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To : All Surveyors and whom it may concern

No : 2019-9-E
Date : 2019.10.31

Subject	9.127 Notice for Amendments to the KR Technical Rules (Guidance, Part 7 Annex 7-10)
Application	05 Nov. 2019 (Date of Construction Contract)

1. Please be informed that the partial amendments have been made to the "Guidance Relating to the Rules for the Classification of Steel Ships, Pt.7 Annex 7-10, Guidelines for Direct Strength Assessment of Ore Carriers" as below and you are kindly requested to apply these amendments on the relevant works.

= Below =

1) Regarding to addition of new load cases reflecting dynamic shear forces due to high GM in beam sea and application of buckling assessment method in Pt.13 (CSR).

2. Furthermore, please be informed that these amendments will be included in 2020 edition for Rule and Guidance on KR Classification Technical Rules which will be published in the first half of 2020.

Attachments: Amended Guidance, Part 7 Annex 7-10, 1 copy. (The End)

(Form No. : FI-03-03) (20.06.2018)

Amended Guidance for the Classification of Steel Ships

Part 7 Ships of Special Service

Annex 7-10 Guidelines for Direct Strength Assessment of Ore Carriers

Oct. 2019

- Main Amendments -

(1) Background

- Addition of new load cases reflecting dynamic shear forces due to high GM in beam sea
- Application of buckling assessment method in Pt 13 (CSR)

(2) Amendments

- See Amendments Tables for Annex 7-10, Part 7

(3) Effective Date

- Effective date : 05 Nov. 2019 (Date of Construction Contract)

Present	Amendments
Annex 7-10 Guidelines for Direct Strength Assessment for Ore Carriers	Annex 7-10 Guidelines for Direct Strength Assessment of Ore Carriers
1. Direct strength calculation The direct strength calculation of the ore carrier is in accordance with the Pt 3, Annex 3-2 Guidance for Direct Strength Assessment and following 1. to 9. and proceeds according to the structural analysis flow chart in Fig 1.	(1) General The direct strength calculation of the ore carrier is in accordance with (1) to (9) and proceeds according to the structural analysis flow chart in Fig 1.
(1) Structural members to be calculated The members that can determine the scantling by direct strength calculation are as follows. Bottom transverse, deck transverse, side transverse, longitudinal bulkhead transverse, cross-tie, floor, inner bottom, bottom shell, side shell, cross deck and girder.	The members that can determine the scantling by direct strength calculation are as follows. Bottom transverse, deck transverse, side transverse, longitudinal bulkhead transverse, cross-tie, floor, inner bottom, bottom shell, side shell, cross deck and girder. Gross thickness is applied for the direct strength calculation. The buckling strength is evaluated for net thickness considering the corrosion margin defined in following (7).
(2) Modelling, Loads, boundary conditions, and supporting conditions Assumed loads, structural models, boundary conditions and supporting condition for the calculation are to be as follows:	(2) Modelling
(A)The procedure of structural modelling for mid cargo hold(or tank)is to be as follows:	The procedure of structural modelling for mid cargo hold(or tank)is to be as follows:
(a) Range of analysis (refer to Fig 2)	(A) Range of analysis
(i) The analysis of the mid-cargo hold structure ... 〈omitted〉	(a) The analysis of the mid-cargo hold structure ... 〈same as the current Guidance〉
(ii) The longitudinal extent of the finite element model ... 〈omitted〉	(b) The longitudinal extent of the finite element model.... 〈same as the current Guidance〉
(iii) The Fwd and Aft models should be .. 〈omitted〉	(c) The Fwd and Aft models should be... 〈same as the current Guidance〉
(b) Structural modelling 〈omitted〉	(B) Structural modelling 〈same as the current Guidance〉

