — spacing of ~~longitudinals~~ stiffeners, in mm;

~~l — span of longitudinals, in mm.~~

l_{bdg} — effective bending span of stiffeners, in m, see Section 6 of Chapter 3.

(2)In the extent of strengthening , the net thickness t_w of web of bow bottom longitudinals, in mm, is not to be less than that obtained from the following formula:

$$t_w = \frac{P_{SL} s l_{shr}}{2 d_{shr} C_t \tau_{eH}}$$

where:

P_{SL} — slamming pressure at the section, in kN/m², see [3.2.1], Section 5 of Chapter 4 or obtained from the direct calculation according to [3.2.3] of the Section;

l_{shr} — effective shear span of stiffeners, in m, see Section 6 of Chapter 3;

d_{shr} — effective shear depth of stiffeners, in mm, see Section 6 of Chapter 3;

C_t — allowable shear stress coefficient, to be taken as:

C_t=1.0 for AC-I acceptance criteria.

3.2.3 Bottom grillage

~~The bottom grillage structure forward strengthened against slamming is to be checked for strength using FE direct calculation.~~The primary supporting structure of bow bottom strengthened against slamming is to be checked for strength. FE direct calculation is to be used in accordance with the following requirements:

(1) Structural FE model

- The longitudinal extent of the model is to include the calculation range as specified in [3.1.1] of this Section and at least extend to ~~one web frame distance~~ the watertight transverse bulkhead forward and aft. The transverse extent is to be selected as possible as to reduce the effect of boundary constraints on the response of bottom grillage.
- Selection and meshing of elements are to comply with the requirements of Section 2, Chapter 7.
- Strength evaluation is to be carried out for all primary members within the extent of strengthening of bottom forward.
- When the stress distribution or stiffness of members is affected by the openings on primary members, the methods may be adopted in accordance with the requirements of Chapter 7.
- The net scantling model is to be used.

(2) Boundary constraints

~~Floors and girders at the boundary of model are to be rigidly fixed.~~ The model is rigidly fixed at the outer boundary of floors and at transverse bulkheads.

(3) Loads

~~According to the principle of slamming, the slamming pressure acts on the floor at the centre girder~~ Slamming pressure acts on the floors at each girder of the checked transverse section, the affected area is a square. The length of a side of this square S_1, in m, is obtained from the following formula:

$$S_1 = \sqrt{1.1 C_B L B \times 10^{-3}}$$

~~The extreme value of slamming pressure at each station of bow bottom will not occur at the same time, therefore the extreme value acting at each station is to be calculated respectively and the maximum pressure of the bottom grillage is obtained.~~ The distribution of slamming pressures on the floor is to be determined according to the following three situations:

1) $S_1 < S$:

The slamming pressure only acts on one floor, see Figure 3.2.3(1), the force Q, in kN/m, acting on the floor in per unit length is to be calculated by the following formula:

$$Q = P_{SL} S_1$$

where:

S — spacing of floors, in m;

P_{SL} — slamming pressures, in kN/m², see [3.2.~~2~~1], Section 5 of Chapter 4 or obtained from the direct calculation according to [3.2.3] of the Section;

2) $S < S_1 < 2S$:

The slamming pressure acts on two floors, see Figure 3.2.3(2), the force Q, in kN/m, acting on the floor in per unit length is to be calculated by the following formula:

$$Q = 0.5 P_{SL} S_1$$

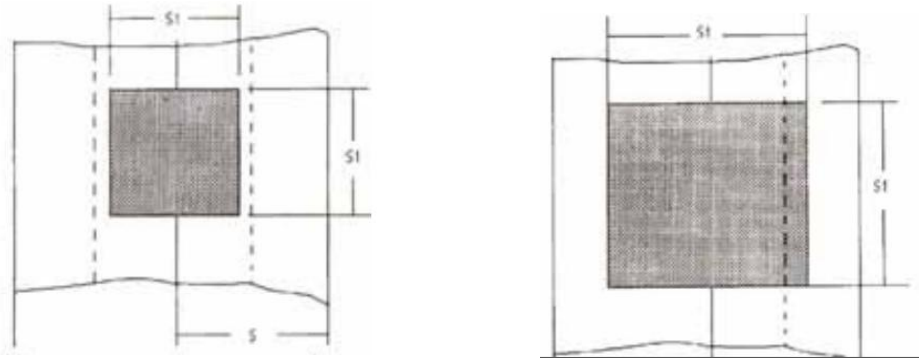
3) $S_1 > 2S$:

The slamming pressure acts on three floors, the force Q_c, in kN/m, acting on the intermediate floor in per unit length is to be calculated by the following formula:

$$Q_C = P_{SL} S$$

The force Q_s, in kN/m, acting on the side floor in per unit length is to be calculated by the following formula:

$$Q_S = 0.5 P_{SL} \left(S_1 - S \right)$$



(1) (2)

Figure 3.2.3

(4) Permissible stress

Each checked transverse section is loaded and calculated separately according to the positions of girders, and the maximum response of the grillage under slamming pressure is determined. Permissible stress of direct calculation of slamming strength for bow bottom grillage is to be determined in accordance with Table 3.2.3.

Permissible Stress **Table 3.2.3**

Member	Positive stress of inner bottom plating σ (N/mm^2)	Positive stress of outer bottom plating σ (N/mm^2)	Shear stress τ (N/mm^2)	Equivalent stress σ_e (N/mm^2)
Girder	136/K	124/K	120/K	200/K
Floor	147/K	147/K	109/K	218/K

3.3 Bow side structure strengthening

3.3.1 Shell plating

The net thickness t, in mm, of shell plating is not to be less than that obtained from the following formula:

$$t = 3.1 b_{r1} s \sqrt{P_{FB} K / 10}$$

where:

s— spacing of secondary members, in m;

b_{r1}— coefficient, to be taken from the following, and not to be less than 0.72:

$b_{r1} = 1.0 \quad \frac{s}{l} \le 0.4$;

$b_{r1} = 1.187 - 0.467 \frac{s}{l} \quad \frac{s}{l} > 0.4$;

l— span of secondary members, in m;

P_{FB}— side impact pressure, see [3.3.1], Section 5 of Chapter 4.

For bulwark shell plating, the plating thickness need not be greater than that of shell plating of forecastle.

3.3.2 Secondary members

(1) The net section modulus Z, in cm^3, and the net web sectional area A, in cm^2, of secondary members such as side ~~longitudinals or side frames~~ shell plating stiffeners are not to be less than those obtained from the following formulae:

~~$Z = 0.243 s P_{FB} l^2 K$~~

$$Z = 0.243 s P_{FB} l_{bdg}^2 K$$

~~$A = 0.0327 b_{r2} l s P_{FB} K$~~

$$A = 0.0327 b_{r2} l_{shr} s P_{FB} K$$

where: ~~$b_{r2} = 1 - \frac{s}{2l}$~~

b_{r2}—coefficient, $b_{r2} = 1 - \frac{s}{2l_{shr}}$;

s — spacing of secondary members, in m;

P_{FB}— side impact pressure, see [3.3.1], Section 5 of Chapter 4;

l_{bdg}— effective bending span of secondary members, in m, see Section 6 of Chapter 3;

l_{shr}—effective shear span of secondary members, in m, see Section 6 of Chapter 3.

~~l — span of secondary members, in m.~~

(2) Tripping brackets

Where the angle between web plating and shell plating of secondary members such as side longitudinals or side frames is less than 70º, tripping brackets are to be provided at mid-span of the members to improve the transverse stability of plate panels.

3.3.3 Primary members

The section modulus Z, in cm^3, and the net web sectional area A, in cm^2, of primary members such as side horizontal girders or vertical webs are not to be less than those obtained from the following formulae:

~~$Z = 0.2SP_{FB}l^2K$~~

$$Z = 0.2SP_{FB}l_{bdg}^2K$$

~~$A = 0.0252SP_{FB}lK$~~

$$A = 0.0252SP_{FB}l_{shr}K$$

where: S — spacing of girders, in m;

P_{FB}— side impact pressure, see [3.3.1], Section 5 of Chapter 4;

l_{bdg}— effective bending span of girders in m, see Section 6 of Chapter 3;

l_{shr}—effective shear span of girders, in m, see Section 6 of Chapter 3.

~~l — span of girders, in m.~~

3.4 Strengthening of stern flat bottom against slamming

3.4.1 Stern bottom structure

For stern flat bottom structure, in the extent of strengthening required by [3.1.3], the requirements for shell plating, stiffeners and primary support members are the same as [3.2], but the section slamming pressure P_{SL} is to be obtained in accordance with [3.4.1], Section 5 of Chapter 4 by direct calculation.

CHAPTER 7 CARGO HOLD DIRECT STRENGTH ANALYSIS

Section 2 CARGO HOLD STRUCTURAL STRENGTH ANALYSIS

3 Load application

3.3 Hull girder loads

3.3.5 Target hull girder horizontal shear force

The target hull girder horizontal shear force at the aft and forward bulkheads, Q_{h-targ}, in kN, for a given FE load combination is taken as:

$$Q_{h-targ-aft} = Q_{h-LC}(aft)$$
$$Q_{h-targ-fwd} = Q_{h-LC}(fwd)$$

where:

$Q_{h-LC}(x)$— Horizontal wave shear foce of dynamic load case, in kN, calculated at x position in accordance with Chapter 4, Section 4, [3.7.4];

$X_{b\text{-}fwd}$, $X_{b\text{-}aft}$ X-coordinate, in m, of the forward and aft bulkheads of mid hold.

$Q_{h-targ-aft}$ and $Q_{h-targ-fwd}$ are to be taken at the aft and forward bulkheads of the mid hold under consideration.

3.3.6 Target hull girder torsional moment

he target hull girder torsional moment, $M_{wt-targ}$, in kN·m, for the dynamic load cases OSTf, OHM, OHS and OVA is the value at the target location taken as:

$$M_{wt-targ} = M_{wt-LC}(x_{targ})$$

where:

$M_{wt-LC}(x)$— Wave torsional moment, in kN·m, for the dynamic load case OST, OHM, OHS and OVA, defined in Chapter 4, Section 2, [2.2.1], calculated at x position;

x_{targ}— ~~Target location for hull girder torsional moment, calculating wave torsional moment at forward bulkhead and after bulkhead of the mid-hold respectively according to Chapter 4, Section 2, [2.2.1], and taking X-coordinate in way of bulkhead with larger wave torsional moment as target location;~~

Target location for hull girder torsional moment, taking X-coordinate in way of torsional moment (whichever is greater) at forward watertight bulkhead and after watertight bulkhead of the mid-hold, where the wave torsional moment is calculated in accordance with [2.2.1], Section 2, Chapter 4;

x_{mid} — X-coordinate, in m, of the mid-hold centre;

x_{bhd}— X-coordinate, in m, of the after or forward transverse bulkhead of mid-hold;

According to the finite element load combination given in Chapter 4, Section 8, wave torsional moment M_{wt-LC} and still water torsional moment M_{st} are to be taken as positive or negative at the same time.

For dynamic load cases other than OSTf, OHM, OHS and OVA, hull girder torsional moment $M_{wt-targ}$, at middle of mid-hold is to be adjusted to zero. For dynamic load cases BSP and BSR, hull girder torsional moment at mid-hold area is to be adjusted to zero as far as possible.

3.4 Procedure to adjust hull girder shear forces and bending moments

3.4.3 Hull girder forces and bending moment due to local loads

With the local load distribution, the hull girder load longitudinal distributions are obtained by assuming the model is simply supported at model ends. The reaction forces at both ends of the model and longitudinal distributions of hull girder shear forces and bending moments induced by local loads at any longitudinal station are determined by the following formulae:

$$R_{V_fore} = -\frac{\sum_i (x_i - x_{aft}) f_{vi}}{x_{fore} - x_{aft}} \qquad R_{V_aft} = \sum_i f_{vi} + R_{V_fore}$$

$$R_{H_fore} = \frac{\sum_i (x_i - x_{aft}) f_{hi}}{x_{fore} - x_{aft}} \qquad R_{H_aft} = -\sum_i f_{hi} + R_{H_fore}$$

$$F_l = \sum_i f_{li}$$

~~$Q_{V_FEM}(x_j) = R_{V_aft} - \sum_i f_{hi}$ when $x_i < x_j$~~

$Q_{V_FEM}(x_j) = R_{V_aft} - \sum_i f_{vi}$ when $x_i < x_j$

$Q_{H_FEM}(x_j) = R_{H_aft} + \sum_i f_{hi}$ when $x_i < x_j$

$Q_{H_FEM}(x_j) = R_{H_aft} + \sum_i f_{hi}$ when $x_i < x_j$

$M_{V-FEM}(x_j) = (x_j - x_{aft}) R_{V_aft} - \sum_i (x_j - x_i) f_{vi}$ when $x_i < x_j$

$M_{H-FEM}(x_j) = (x_j - x_{aft}) R_{H_aft} + \sum_i (x_j - x_i) f_{hi}$ when $x_i < x_j$

3.4.8 Method 2 for vertical shear force adjustment at both bulkhead

The required adjustments in shear force at both transverse bulkheads of the mid-hold are to be made by applying:

- Vertical bending moments, M_{Y_aft}, M_{Y_fore} at model ends and,
- Vertical loads at the transverse frame positions as shown in Table 3.4.7(2) in order to generate vertical shear forces, ΔQ_{V_aft} and ΔQ_{V_fwd}, at the transverse bulkhead positions.

Table 3.4.7(1) shows examples of the shear adjustment application due to the vertical bending moments and to vertical loads.

$$M_{Y_aft} = \frac{X_{fore} - X_{aft}}{2} \cdot \frac{Q_{V_targ_fwd} - Q_{V_fwd} + Q_{V_targ_aft} - Q_{V_aft}}{2}$$

$$M_{Y_fore} = M_{Y_aft}$$

$$\Delta Q_{V_fwd} = \frac{Q_{V_targ_fwd} - Q_{V_fwd} - \left(Q_{V_targ_aft} - Q_{V_aft}\right)}{2}$$

$$\Delta Q_{V_aft} = -\Delta Q_{V_fwd}$$

where:

M_{Y_fore}— Vertical bending moment, in kN·m, to be applied at the fore end in accordance with [3.4.9], to enforce the hull girder vertical shear force adjustment. The sign convention is that of the finite element model axis;

M_{Y_aft}— Vertical bending moment, in kN·m, to be applied at the aft end in accordance with [3.4.9], to enforce the hull girder vertical shear force adjustment. The sign convention is that of the finite element model axis;

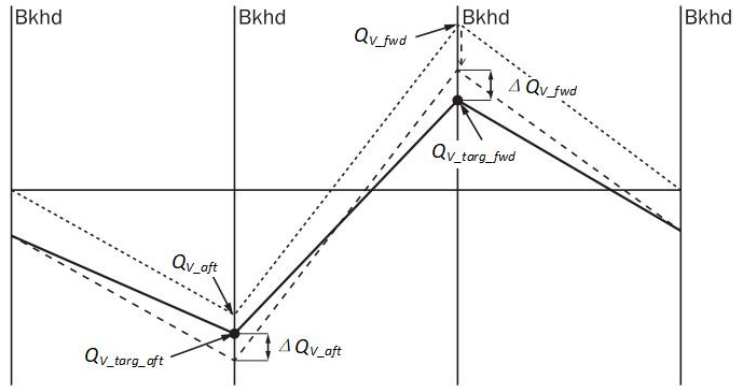
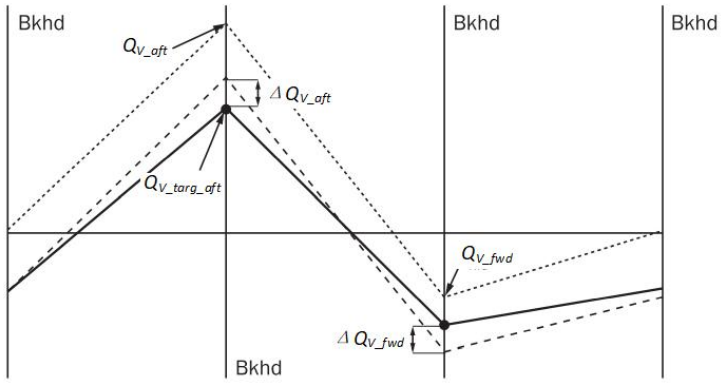
ΔQ_{V_aft}— Adjustment of shear force, in kN, at aft bulkhead of mid-hold;

ΔQ_{V_fwd}— Adjustment of shear force, in kN, at fore bulkhead of mid-hold.

The above adjustments in shear forces, ΔQ_{V_aft} and ΔQ_{V_fwd}, at the transverse bulkhead positions are to be generated by applying vertical loads at the transverse frame positions as shown in Table 3.4.7(2). The transverse frame positions correspond to the floors. Vertical correction loads are not to be applied to any transverse tight bulkheads, any frames forward of the forward cargo hold and any frames aft of the aft cargo hold of the finite element model.

The vertical loads to be applied to each transverse frame to generate the increase/decrease in shear force at the bulkheads may be calculated as shown in Table 3.4.7(2). In case of uniform frame spacing, the amount of vertical force to be distributed at each transverse frame may be calculated in accordance with Table 3.4.7(3).

Target and required shear force adjustment by applying vertical forces Table 3.4.7(1)

Vertical shear force diagram	Aft bulkhead	Fore bulkhead
	Shear force target	Shear force target
	$Q_{V_targ_aft}$ (-ve)	$Q_{V_targ_fwd}$ (+ve)
	$Q_{V_targ_aft}$ (+ve)	$Q_{V_targ_fwd}$ (-ve)

Vertical shear force after both adjustments

Vertical shear force after adjustment by use of M_{Y-aft} and M_{Y-fore}

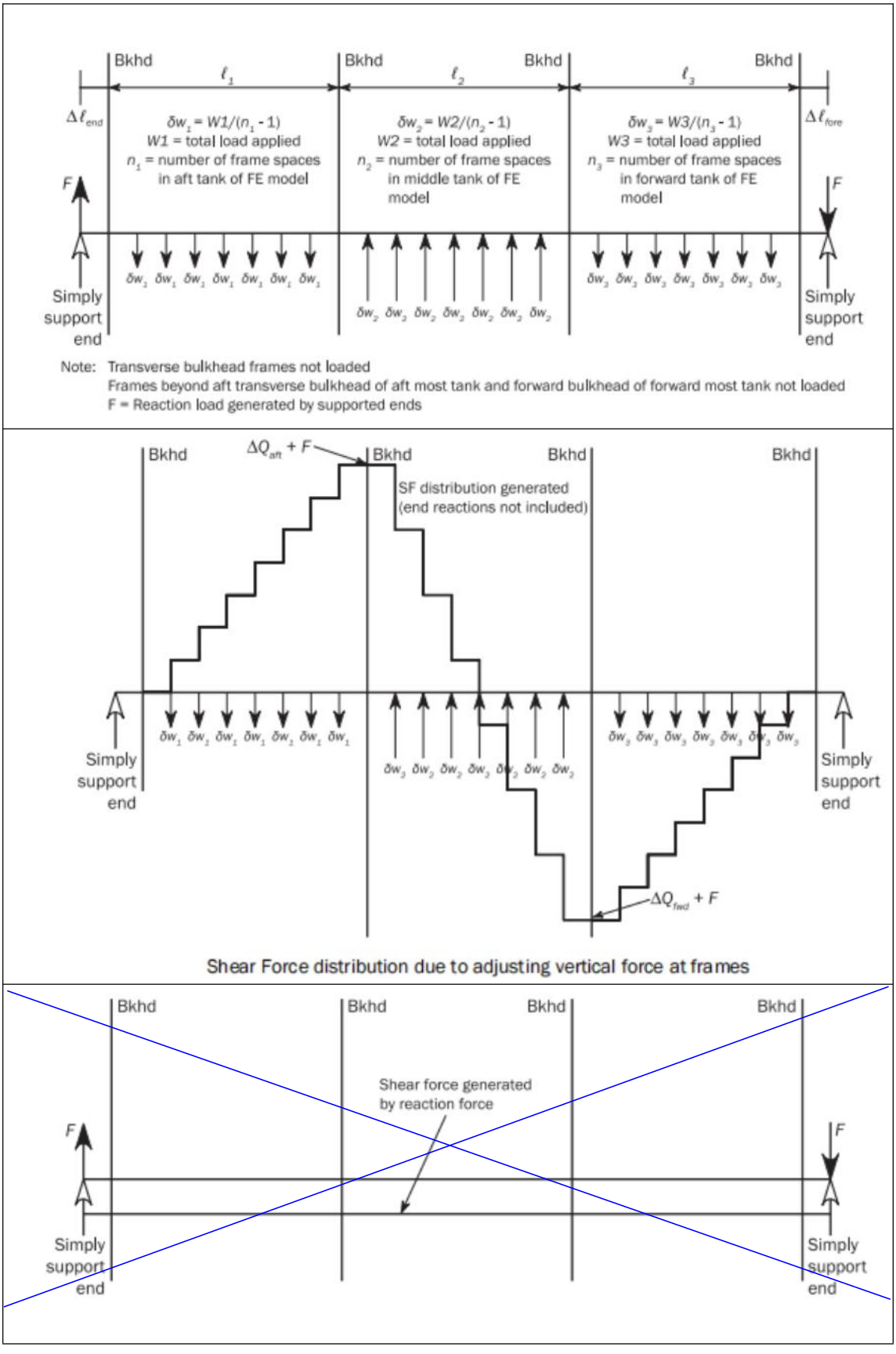
Vertical shear force due to local loads

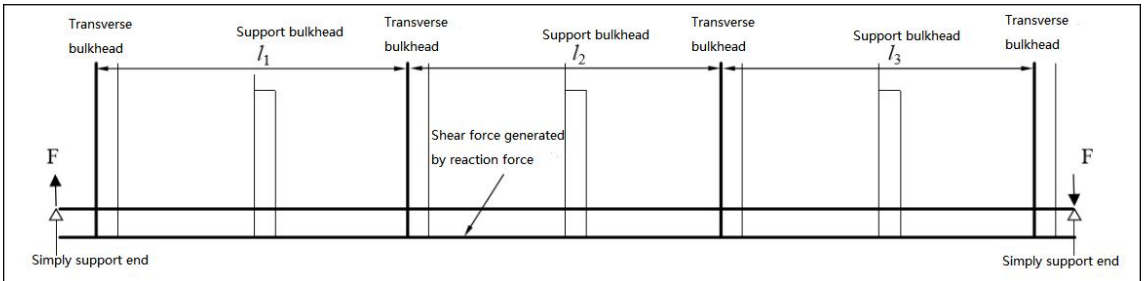
Note 1：-ve means negative.

Note 2：+ve means positive.

Distribution of adjusting vertical force at frames and resulting shear force distributions

Table 3.4.7(2)





Note: F=0 if l_1=l_3 and Δl_{fore}= Δl_{end}, and loads are symmetrical about mid-length of model.

Note 1: For definition of symbols, see Table 3.4.7(3).

Formulae for calculation of vertical loads for adjusting vertical shear forces Table 3.4.7(3)

$$\delta w_1 = \frac{\Delta Q_{V_aft}(2l - l_2 - l_3) + \Delta Q_{V_fwd} l_2 + l_3}{(n_1 - 1)(2l - l_1 - 2l_2 - l_3)}$$

$$\delta w_1 = \frac{\Delta Q_{V_aft}(2l - l_2 - l_3) + \Delta Q_{V_fwd}(l_2 + l_3)}{(n_1 - 1)(2l - l_1 - 2l_2 - l_3)}$$

$$\delta w2 = \frac{(W1 + W3)}{(n_2 - 1)} = \frac{(\Delta Q_{V_aft} - \Delta Q_{V_fwd})}{(n_2 - 1)}$$

$$\delta w3 = \frac{-\Delta Q_{V_fwd}(2l - l_1 - l_2) - \Delta Q_{V_aft}(l_1 + l_2)}{(n_3 - 1)(2l - l_1 - 2l_2 - l_3)}$$

$$F = F_{aft} = F_{fwd} = 0.5\left(\frac{W1(l_2 + l_1) - W3(l_2 + l_3)}{l}\right)$$

where:

l_1— Length of aft cargo hold of model, in m;

l_2— Length of mid-hold of model, in m;

l_3— Length of forward cargo hold of model, in m;

ΔQ_{V_aft}— Required adjustment in shear force, in kN, at aft bulkhead of middle hold, see [3.4.7];

ΔQ_{V_fwd}— Required adjustment in shear force, in kN, at fore bulkhead of middle hold, see [3.4.7];

F— End reactions, in kN, due to application of vertical loads to frames;

$W1$— Total evenly distributed vertical load, in kN, applied to aft hold of finite element model, $(n_1 - 1)\delta w_1$;

$W2$— Total evenly distributed vertical load, in kN, applied to mid-hold of finite element model, $(n_2 - 1)\delta w_2$;

$W3$— Total evenly distributed vertical load, in kN, applied to forward hold of finite element model, $(n_3 - 1)\delta w_3$;

n_1— Number of frame spaces in aft cargo hold of finite element model;

n_2— Number of frame spaces in mid-hold of finite element model;

n_3— Number of frame spaces in forward cargo hold of finite element model;

δw_1—	Distributed load, in kN, at frame in aft cargo hold of finite element model;
$\delta w2$—	Distributed load, in kN, at frame in mid-hold of finite element model;
$\delta w3$—	istributed load, in kN, at frame in forward cargo hold of finite element model;
Δl_{end}—	Distance, in m, between end bulkhead of aft cargo hold to aft end of finite element model;
Δl_{fore}—	Distance, in m, between fore bulkhead of forward cargo hold to forward end of finite element model;
L—	Total length, in m, of finite element model including portions beyond end bulkheads: $l_1 + l_2 + l_3 + \Delta l_{end} + \Delta l_{fore}$

Note 1: Positive direction of loads, shear forces and adjusting vertical forces in the formulae is in accordance with Table 3.4.7(1) and Table 3.4.7(2).