Present	Amendments
	(3) Boundary condition 〈same as the current Guidance〉
(B) Applied loads	(4) Applied loads (A) Internal loads
(i) Loads due to ore cargo, grain cargo, etc. are as fol lows; ① The height and surface of the cargo are to be determined in accordance with below (see Fig 8, 9 and 10) 〈omitted〉	(a) Loads due to ore cargo, grain cargo, etc. are as follows; (i) The height and surface of the cargo are to be determined in accordance with below (see Fig 8, 9 and 10) 〈same as the current Guidance〉 V_H : Volume, in m^3, of cargo hold up to level of the intersection of the main deck with the hatch coaming excluding the volume enclosed by hatch coaming. 〈same as the current Guidance〉
② The loads on the vertical walls of the hold are to be determined by the following formula. 〈omitted〉	(ii) The loads on the vertical walls of the hold are to be determined by the following formula. 〈same as the current Guidance〉
- In order to evaluate the total force in the vertical direction, shear loads acting on the slope plate of the bilge hopper tank and lower stool by bulk dry bulk cargo are to be taken into account. The shear load acting on the sloped members by the bulk cargo in the still water is given by the following formula. $h_S = \frac{(1-K_C)(h_C+h_{DB}-z)}{\tan\beta}$ 〈omitted〉	- In order to evaluate the total force in the vertical direction, shear loads acting on the slope plate of the bilge hopper tank and lower stool by bulk dry bulk cargo are to be taken into account. The shear load acting on the sloped members by the ore cargo in the still water is given by the following formula. $w_{sh} = 9.81\gamma \frac{(1-K_C)(h_C+h_{DB}-z)}{\tan\beta}$ $(\mathrm{kN/m^2})$ 〈same as the current Guidance〉
(ii) Loads due to ballast water 〈omitted〉 (iii) Load under hydrostatic test The water head of the tank to be subjected to the hydrostatic test should be the tank top + 2.4 m (b) Hydrostatic pressure The hydrostatic pressure is to be in accordance with Pt. 3 Appendix 3-2 III 1 (8).	(b) Loads due to ballast water 〈same as the current Guidance〉 (c) Load under hydrostatic test The water head of the tank to be subjected to the hydrostatic test should be the tank top + 2.4 m (B) Hydrostatic pressure The hydrostatic pressure is to be in accordance with Pt. 3 Annex 3-2, III 1 (8).

Present	Amendments
(c) Wave loads The wave loads are to be in accordance with Pt. 3 Appendix 3-2 III 1 (9). (d) Hull weight Consider the self weight of the hull considering gravitational acceleration. (e) Load due to upper structure If the upper structure is included in structural model, the load considered with acceleration of gravity are to be considered. If the upper structure is not included in structural model, loads on upper structure are to be distributed on relevant deck nodes. (f) Load due to the main engine The loads due to the main engine are to be distributed on relevant nodes of M/E foundation. (C) Boundary condition and supporting condition of structural modelling 〈omitted〉 (3) Consideration of hull girder shear force (A) The hull girder shear force........ 〈omitted〉 (B) For mid hold, shear force is to comply with Pt 13, Ch. 7 Sec. 2 of the Rles. For Fwd and Aft hold, shear force is to comply with Pt 13, Ch. 7 Sec. 2 of the Rles. (C) The direct calculation of the shear flow is to comply with Pt 13, Ch. 5 Annex 1 of the Rules. (4) Considering of hull girder bending moment (A) The hull girder bending moment is adjusted after adjusting the shear force. (B) In the analysis of the vertical bending moment, the target hull girder bending moment is the maximum vertical bending moment that can occur at the center of the mid hold in the finite element model. The target value of the hull girder bending moment is obtained as follows. $M_{v-targ} = M_s + M_w$	(C) Wave loads The wave loads are to be in accordance with Pt. 3 Annex 3-2, III 1 (9). (D) Hull weight Consider the self weight of the hull considering gravitational acceleration. (E) Load due to upper structure If the upper structure is included in structural model, the load considered with acceleration of gravity are to be considered. If the upper structure is not included in structural model, loads on upper structure are to be distributed on relevant deck nodes. (F) Load due to the main engine The loads due to the main engine are to be distributed on relevant nodes of M/E foundation. (G) Consideration of hull girder shear force (a) The hull girder shear force.......... 〈same as the current Guidance〉 (b) For mid hold, shear force is to comply with Pt 13, Sub-Pt. 1, Ch. 7 Sec. 2. For Fwd and Aft hold, shear force is to comply with Pt 13, Sub-Pt. 1, Ch. 7 Sec. 2. (c) The direct calculation of the shear flow is to comply with Pt 13, Sub-Pt. 1, Ch. 5, Annex 1. (H) Considering of hull girder vertical bending moment (a) The hull girder vertical bending moment is adjusted after adjusting the shear force. (b) In the analysis of the vertical bending moment, the target hull girder vertical bending moment is the maximum vertical bending moment that can occur at the center of the mid hold in the finite element model. The target value of the hull girder vertical bending moment is obtained as follows. $M_{v-targ} = M_s + M_w$