Note 2: $W_1 + W_3 = W_2$

Note 3: The above formulae are only applicable if uniform frame spacing is used within each hold. The length and frame spacing of individual cargo holds may be different.

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

In case the target vertical bending moment needs to be reached, an additional vertical bending moment is to be applied at both ends of the cargo hold finite element model to generate this target value in the mid-hold of the model. This end vertical bending moment is given as follows:

$$M_{v-end} = M_{v-targ} - M_{v-peak}$$

where:

M_{v-end}— Additional vertical bending moment, in kN·m, to be applied to both ends of finite element model in accordance with [3.4.810];

M_{v-targ}— Hogging (positive) or sagging (negative) vertical bending moment, in kN·m, as specified in [3.3.2];

M_{v-peak}— Maximum or minimum bending moment, in kN·m, within the length of the mid-hold due to the local loads described in [3.4.3] and due to the shear force adjustment as defined in [3.4.5].

$M_{v\text{-}peak}$ is to be taken as the maximum bending moment if $M_{v\text{-}targ}$ is hogging (positive) and as the minimum bending moment if $M_{v\text{-}targ}$ is sagging (negative). $M_{v\text{-}peak}$ is to be calculated as follows based on a simply supported beam model:

$$\mathrm{M_{v-peak}} = Extremum\{M_{v_FEM}(x) + M_{lineload} + M_{Y_aft}\left(2\frac{x - x_{aft}}{x_{fore} - x_{aft}} - 1\right)\}$$

$M_{v_FEM}(x)$— Vertical bending moment, in kN·m, at position x, due to the local loads as described in [3.4.3];

M_{Y_aft}— End bending moment, in kN·m, to be taken as:

When method 1 is applied: the value as defined in [3.4.6];

When method 2 is applied: the value as defined in [3.4.7];

Otherwise: $M_{Y_{aft}}=0$

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

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

F— Reaction force, in kN, at model ends due to application of vertical loads to frames as defined in Table 3.4.7(2);

X— X-coordinate, in m, of frame in way of the mid-hold;

δw_i— Vertical load, in kN, at web frame station i applied to generate required shear force.

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 finite element model to generate this target value within the mid-hold. The additional horizontal bending moment is to be taken as:

$$M_{h-end} = M_{h-targ} - M_{h-peak}$$

M_{h-end}— Additional horizontal bending moment, in kN·m, to be applied to both ends of the finite element model according to [3.4.~~8~~10];

M_{h-targ}— Horizontal bending moment, as defined in [3.3.4];

M_{h-peak}— Maximum or minimum horizontal bending moment, in kN·m, within the length of the mid-hold due to the local loads described in [3.4.3]. $M_{h\text{-}peak}$ is to be taken as the maximum horizontal bending moment if $M_{h\text{-}targ}$ is positive (starboard side in tension) and as the minimum horizontal bending moment if $M_{h\text{-}targ}$ is negative (port side in tension). $M_{h\text{-}peak}$ is to be calculated as follows based on a simply supported beam model: $M_{h-peak} = Extremum\{M_{H_FEM}(x)\}$

$M_{H_FEM}(x)$— Horizontal bending moment, in kN·m, at position x, due to the local loads as described in [3.4.3].

3.5 Procedure to adjust hull girder torsional moments

3.5.1 General requirements

The procedure in this sub-article describes how to adjust the hull girder torsional moment distribution on the cargo hold finite element model to achieve the target torsional moment at the target location. The hull girder torsional moment target values are given in [3.3.~~5~~6].

CHAPTER 8 GLOABAL FINITE ELEMENT STRENGTH ASSESSMENT

Section 1 GENERAL

1 General

1.1 Application

1.1.1 This Chapter gives the requirements for global finite element strength assessment when the primary supporting members of the container ship are under the combined action of bending and torsional loads, including the yield and buckling strengths.

1.1.2 For container ships complying with one of the following conditions, global finite element strength assessment is to be carried out and the notation GFE is to be assigned according to the requirements of this Chapter:

(1) 250 m or over in length *L*;

~~(2) where the width of hatch openings in the strength deck greater than 0.89*B*;~~

(~~3~~2) where the structural arrangement is of non-conventional type.

CHAPTER 9 BUCKLING

Section 2 SLENDERNESS REQUIREMENTS

2 Plates

2.1 Net thickness of plate panels

~~2.1.1 The net thickness of plate panels is to satisfy the following criteria:~~

$$~~t_p \geq \frac{b}{C}\sqrt{\frac{R_{eH}}{235}}~~$$

~~where: C — Slenderness coefficient taken as:~~
~~C=100 for hull envelope and cargo and tank boundaries;~~
~~C=125 for other structures;~~

~~R_{eH} — Specified minimum yield stress of the plate material, in N/mm^2~~
~~A lower specified minimum yield stress may be used in this slenderness criterion provided the requirements specified in Sec 3 and Sec 4 are satisfied for the strake assumed in the same lower specified minimum yield stress value.~~

2.1.1 The net thickness of plate panels t_p, in mm, is to satisfy the following criteria:

$$t_p \geq \frac{b}{C}$$

where: C— Slenderness coefficient taken as:

C=100 for shell plating, strength deck, excluding the strength deck within the superstructure;

C=175 for structures within deckhouses and superstructures, as well as internal structures of ships with multiple continuous decks, excluding compartments and watertight boundaries;

C=125 for other structure.

This requirement does not apply to the bilge plates within the cylindrical part of the ship and radius gunwale.

3 Stiffeners

3.1 Proportions of stiffeners

Slenderness coefficients **Table 3.1.1**

Type of Stiffener	C_w	C_f
Angle bars and L2 bars	75	12(3)
T-bars	75	12(3)
Bulb bars	45	—
Flat bars	22(1)(2)	—

Notes: (1) For flat bar stiffeners not contributing to the longitudinal strength of the hull girder, C_w may be taken as 26.
(2) For flat bar stiffeners on watertight floors in double bottom ballast tanks, where the double bottom

girders are arranged at not more than 3 frame spaces, C_w may be taken as 30.
(3) For angle bars and T-bars with discontinuous straight flanges/face plates fitted with end brackets, C_f may be taken as 22.

3.1.3 Bending stiffness of stiffeners

The net moment of inertia, in cm^4, of the stiffener with the effective width of attached plate, about the neutral axis parallel to the attached plating, is not to be less than the minimum value given by:

$$I_{st} \geq C\ell^2 A_{eff} \frac{R_{eH}}{235}$$

where:

A_{eff} —Net sectional area of stiffener including effective attached plate, s_{eff}, in cm^2;

R_{eH} —Specified minimum yield stress of the material of the attached plate, in N/mm^2;

C—Slenderness coefficient taken as:

C=1.43 for ~~longitudinal stiffeners including sniped~~ stiffeners contributing to the longitudinal strength;

C=0.72 for other stiffeners.

4 Primary supporting members

4.1 Proportions and stiffness

4.1.1 Proportions of web plate and flange

The net thicknesses of the web plates and flanges of primary supporting members are to satisfy the following criteria:

(1) Web plate

$$t_w \geq \frac{s_w}{C_w}\sqrt{\frac{R_{eH}}{235}}$$

For the web plates, a lower R_{eH} may be used in this slenderness criterion provided the requirements specified in Sec 3 and Sec 4, if applicable, are satisfied for the structure assumed in the same lower R_{eH}.

(2) Flange

$$t_f \geq \frac{b_{f-out}}{C_f}\sqrt{\frac{R_{eH}}{235}}$$

where: s_w — Plate breadth, in mm, taken as the spacing of the web stiffeners;

C_w — Slenderness coefficient for the web plate taken as:

~~C_w=100~~

C_w=125 for double-hull structures, e.g. platforms between double hull, vertical bulkheads, double bottom floors etc.;

C_w=100 for other structures;

C_f — Slenderness coefficient for the flange taken ~~as~~ in accordance with Table 3.1.1~~:~~.

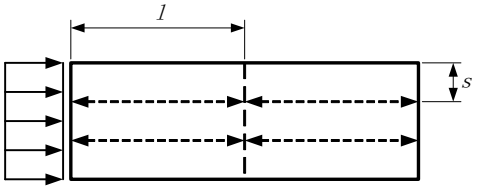
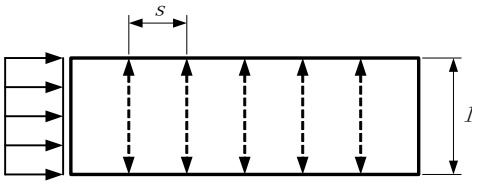
~~C_f=12~~

If requirement (2) is not fulfilled, the effective free flange outstand, in mm, used in strength assessment including the calculation of actual net section modulus, is to be taken as:

$$b_{f-out-\max} = C_f t_f \sqrt{\frac{235}{R_{eH}}}$$

4.2 Web stiffeners of primary supporting members

Stiffness criteria for web stiffeners **Table 4.2.2**

	Stiffener arrangement	Minimum moment of inertia of web stiffeners, in cm^4
A	Web stiffeners fitted along the PSM span 	$I_{st} \geq C\ell^2 A_{eff} \frac{R_{eH}}{235}$
B	Web stiffeners fitted normal to the PSM span 	$I_{st} \geq 1.14\ell s^2 t_w \left(2.5\frac{1000\ell}{s} - 2\frac{s}{1000\ell}\right)\frac{R_{eH}}{235}\cdot 10^{-5}$

where: C Slenderness coefficient to be taken as:
C=1.43 for ~~longitudinal stiffeners including sniped~~ continuous stiffeners contributing to the longitudinal strength;
C=0.72 for other stiffeners;

ℓ Length of web stiffener, in m
(1) For web stiffeners welded to local supporting members, the length is to be measured between the flanges of the local support members;
(2) For sniped web stiffeners, the length is to be measured between the lateral supports, e.g. the total distance between the flanges of the primary supporting member as shown for stiffener arrangement B;

A_{eff} Net section area of web stiffener including effective attached plate, s_{eff}, in cm^2;

t_w Net web thickness of the primary supporting member, in mm;

R_{eH} Specified minimum yield stress of the material of the web plate of the primary supporting member, in N/mm^2.

5 Brackets

5.1 Tripping brackets

5.1.1 Unsupported flange length

The unsupported length of the flange of the primary supporting member, in m, need not be less than 3.0 m, ~~i.e. the distance between tripping brackets,~~ but the maximum value $S_{b_\max}$, in m, is not to be greater than the value calculated in accordance with the following formula:

~~$$S_b = b_f C \sqrt{\frac{A_{f-n50}}{\left(A_{f-n50} + \frac{A_{w-n50}}{3}\right)}\left(\frac{235}{R_{eH}}\right)}$$~~ ~~, but need not be less than s_{b-min}~~

$$S_{b_\max} = b_f C$$

and is also to satisfy: $S_{b_max} \leq 6\text{m}$ for deck and bottom;

$S_{b_max} \leq 5\text{m}$ for bulkhead and side.

where: b_f — Flange breadth of primary supporting members, in mm;

C — Slenderness coefficient taken as:

~~(1) 0.022 for symmetrical flanges;~~

~~(2) 0.033 for asymmetrical flanges;~~

C = 0.022 for symmetrical flanges in deck and bottom areas;

C = 0.025 for asymmetrical flanges in deck and bottom areas;

C = 0.015 for symmetrical flanges in bulkhead and side areas;

C = 0.020for asymmetrical flanges in bulkhead and side areas.

~~A_{f-n50} — Net cross sectional area of flange, in cm^2;~~

~~A_{w-n50} — Net cross sectional area of the web plate, in cm^2;~~

~~R_{eH} — Specified minimum yield stress of the PSM material, in N/mm^2;~~

~~$S_{b-\min}$: Minimum unsupported flange length taken as:~~

~~(1) $S_{b-\min}$ =3.0 m for the cargo tank/hold region, on tank/hold boundaries or the hull envelope including external decks;~~

~~(2) $S_{b-\min}$ =4.0 m for other areas.~~

5.3 Edge reinforcement

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:

~~$h_w = Cl_b\sqrt{\frac{R_{eH}}{235}}$~~ $h_w = Cl_b\sqrt{\frac{R_{eH}}{235}} \times 10^3$ or 50 mm, whichever is greater

where: C — Slenderness coefficient taken as:

~~(1)~~ C=75 for end brackets;

~~(2)~~ C=50 for tripping brackets;

l_b — Effective length of bracket edge, in mm, see Table 5.2.1;

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

CHAPTER 10 FATIGUE

Section 1 GENERAL PROVISIONS

1 General requirements

1.1 Scope

1.1.5 For container ships complying with either of following conditions, finite element stress analysis is to be used for fatigue strength assessment:
(1) Ship length L more than 250m;
~~(2) Strength deck hatch width more than 0.89B;~~
(~~3~~ 2) Unconventional structure arrangement.

6 Loading conditions

6.1 Fatigue assessment standard loading conditions

6.1.1 Fatigue analysis is to be carried out for representative loading conditions according to the intended ship's operation as given in [6.1.2].
6.1.2 The loading conditions for container ship simplified stress analysis and finite element fatigue strength calculation and corresponding fraction of time for each loading condition, $\alpha_{(j)}$, are defined in Table 6.1.2. The standard loading conditions for fatigue assessment of container ships are provided in Chapter 4, Section 8.

Fraction of time in each loading condition for container ship **Table 6.1.2**

Loading conditions	$\alpha_{(j)}$
Full Load condition (Homogeneous)	~~0.75~~ 1(1)
~~Normal ballast condition~~	~~0.25~~

Note (1): The full load loading pattern may be determined by the designer based on actual operating conditions and submitted to CCS for approval. If no specific data is available, it may be assumed that the double side ballast tanks carry ballast water for 70% of the service time and remain empty for 30% of the service time.

Section 2 STRUCTURAL DETAILS TO BE ASSESSED

2 Finite element stress analysis

2.1 Structural details to be assessed

2.1.3 Structural details of side longitudinal bulkheads and scallops
Structural details of side longitudinal bulkheads and scallops in Table 2.1.3(1) are to meet structural detail design standard of Chapter 10, Section 7, otherwise, finite element fatigue assessment is to be carried out. For hot spot location and fatigue strength assessment, see Tables 2.1.3(2) and (3).

Structural details of side longitudinal bulkheads and scallops **Table 2.1.3(1)**

No.	Critical detail	Structural detail design standard	Application
1	Side longitudinal bulkhead without web stiffener, for detailed hot spots, see Table 2.1.3(2)	Chapter 10, Section 7, [2.1]	Cargo hold
2	Scallops in way of block joints on strength deck, for detailed hot spots, see Table 2.1.3(3)	Chapter 10, Section 7, [3]	Close to mid hold (down to 0.1D from deck corner)

3	Deck plating and longitudinal hatch coaming end bracket toe	Chapter 10, Section 7, [4]	Longitudinal hatch coaming end bracket toe
4	Strength deck hatch corner at fore end of engine room	Chapter 10, Section 7, [4]	Hatch corner at fore end of engine room
Note: No. 3 and 4 are applicable to container ships not complying with Chapter 10, Section 1, [1.1.5].			

Section 3 FATIGUE EVALUATION

Symbols

For symbols not defined in this Section, refer to Chapter 1, Section 4.

(i) — Suffix which denotes load case HVM, HVS, FVM, BSR-P, BSR-S, BSP-P, BSP-S, OST-P, OST-S, OHM-P, OHM-S, OHS-P or OHS-S specified in Chapter 4, Section 2.
'*i1*' denotes load case: HVM-1, HVS-1, FVM-1, BSR-1P, BSR-1S, BSP-1P, BSP-1S, OSTf-1P, OSTf-1S, OHM-1P, OHM-1S, OHS-1P or OHS-1S.
'*i2*' denotes load case: HVM-2, HVS-2, FVM-2, BSR-2P, BSR-2S, BSP-2P, BSP-2S, OSTf-2P, OSTf-2S, OHM-2P, OHM-2S, OHS-2P or OHS-2S;

(j) — Suffix which denotes loading condition: full load or normal ballast as defined in Chapter 10, Section 1, [6.1];

T_C — Time in corrosive environment, in years, according to Table ~~4.1.5~~5.3.1;

T_D — Design life, in years, to be taken as 25 years;

T_{DF} — Design fatigue life, in year, as defined in Chapter 10, Section 1;

T_F — Fatigue life, in year, calculated according to [5];

m — Inverse slope of the design S-N curve, as given in Table 4.1.4 for in-air environment and in Table 4.1.5 for corrosive environment.
The inverse slope for S-N curves in-air environment changes from m to $m+2$ at N = 10^7 cycles;

n_{LC} — Number of applicable loading conditions, as defined in Chapter 10, Section 1, [6.2];

f_c — Correction factor as defined in Chapter 10, Section 1, ~~[5.1.2]~~[5.2.1];

f_{thick} — Correction factor for plate thickness effect given in [3.3];

$f_{mean,i(j)}$ — Correction factor for mean stress effect given in [3.2].

3 Reference stresses for fatigue assessment

3.1.3 Base material free edge

For base material free edge, the fatigue stress range, $\Delta\sigma_{FS,i(j)}$, in N/mm^2, is taken as the local stress range at free edge, $\Delta\sigma_{BS,i(j)}$, as defined in Chapter 10, Section 1, [2.4] with correction factors:

~~$\Delta\sigma_{FS,i(j)} = f_e \cdot K_{sf} \cdot f_{material} \cdot f_{mean,i(j)} \cdot f_{thick} \cdot \Delta\sigma_{BS,i(j)}$~~

$$\Delta\sigma_{FS,i(j)} = f_e \cdot K_{sf} \cdot f_{material} \cdot f_{mean,i(j)} \cdot f_{thick} \cdot f_c \cdot \Delta\sigma_{BS,i(j)}$$

Section 4 SIMPLIFIED STRESS ANALYSIS

Symbols

For symbols not defined in this Section, refer to Chapter 1, Section 4.

（i）— Suffix which denotes dynamic load case HVM, HVS, FVM, BSR-P, BRS-S, BSP-P, BSP-S, OSTf-P, OSTf-S, OHM-P, OHM-S, OHS-P or OHS-S specified in Chapter 4, Section 2.

'*i1*' denotes dynamic load case HVM-1, HVS-1, FVM-1, BSR-1P, BSR-1S, BSP-1P, BSP-1S, OSTf-1P, OSTf-1S, OHM-1P or OHS-1S.

'*i2*' denotes dynamic load case HVM-2, HVS-2, FVM-2, BSR-2P, BSR-2S, BSP-2P, BSP-2S, OSTf-2P, OSTf-2S, OHM-2P or OHS-2S;

Section 7 STRUCTURE DETAIL DESIGN STANDARD

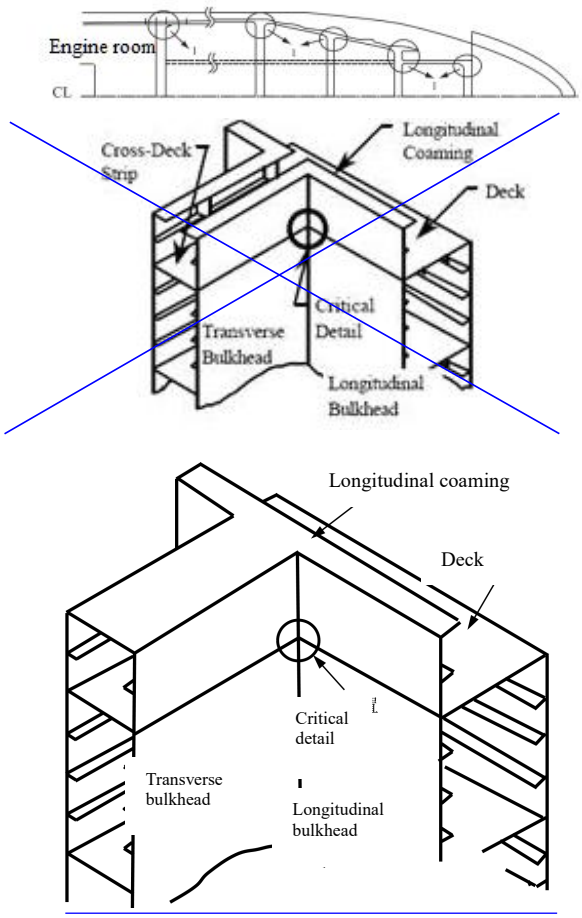
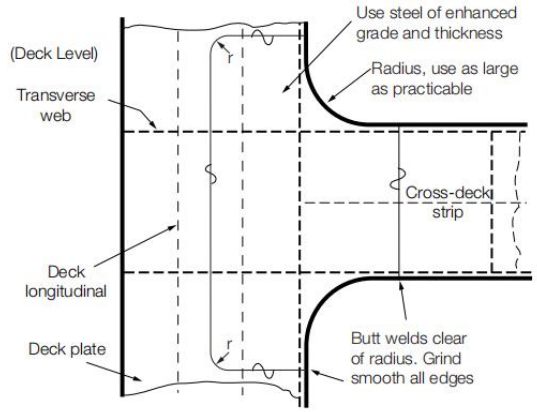
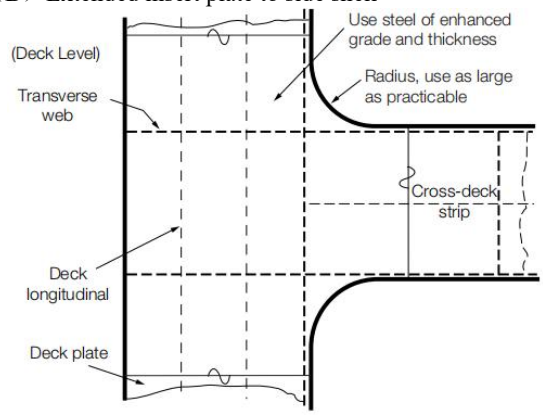
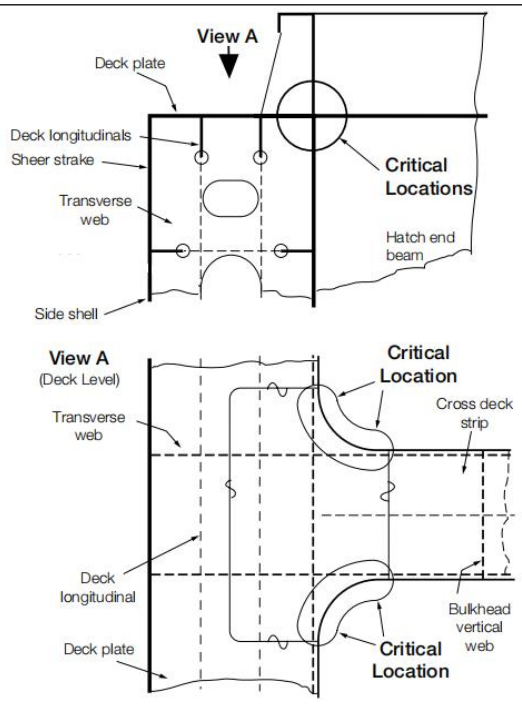
4 Hatch corner

4.1 Design standard

4.1.1 Hatch corners in the cargo hold region, located on the strength deck of bulk carriers are required to be designed according to design standard, as shown in Table 4.1.1(1) ~ (5).

Deck plating in way of the hatch corners of cargo region

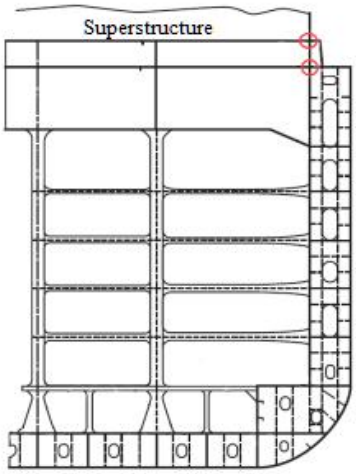
Table 4.1.1(1)

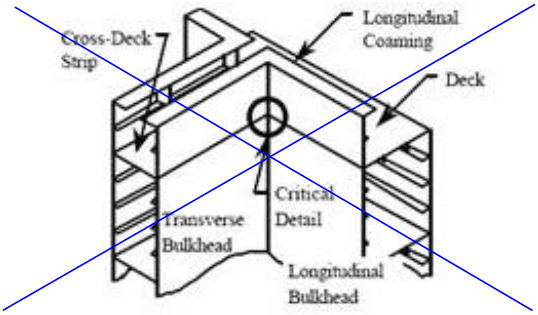
Critical areas	Design standard
	（A）Large radius deck corner insert plate  （B）Extended insert plate to side shell 
Critical locations 	

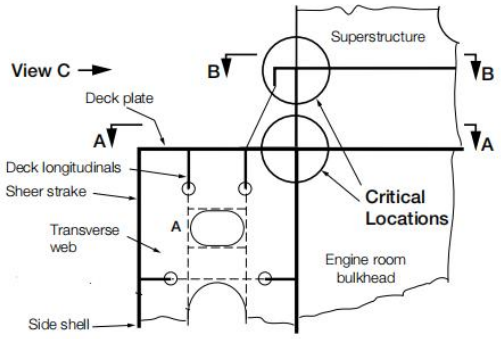
Critical location	Deck plating in way of the hatch corners of cargo region
Structure detail design standard	Use insert plates of enhanced steel grade and thickness. Attention is drawn to the transition of plating of different thickness.
Building tolerances	Ensure good alignment between hatch end beam and support in the topside tank. Special attention is drawn to taper details of the insert plate. Insert plates may be avoided by modifying the corner detail to reduce stress levels and use EH grade plate.
Welding requirements	● Ensure start and stop of welding is as far away as practicable from the corners of the insert plate; ● Ensure smooth transition of welds between corner insert plates and upper deck plating. Attention is drawn to the protection of corners; ● Ensure weld profiles are ground smooth and free of notches after fit-up in way of insert plate free edges.

Deck plating in way of the hatch corners near superstructure, intersection of hatch coaming with superstructure

Table 4.1.1(2)

<table>
<tr><th>Critical areas</th><th>Design standard</th></tr>
<tr><td>




Critical location


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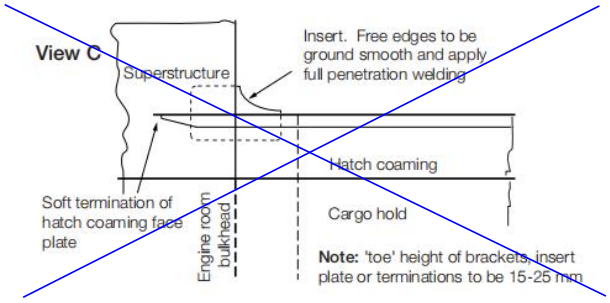
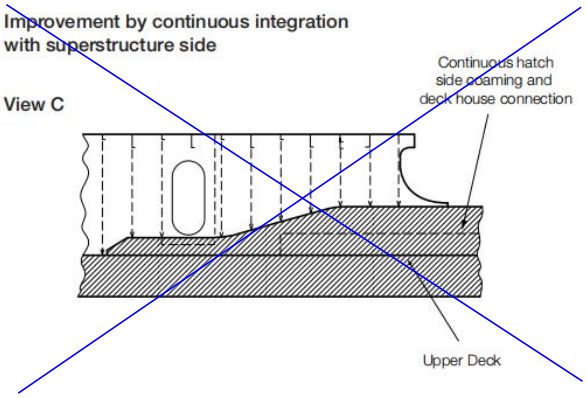
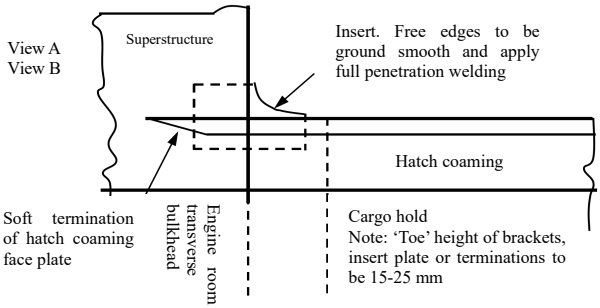
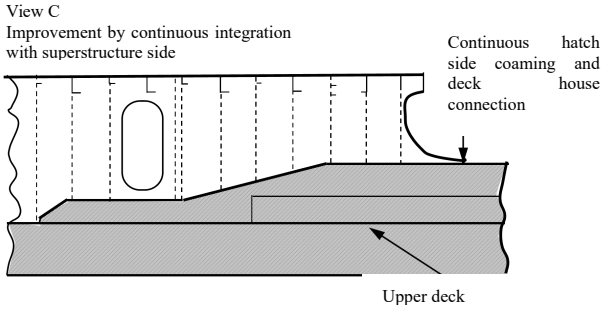








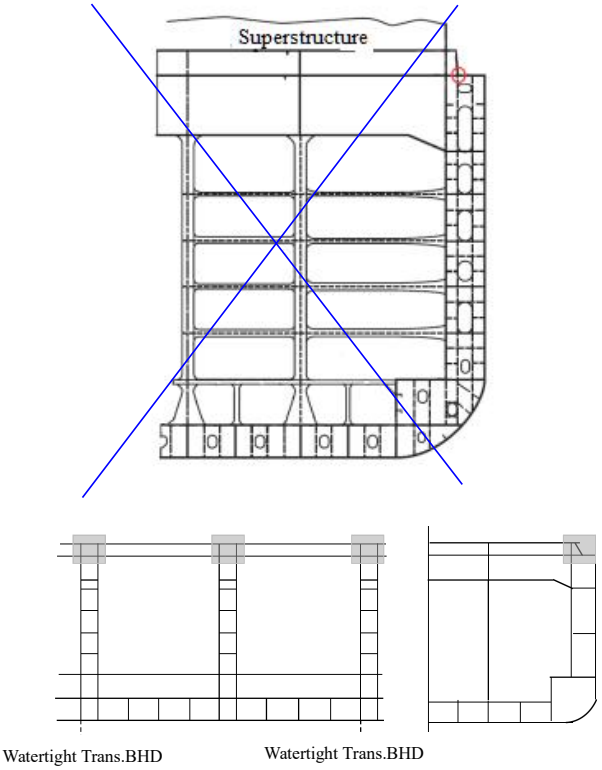
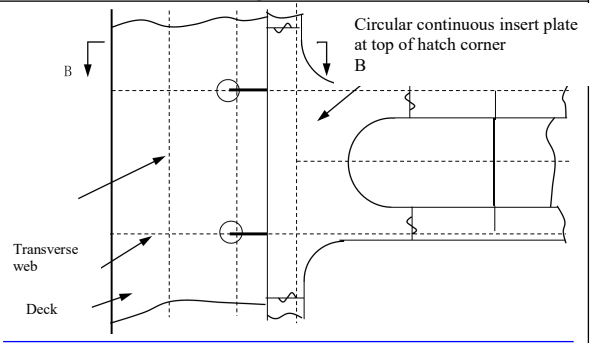
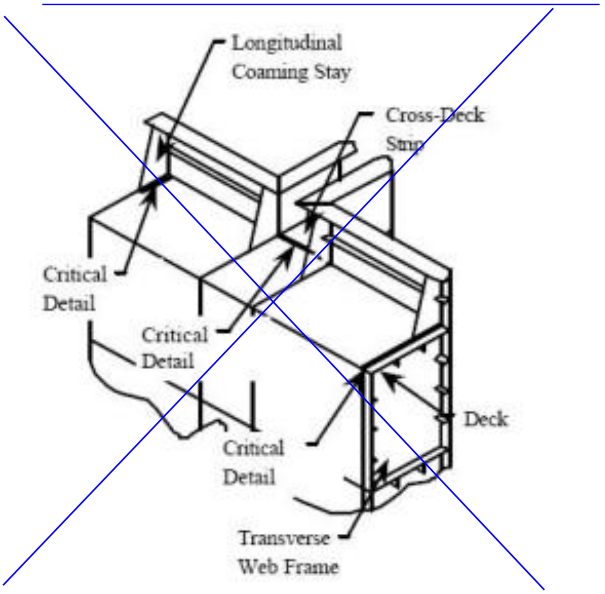
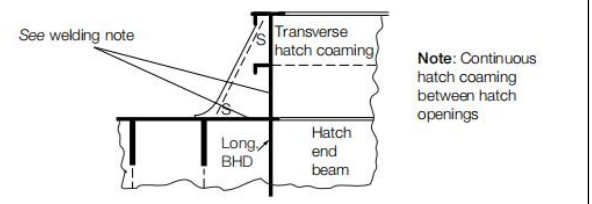
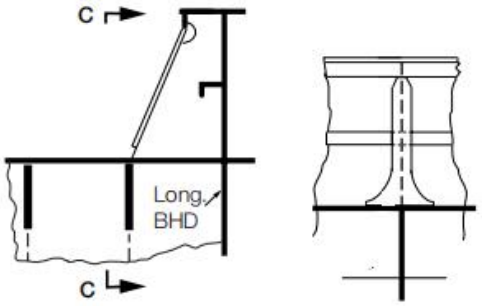
</td></tr>
</table>

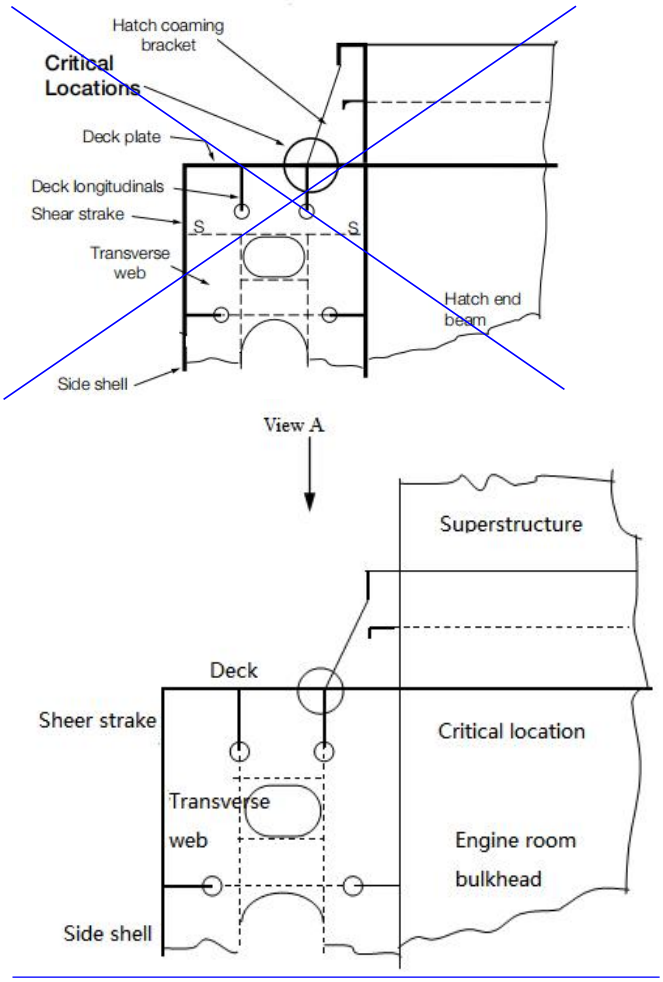
Critical location	Deck plating in way of the hatch corners near superstructure, intersection of hatch coaming with superstructure.
Structure detail design standard	Use insert plates of enhanced steel grade and thickness. A radiused corner is to be provided to reduce stress concentration. Ensure gradual transition or tapering to thinner plating as far as practicable. Grind edge smooth of the bracket to superstructure and use enhanced steel grade and thickness in superstructure side shell.
Building tolerances	Ensure good alignment between main structure support members in the vicinity.

Welding requirements	● Ensure start and stop of welding is as far away as practicable from the toes of brackets or corners; ● A wraparound weld, with smooth transition and free of weld defects, i.e. undercuts, notches etc, around toe connections of bracket to upper deck and toe connections of insert plating to superstructure.

Toe connection of continuous coaming stay bracket to the deck plating

Table 4.1.1(3)

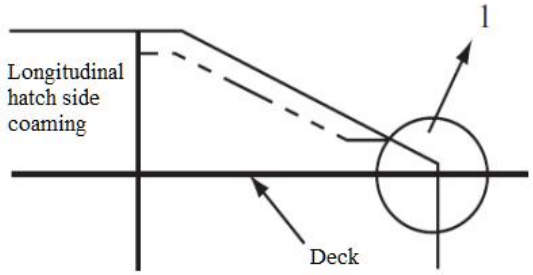
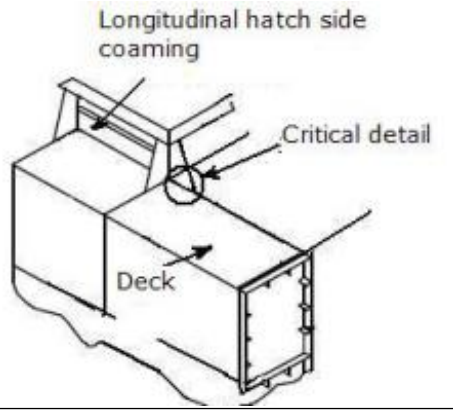
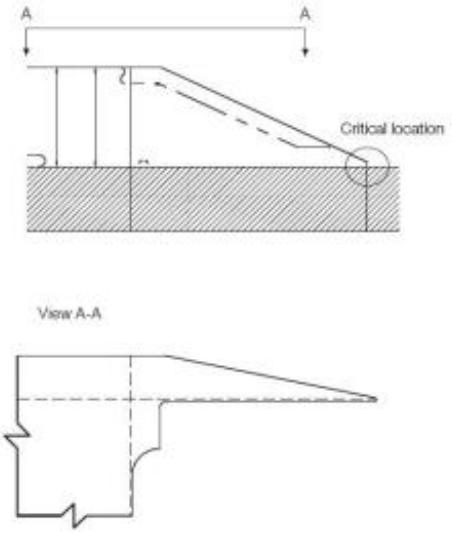
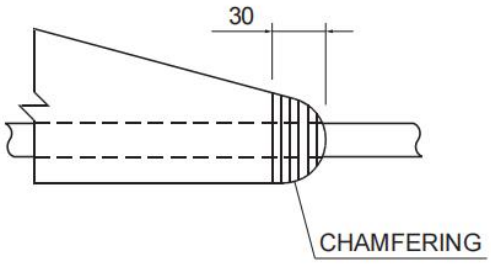
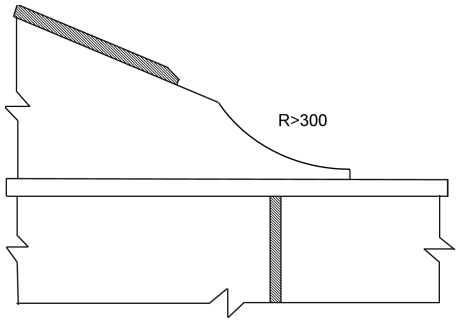
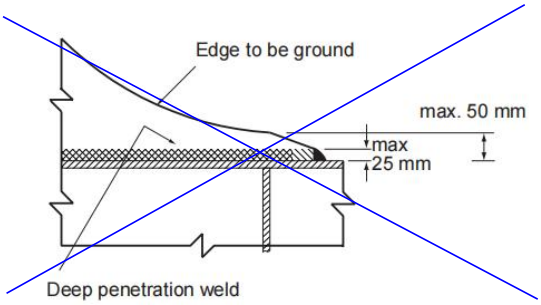
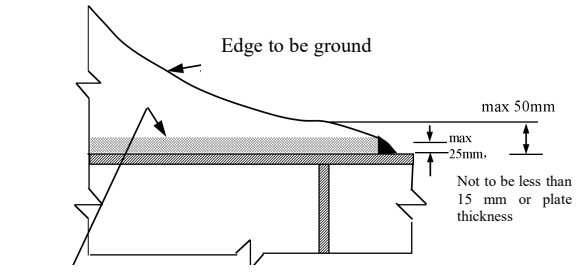
Critical areas	Design standard
	
	 Alternative plan Section C-C 
Critical location	



Critical location	Toe connection of continuous coaming stay bracket to the deck plating
Structure detail design standard	Extend the hatch coaming, the transverse bulkheads and the transverse bracket to provide an integral soft toe for smooth transition of stresses into the deck.
Building tolerances	Ensure good alignment between stay brackets and supporting structure. Misalignment is to be not greater than (t/3) where t is the thinner of the webs to be aligned (measured at the thickness centre).
Welding requirements	● Ensure start and stop of welding is as far away as practicable from the toes of brackets or corners; ● A wraparound weld, with smooth transition and free of weld defects liable to cause stress concentration, i.e. undercuts, notches etc, around toe connections of stay brackets to deck plating; ● Full penetration or deep penetration fillet welding is to be incorporated in welding of hatch coaming stay bracket and hatch coaming in way of transverse bulkheads.

Toe connection of the longitudinal hatch side coaming fore and aft termination

Table 4.1.1(4)

Critical areas	**Design standard**
  Critical location 	    ~~Explanations:~~

Critical location	Toe connection of the longitudinal hatch side coaming fore and aft termination
Structure detail design standard	Continuous extended and radiused/reversed radiused coaming with soft toe termination to reduce the stress concentration in hot spot
Building tolerances	Ensure good alignment of termination plate with the underdeck longitudinal member (bulkhead or girder).
Welding requirements	● Ensure start and stop of welding is as far away as practicable from the toe; ● A wraparound weld, with smooth transition and free of weld defects liable to cause stress concentration, i.e. undercuts, notches etc, around toe connection of the longitudinal hatch side coaming fore and aft termination to deck plating; ● Use deep penetration welding or full penetration welding for a distance of 300 mm from the toe termination. The deep penetration weld and the free edge of the coaming's termination are to be ground.

~~Deck plating in way of the hatch corners near superstructure, intersection of hatch coaming with superstructure~~ Hatch corner on strength deck forward of engine room and top plate of hatch coaming

Table 4.1.1(5)

<table>
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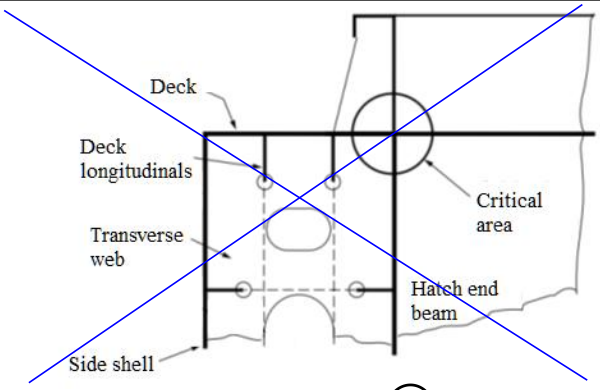
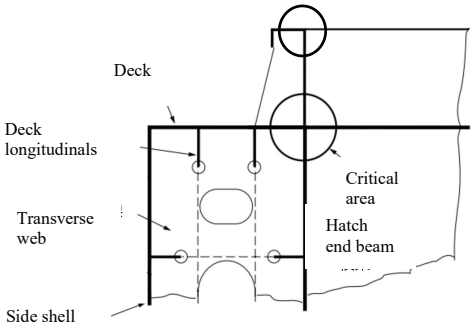
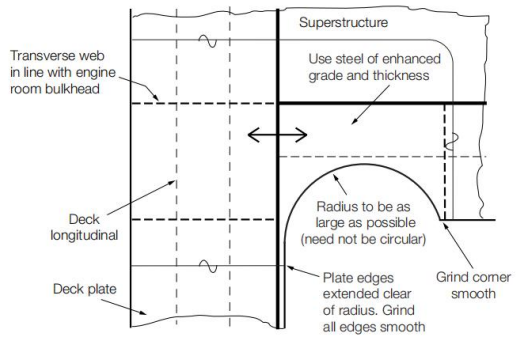
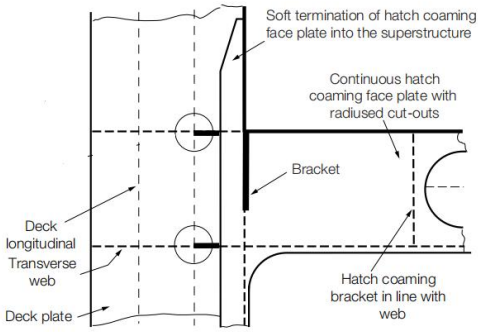




</td><td>
Deck level


Hatch coaming level


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<tr><th colspan="2">Critical location</th></tr>
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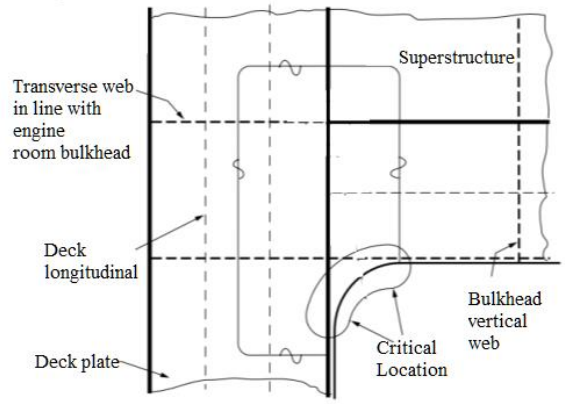

</td></tr>
</table>

Critical location	~~Deck plating in way of the hatch corners near superstructure, intersection of hatch coaming with superstructure~~.Hatch corner on strength deck forward of engine room and top plate of hatch coaming
Structure detail design standard	Extending deck corner insert plate to side shell, and/or introduction of large radius corner. Use insert plates of enhanced steel grade and thickness. A radiused corner is to be provided to reduce stress concentration. Attention is drawn to the transition of plating of different thickness. Grind edge smooth of the bracket to superstructure and use enhanced steel grade and thickness in superstructure side shell.
Building tolerances	Ensure good alignment between main structure support members in the vicinity.
Welding requirements	● Ensure start and stop of welding is as far away as practicable from the toes of brackets or corners; ● A wraparound weld, with smooth transition and free of weld defects, i.e. undercuts,notches etc, around connections of bracket toes to upper deck.

CHAPTER 12 CONTAINER SECURING

Section 1 GENERAL

1 General requirements

1.2 Class notation

1.2.1 Where the ship has onboard container lashing program ~~and applies~~, it is to apply for the notation CLC, the strength of container securing is to be assessed according to the requirements of Sections 1 to 5, Chapter 12 of this Rules, and the lashing program is to be approved in accordance with the requirements in Section 7 of Chapter 12.

1.2.2 In addition to the requirements for CLC, the notation CLC(V) may be assigned, taking into account of the requirements for specific routes in Section 8 of Chapter 12. The specific routes include navigation limited to individual routes or regions, such as the North Pacific route and the Mediterranean region, as well as navigation limited to areas outside a specific region, such as the area outside the North Atlantic region.

1.2.3 In addition to the requirements for CLC(V), the notation CLC(V,W) may be assigned, taking into account of the seasons and weather factors of specific routes in Section 8 of Chapter 12.

Section 6 STRENGTH EVALUATION OF CONTAINER SECURING STRUCTURE

1 Strength evaluation

1.2 Lashing bridges

1.2.5 To better describe the force distribution of each structural part in each direction, strength checking of lashing bridge is to adopt 3-dimensional finite element structural analysis, and the as-built thickness is to be used for the size of model structure. The extent of the model, the elements and the boundary conditions are based on the following principles:

(1) The finite element model is to include all lashing bridges above the deck or hatch cover. The boundary conditions are to restrict all translations between elements and deck or hatch cover.

(2) The FE model is to include the lashing bridge and the adjacent hull structure, which is generally to extend vertically to the second deck and horizontally to the front and rear transverse frames. The boundary conditions are to restrict the longitudinal translational, transverse and vertical rotational degrees of the front and rear boundary nodes, and the transverse and vertical translational degrees of the lower boundary nodes.

(3) The mesh size of the plate element is generally 100 mm × 100 mm, and triangle elements are to be avoided as far as possible in high stress areas and high stress changing areas.

(4) In order to evaluate more accurately the stress level and distribution in way of the concentration of local structural stresses, e.g. tapered bracket, connection of stanchion and deck, the mesh size may be 50mm×50mm.

Section 7 LASHING CALCULATION PROGRAM

~~1 General requirements~~

~~1.1 General requirements~~

1.1.1 The lashing calculation program is a software program installed in the onboard computer, which is to be capable of calculating container securing strength in accordance with the requirements of this Appendix.
1.1.2 Recommendations for the lashing calculation program include program approval and full scale installation inspection.

2 Requirements for specific approval of lashing calculation program
2.1 Approval requirements
2.1.1 The specific approval of lashing calculation program means, for the purpose of a specific ship, the approval of the program installed on board, i.e. the approval of the design method, calculation functions and principles, input data, output data, operation manual and test report and other documents.
2.1.2 The specific approval of lashing calculation program may specifically include the following:
(1) Design method, calculation functions and principles of the program are to be in conformity with the requirements and comply with the functional requirements of 2.1.3 of this Section.
(2) All input data of the program are to be consistent with those of the actual ship.
(3) By comparing calculation results for test conditions selected according to 2.3 of this Section with those of CCS plan approval software, the error is to be controlled within ±5%.
(4) Operation manual of the lashing calculation program is to comply with the requirements of 2.4 of this Section.
2.1.3 Lashing calculation program is to have the following functional requirements:
(1) The program is to be such that a common user can not alter the inputted data of the actual ship such as the geometric characteristics and permissible values.
(2) The program is to be such that any user can not alter the inputted calculation program.
(3) The program is to, as far as possible, reduce significant or illogical input errors.
(4) The program is to be capable of clearly judging whether a calculation condition complies with the relevant requirements and carrying out calculation for a certain condition. Where the calculation results exceed permissible values, the user is to be alerted by distinct means such as prominent display, special markings or visual and audible alarms, screen display or printout.
(5) The program interface is to be fully user-friendly and to alert the user with an alarm in case of any operational error. Data loss or computer crash caused by the user's error is to be minimized.
(6) The program is to be provided with passwords so that the computer will refuse to work and alert the user with an alarm where any illegal password is input.
(7) The program is to be capable of calculating the container securing strength under any condition, and carrying out calculation and storing the date and time of calculation results by means of screen display and printout. The screen display and printout are to include the following information under any condition:
- initial metacentric height;
- position of container stack;
- actual weight of stacked container;
- maximum permissible stack weight;
- lashing arrangement of stacked containers;
- transverse acceleration of each tier of container;
- racking force of each tier of container;
- vertical tension and pressure between each tier of container;
- stack bottom pressure;
- lashing force;
- transverse horizontal pressure and tension;
- warnings (if any strength criteria is exceeded).

2.2 Steps for implementing approval of lashing calculation program
2.2.1 The applicant is to submit the following plans and information to CCS for approval:
(1) Instructions for lashing calculation program, which is to include program design method, calculation function and data structure;
(2) Operation manual of lashing calculation program;
(3) Test report of lashing calculation program.
2.2.2 The applicant is to provide relevant plan or data of a specific ship (e.g. general arrangement of ship,

container securing manual/arrangement plan) for information or checking calculation.
2.2.3 On completion of approving above plans and information, cover pages of operation manual of lashing calculation program and test report may be affixed with an approval stamp, and it is to be indicated in the issued plan approval comment that class notation CLC or class notations CLC(V) and CLC(V,W) are recommended to be assigned.

2.3 Test condition
2.3.1 Test condition is to be selected from container securing manual/arrangement plan of the ship.
2.3.2 Test condition is at least to include:
(1) container lashing arrangement condition corresponding to minimum and maximum initial metacentric height;
(2) for ships assigned class notation CLC(V) or CLC(V,W), the corresponding additional condition.
2.3.3 Test condition is to include all functions of program as far as possible.
2.3.4 Approved test condition is to be kept as input data to ensure that they can not be revised by the user. A copy of approved test condition is to be kept on board.

2.4 Operation manual
2.4.1 At least one copy of operation manual of lashing calculation program approved by CCS is to be kept on board.
2.4.2 The operation manual of lashing calculation program is to be written by a language used by the user on board, and the language is to be the same as that for screen display, printout and the approved container securing manual/arrangement plan kept on board. Where the language is not English, a translation into English is to be provided.
2.4.3 The operation manual is to be written in a clear and unambiguous manner. The use of flowcharts is recommended for illustrating operational processes.
2.4.4 The operation manual is to include the following:
(1) particulars and version number of the lashing calculation program;
(2) specification of hardware needed to run the lashing calculation program and guidance for program installation;
(3) program running steps shown in menus and dialogues, error messages and warnings likely to be encountered during the program run and instructions for subsequent actions to be taken in such case;
(4) description of test conditions;
(5) operation of program shown by calculation cases;
(6) input and output data, calculation results shown by screen display, necessary explanatory text;
(7) explanation for function keys.

2.5 Full scale installation inspection
2.5.1 The shipowner or the entrusting party is to submit application to CCS survey unit of port of call of ship.
2.5.2 The crew may grasp operation and calculation of lashing calculation program of the ship by means of study or training, and installation inspection is to be carried out by crew of the ship.
2.5.3 Full scale installation inspection is to be carried out with the presence of CCS surveyor. Installation inspection is generally to include following items:
(1) Checking that the user's operation manual and test report approved by CCS are kept on board the ship.
(2) Examining the environment and position for installing the program: confirming that the position and method for installing the program are as required in the instruction.
(3) Program stability test: the program is to be capable of working normally after a continuous running period of one hour.
(4) Program security test: where an illegal password is inputted (or in case of human inadvertent operation), the program should refuse to work.
(5) Program safety test: a common user is not to be capable of changing the application program and the input ship's data such as geometrical characteristics and permissible values.
(6) Program functional test: the calculation results from the program operated by the crew of the ship based upon the conditions as stated in the approved test report, the calculations are to be the same as those in the

~~approved test report.~~
~~2.5.4 During installation inspection, test report printed by lashing calculation program is to be confirmed and endorsed by site surveyor. On completion of satisfactory installation inspection, site surveyor is to issue report and CCS is to assign relevant class notation.~~
~~2.5.5 For ships provided with lashing calculation program approved by other IACS member societies, the operation manual and test report approved by these Societies may be reviewed and installation inspections are to be carried out in accordance with 2.5.3 of this Section.~~
~~2.5.6 For ships provided with lashing calculation program not complying with the relevant requirements of CCS or approved by a party which is not a member of IACS, the program approval and the installation inspection is to be carried out once again.~~

1 General

1.1 General requirements

1.1.1 All seagoing dedicated container ships are to be provided with lashing software complying with the requirements of this section.
1.1.2 Lashing software is an electronic data processing tool for onboard analysis of forces in container stacks and thereby reflects the parameters of the lashing system as described in the Cargo Securing Manual.
1.1.3 An approved lashing software is not a substitute for the approved Cargo Securing Manual. It is considered as a supplement to the approved Cargo Securing Manual.
1.1.4 The lashing software is a ship specific tool, and the results of the calculations are only applicable to the ship for which it has been approved.

2 Approval of software

2.1 Operation manual

2.2.1 An operation manual is to be provided for the lashing software and be kept on board, which is to be approved by CCS.
2.2.2 The language of the operation manual is to be the same as the language of the approved Cargo Securing Manual. A translation into another language considered appropriate may be required.
2.2.3 The operation manual is to contain descriptions and instructions, as appropriate, as per the following list:
(1) a general description of the lashing software;
(2) installation;
(3) function keys;
(4) menu displays;
(5) input and output data;
(6) required minimum hardware to operate the software;
(7) instruction on testing the lashing software with the test loading condition;
(8) a list of all terms, definitions, error messages and warnings likely to be encountered by the user; and
(9) in the case of error messages and warnings, there are to be unambiguous user instructions for subsequent action to be taken in each case.

2.3 Functional requirements

2.3.1 The lashing software is to be capable of calculating forces on containers and container securing equipment for any loading conditions for each container stack.
2.3.2 It is also to be capable of indicating the respective permissible values in order to assist the master in his/her judgement on whether the ship is loaded within the approved limits. The following parameters are to be presented:
(1) summary of ship particulars such as IMO No., length, and breadth;
(2) summary of loading conditions showing relevant input parameters such as draught and GM;
(3) stack and container positions;
(4) actual stack weights verified against permissible stack weights;
(5) relevant properties of securing devices, including permissible loads;
(6) accelerations and other external forces such as wind containers are exposed to;
(7) listing of all calculated forces on containers and container securing equipment, and evaluation of

compliance of the calculated forces with the corresponding allowable values.
2.3.3 The container and lashing arrangements in each bay on deck and in holds are to be shown graphically.
2.3.4 The data are to be presented on screen and in hard copy printout in a clear and unambiguous manner.
2.3.5 A clear warning is to be given on screen and in hard copy printout if any of the allowable forces are exceeded.
2.3.6 In addition to the printout content, each page of the printout is to contain ship's identification, lashing software name and version number, date and time of the printout, and the title of the loading condition. The printout is to be paginated sequentially, and the total number of printout pages are to be shown.
2.3.7 Units of measurement are to be clearly identified and used consistently.
2.3.8 Incorrect data input by the users, such as negative draught values, are to be prohibited. An error message is to be prompted on screen and in hard copy printout in a clear and unambiguous manner.

2.4 Test Loading Conditions

2.4.1 The lashing software is to be delivered with test loading conditions for selected stacks and bays covering applicable stowage patterns for containers of different dimensions contained in the Cargo Securing Manual. It is generally to cover the container stacking of the ship's bow, amidships and stern bay, including at least one lashing calculation for the conditions listed in the Cargo Securing Manual. For ships assigned the CLC (V) or CLC (V,W) notation, the corresponding additional conditions are to be supplemented.
2.4.2 The test loading conditions and their results are to be permanently stored in the computer where the lashing software is installed and be protected against unintentional or unauthorized modifications and access.

2.5 Approval of Lashing Software

2.5.1 The lashing software is subject to approval and is to include:
(1) verification of type approval, if any;
(2) verification that the latest ship data has been used;
(3) verification and approval of the test loading conditions and their results;
(4) verification if requirements of 2.3 are satisfied;
(5) checking of proper installation, and verification of the instrument on board in accordance with the approved test loading conditions;
(6) checking the availability of the operation manual on board.
2.5.2 In case of modifications implying changes in the ship’s design or container securing arrangement, the software is to be modified accordingly and re-approved.
2.5.3 Any changes in software version related to the container securing calculations are to be reported and be approved.
2.5.4 Upon installation, the lashing software is to be verified with the approved test loading conditions in the presence of surveyor. It is to be checked that the operation manual for the lashing software is available on board.
2.5.5 Verification does not absolve the shipowner of responsibility for ensuring that the information supplied into the lashing software is consistent with the current condition of the ship and approved Cargo Securing Manual.

2.6 Acceptable Tolerances

2.6.1 The results of the lashing software are compared with those of the CCS plan approval software. The tolerance of the accuracy of the results from the lashing software is to be below 1.0% of the allowable values. However, deviations may be accepted provided that there is a satisfactory explanation for the deviation and that there will be no adverse effects on the safety of the ship.

2.7 Annual and Special Survey

2.7.1 At each annual and special survey, it is to be checked that the operation manual is available on board.
2.7.2 The lashing software is to be checked for accuracy annually by the ship's Master by applying the test

loading conditions. If the surveyor is not present for lashing software check, a copy of the test loading condition results obtained by this check is to be retained on board as documentation of satisfactory testing for the surveyor's verification at the next scheduled survey.

2.7.3 At each special survey this checking is to be done in the presence of surveyor.

Section 9 APPROVAL AND CERTIFICATION OF CONTAINER SECURING SYSTEMS

1 General

1.1 General requirements

1.1.1 All seagoing dedicated container ships are to comply with the requirements of this section.

1.1.2 It is important for the safety of the ship and the protection of the cargo and personnel that the cargo is secured properly especially accounting for strength of the supporting structures and securing fittings. Hereto, a scope containing the following for approval and/or certification of container securing systems is defined:

(1) fixed and portable container securing fittings;

(2) arrangement plan of fixed container securing fittings;

(3) drawings of container supporting structures (container stanchions, hatch covers, lashing bridges, and cell guides, if any);

(4) cargo safe access plan;

(5) container stowage and securing plan;

(6) lashing software.

2 Approval and certification

2.1 Fixed and Portable Container Securing Fittings

2.1.1 Fixed container securing fittings are used to secure and support containers and are permanently welded to the ship structure.

2.1.2 Portable container securing fittings are used to secure containers and are not categorised as fixed container securing fittings.

2.1.3 Minimum Breaking Load corresponds to the minimum load at which the first crack appears in the tested representative samples.

2.1.4 Minimum Proof Load corresponds to the test load below which visible permanent deformation is not allowed.

2.1.5 Drawings of fixed and portable container securing fittings are to show dimensions, materials, design loads, and manufacturer’s markings.

2.1.6 Each fixed and portable container securing fitting type is subject to prototype testing to determine the minimum breaking loads. The minimum breaking load obtained from prototype testing is to be equal to or exceed the design minimum breaking load.

2.1.7 Fixed and portable container securing fittings are subject to production testing prior to delivery or installation. A number of samples from a batch of the container securing fittings is to be loaded to minimum proof load of the fittings. The production testing approval documents of delivered container securing fittings are to be kept on board and may be included in the approved Cargo Securing Manual.

2.1.8 The plan detailing the arrangement of the fixed container securing fittings is to be approved. The arrangement plan is to include the following for all areas where the fittings are installed:

(1) The type of fixed container securing fittings such as container foundations and lashing eye plates;

(2) Unambiguous location of installed fittings such as their location relative to clearly described locations of the ship structures.

2.2 Drawings of Container Supporting Structures

2.2.1 The drawings of the structures necessary for conducting container stowage and securing are subject to approval. The drawings are to be detailed enough to allow their model generation for structural analyses. A plan is to be provided showing all relevant design loads for structural assessment of the container supporting structures and their foundations.

2.2.2 Structures involved in container stowage and securing include hatch covers, container stanchions, lashing bridges and cell guides.

2.3 Cargo Safe Access Plan

2.3.1 The cargo safe access plan is to be examined for its compliance with the requirements prescribed in MSC.1/Circ.1353/Rev.2 (refer to CCS Guidelines for the Preparation of the Cargo Securing Manual).

2.4 Container Stowage and Securing Plan

2.4.1 If the stowage and securing plan, as referred to in MSC.1/Circ.1353/Rev.2 [4.2.1] and [4.2.2] (refer to CCS Guidelines for the Preparation of the Cargo Securing Manual), is required by the Administration, the plan is subject to approval in accordance with [2.4.2] and [2.4.3].

2.4.2 The container stowage plan is to include at least the following information for each container type the ship is designed for:

(1) longitudinal and athwartship views of under deck and on deck stowage locations of containers including reefers as appropriate;

(2) alternative stowage patterns for containers of different dimensions;

(3) maximum stack masses;

(4) maximum stack heights with respect to approved sight lines; and

(5) maximum nominal container capacity.

2.4.3 The container securing arrangement plan is to contain all information necessary to prepare lashing calculations. The container securing arrangement plan is to include at least the following information:

(1) summary of ship particulars such as IMO No., length and breadth;

(2) summary of loading conditions showing relevant input parameters such as draught and GM;

(3) longitudinal views of under deck and on deck stowage locations of containers as appropriate showing nominal capacity;

(4) maximum stack masses;

(5) relevant properties of securing fittings, including permissible loads;

(6) graphical presentation of container and lashing arrangements in each bay on deck and in holds for sample loading conditions for each container type the ship is allowed to carry;

(7) stack total mass and the sequence of masses in a stack;

(8) minimum quantity of fittings required to secure containers for the presented sample loading conditions.

2.5 Lashing Software

2.5.1 If the ship is provided with lashing software on board, the approval is to follow the requirements of Section 7 of this Chapter.

CHAPTER 13 CONSTRUCTION

Section 3 DESIGN OF WELD JOINTS

2 Tee or cross joint

2.4 Partial or full penetration welds

2.4.4 Extent of full or partial penetration welding

~~The extent of full or partial penetration welding in each particular location listed in [2.4.5] and [2.4.6] is to be approved by CCS.~~ Full penetration welding is in general to be carried out at locations listed in [2.4.5], and partial penetration welding is in general to be carried out at locations listed in [2.4.6]. Requirements may be reduced appropriately for areas other than high stress areas or critical areas. However, the minimum extent of full/partial penetration welding from the reference point (i.e. intersection point of structural members, end of bracket toe, etc.) is not to be taken less than 300 mm, unless otherwise specifically stated.

2.4.5 Locations required for full penetration welding

~~Full penetration welds are to be used in the following locations and elsewhere as required by the rules:~~

~~(1) Connection of bilge tank to inner shell longitudinal bulkhead, inner bottom plate;~~

~~(2) Connection of radiused hatch coaming plate at corners to deck.~~

~~(3) Connection of watertight transverse bulkhead to inner shell longitudinal bulkhead, inner bottome plate;~~

~~(4) Connection of transverse support bulkhead girder to inner shell longitudinal bulkhead;~~

(1) Intersections at transverse web frames in bilge side tanks, with the inner shell longitudinal bulkhead and the top plate of bilge side tanks;

(2) Intersections at solid floors, between the inner shell longitudinal bulkhead, the inner bottom plate and the double bottom side girders;

~~(5)~~ (3)Edge reinforcement or pipe penetration with tightness requirements both to strength deck, sheer strake and bottom plating within 0.6 *L* amidships, when the dimensions of the opening exceeds 300 mm.

~~(6)Abutting plate panels with as-built thickness less than or equal to 12 mm, forming outer shell boundaries below the scantling draught, including but not limited to: sea chests, rudder trunks, and portions of transom. For as-built thickness greater than 12 mm, partial penetration in accordance with [2.4.1].~~

~~(7)~~(4)For toe connections of longitudinal hatch coaming end bracket to the deck plating, full penetration weld for a distance of 0.15 *Hc* (or not less than the minimum value required in 2.4.4) from toe of side coaming termination bracket is required, where *Hc* is the hatch coaming height.

~~(8)~~(5)Connection of rudder horns and shaft brackets to shell structure.

2.4.6 Locations required for partial penetration welding

~~Partial penetration welding as defined in [2.4.2], is to be used in the following locations. Based on the other criteria, such as the fatigue assessment given in chapter 10, partial penetration welding may be used elsewhere:~~

~~(1) Connection of longitudinal/transverse bulkhead primary supporting member ends to double bottom, inner hull longitudinal bulkhead;~~

~~(2) Primary supporting members of bulkhead;~~

~~(3) Connection of transverse bulkhead plate to inner bottom plate;~~

~~(4) Connection of transverse bulkhead vertical girder or horizontal girder at toe;~~

~~(5) Hatch coaming bracket;~~

~~(6) Floor for supporting transverse bulkhead plate;~~

(1) Connection between upper deck and sheer strake with as-built thickness greater than or equal to 15 mm;

(2) Intersections of hatch end beams with inner shell longitudinal bulkhead and second deck;

(3) Connection between vertical stringers of supporting bulkheads and inner bottom plate;

(4) Connections between inner bottom plate extension brackets with as-built thickness greater than 12

mm and stepped vertical plates / inner shell longitudinal bulkhead;
(5) Connections between solid floor supporting structures in bilge side tanks and bilge longitudinals at watertight transverse bulkhead plates;
(6) Shell plate boundaries formed below the scantling draught (including but not limited to sea chests, rudder trunk and portions of transom);
(7) Pillars ~~and transverse bulkhead top plate~~ of lashing bridge and hatch coaming top plate;
(8) Box post and deck.

2.5 Weld size criteria

Minimum leg size **Figure 2.5.2(1)**

Area	Type of space		Minimum length, in mm~~(1)~~/mm
Cargo hold region	Cargo tanks and holds		5.0(1)
	Water ballast tanks	Within 3m below top of tank(2)	6.5(1)
		Elsewhere	6.0(1)
	Dry spaces and voids		5.0~~(1)~~
	Other tanks		6.0(1)
Other areas	Water ballast tanks	Within 3m below top of tank(2)	6.0(1)
		Elsewhere	5.5(1)
	Fuel oil, diesel oil, fresh water and other tanks		4.5
	Dry spaces and voids		4.0
	Superstructures and deckhouses		3.5

(1) If the as-built thickness of the element is less than 12 mm, the minimum leg length may be reduced by 0.5 mm.
(2) Only applicable to cargo tanks and ballast tanks with weather deck as the tank top. The 3m distance is measured vertically from and parallel to the top of the tank.

Weld factors for different structural members **Table 2.5.2(2)**

Hull area	Connection			f_{weld}
	Of	To		
General, unless otherwise specified in the table	Watertight plate	Boundary plating		0.48
	Oil-tight plate	Boundary plating		0.51
	Brackets at ends of members			0.48
	Ordinary stiffener and collar plates	Deep tank bulkheads		0.24
		Web of primary supporting members and collar plates		0.38
	Web of stiffener	Plating (except deep tank bulkhead)		0.20
		Face plates of built-up stiffeners	At ends (15% of span)	0.38
			Elsewhere	0.20
Bottom and double bottom	Ordinary stiffener	Bottom and inner bottom plating		0.24
	Centre girder	Shell plates		0.38
		Inner bottom plate		0.38
	Side girder including intercostal plates	Bottom and inner bottom plating		0.24
	Floor	Shell plates and inner bottom plates	At ends, on a length equal to two frame spaces	0.38
		Centre girder and side girders in way of hopper tanks		0.38
		Elsewhere		0.24
	Bracket on centre girder	Centre girder, inner bottom, floors and shell plates		0.38
	Web stiffener	Floor and girder		0.20
Side and inner side in double side structure	Web of primary supporting members	Side plating		0.30
		Opening stiffener		0.24
		Inner side plating and web of primary supporting	in way of deck transverse and end connections	0.43
			in way of cross tie	0.36

				elsewhere	0.30
	Web stiffeners		Top strake, upper strake of inner shell longitudinal bulkhead		0.38
	~~Top strake, longitudinal bulkhead end plate~~		~~Main deck, torsion box longitudinal~~		~~FPW(4)~~
Deck	~~Strength deck~~	~~$t_{as\text{-}built} \geq 13$~~	~~Side shell plating within $0.6L$ midship~~		~~PPW(3)~~
			~~Elsewhere~~		~~0.48~~
		~~$t_{as\text{-}built} < 13$~~	~~Side shell plating~~		~~0.48~~
	Upper strake of inner shell longitudinal bulkhead		Upper deck (at transverse bulkhead and fore and aft part)		PPW(1)
			Elsewhere		0.48
	Other deck		Side shell plating		0.38
			Stiffeners		0.20
	Hatch coaming side plate		~~Deck plating g within $0.6L$ midship~~ Upper deck (at transverse bulkhead and fore and aft part)		PPW~~(3)~~(1)
			Elsewhere		0.48
	Web stiffeners		~~Coaming webs~~ Upper deck, hatch coaming side plate/top plate		~~0.20~~ ~~(2)~~0.38
Vertical Bulkheads	~~Bulkead vertical web~~		~~Bulkhead horizontal girder~~		~~0.48~~
	~~Web of bulkhead girder~~		Bulkhead web face plate		0.38
	~~Longitudinal~~Stiffeners		Bulkhead plating	At ends (25% of span), where no end brackets are fitted	0.48
			Bulkhead plating	Elsewhere	0.24
Aft peak	Internal members		Boundaries and each other: below waterline		0.38
			Above waterline		0.20
Fore peak	Internal members		Boundaries and each other		0.20
Machinery space	Centre girder		Keel and inner bottom		0.48
	Floor		Centre girder		0.48
	Engine foundation girders		Top plate and primary hull structure		PPW~~(3)~~(1)
	Floors and girders		Inner bottom and shell plate		0.38
Super structure and deckhouse	External bulkhead (first and second tier erections)		Deck, external bulkhead		0.48
	External bulkheads and internal bulkheads		Elsewhere		0.20

~~(1)*fweld* = 0.43 for hatch coaming other than in cargo holds.~~
~~(2)Continuous welding.~~
~~(3)~~(1)PPW: Partial penetration welding in accordance with [2.4.2].
~~(4)FPW: Full penetration welding in accordance with [2.4.2].~~

CHAPTER 14 SHIP IN OPERATION - RENEWAL CRITERIA

Section 1 PRINCIPLES AND SURVEY REQUIREMENTS

1 Principles

1.1 Application

1.1.1 The purpose of this chapter is to provide criteria for the allowable thickness diminution of ships' hull structures.

1.1.2 The criteria apply only to ships in operation that are classed in accordance with the Rules. As an alternative, the requirements of Appendix 1 Criteria for renewal of hull structural members of Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships may also apply.

1.1.3 Thickness measurement is to be used to assess ship' hull structures against the specified renewal criteria.

1.3 Requirements for documentation

1.3.1 Plans

The plans to be supplied onboard the ship, as required in Ch 1, Sec 3, are to include, for each structural element, both the as-built and renewal thickness as defined in Sec 2 of the chapter. Where the renewal thickness in not indicated on the plans, explanations on renewal thickness of members are to be submitted separately. Any thickness for voluntary addition is also to be clearly indicated on the plans.

Ships subject to renewal of hull structural members in accordance with Appendix 1, Chapter 5, PART ONE of CCS Rules for Classification of Sea-going Steel Ships are excluded.

The list of plans and information to be kept on board is given in PART ONE of CCS Rules for Classification of Sea-going Steel Ships.