Present	Amendments
where M_s : vertical bending moment in still water (kNm) M_w : wave bending moment according to **P**t 3, Ch. 3 Table 3.3.1 (kNm) (C) The distribution of hull girder bending moments caused by local loads applied to the model is calculated using simple beam theory in accordance with Pt. 13-1 Ch. 7 Sec. 2 of the Rles. (D) If the target vertical bending... 〈omitted〉 (E) The bending moment adjustment procedure for the fore and aft part structural analysis is to comply with the requirements in Pt. 13 Ch. 7 Sec. 2. and 4.4.9 of the Rules. (5) Load case 〈omitted〉	where M_s : vertical bending moment in still water (kNm) M_w : wave vertical bending moment according to Pt 3, Ch. 3 Table 3.3.1 (kNm) (c) The distribution of hull girder vertical bending moments caused by local loads applied to the model is calculated using simple beam theory in accordance with Pt. 13, Sub-Pt. 1, Ch. 7, Sec. 2. (d) If the target vertical bending... 〈same as the current Guidance〉 (e) The vertical bending moment adjustment procedure for the fore and aft part structural analysis is to comply with the requirements in Pt. 13, Sub-Pt. 1, Ch. 7 Sec. 2. and 4.4.9. (I) Load case 〈same as the current Guidance〉 (5) Consideration of dynamic shear loads in beam sea condition (A) General (a) In order to verify the structural integrity of transverse members under dynamic shear load due to rolling motion and high GM in beam sea condition, BSR and BSP load cases are to be applied as shown in Table 8 and Table 9. BSR and BSP load cases means as follows; - 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. - 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.

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	(b) These BSR and BSP load cases are to be applied to homogeneous loading with $\gamma = 3.0\ (\mathrm{ton/m^3})$ of high density cargo for mid hold model only. The loading pattern described in No. 1 condition of Table 5. should be applied. (B) Applied loads (a) The symbol's definitions in BSR load cases are following; T_θ : The roll period, in s, is to be taken as; $T_\theta = \dfrac{2.3\pi k_r}{\sqrt{g\,GM}}$. where; k_r : Roll radius of gyration, in m, in the considered loading condition. 0.25B is to be adopted unless provided in the loading manual. GM : Metacentric height, in m, in the considered loading condition. 0.20B is to be adopted unless provided in the loading manual. g : $9.81\,m/s^2$ θ : The roll angle, in deg, is to be taken as ; $\theta = \dfrac{9000(1.25-0.025\,T_\theta)f_{BK}}{(B+75)\pi}$ where; f_{BK} : To be taken as: $f_{BK} = 1.2$ for ships without bilge keel. $f_{BK} = 1.0$ for ships with bilge keel. T_ϕ : The pitch period, in s, is to be taken as: $T_\phi = \sqrt{\dfrac{2.6\pi L}{g}}$ ϕ : The pitch angle, in deg, is to be taken as: $\phi = 1350\,L^{-0.94}\left\{1+\dfrac{3.0}{\sqrt{gL}}\right\}$ a_0: Acceleration parameter, to be taken as: $a_0 = (1.58-0.47C_B)\left(\dfrac{2.4}{\sqrt{L}}+\dfrac{34}{L}-\dfrac{600}{L^2}\right)$ x, y, z : X, Y and Z coordinates, in m, of the considered point at the intersection among the longitudinal plane of symmetry of ship, the aft end of L and the baseline.

Present	Amendments
	R: Vertical coordinate, in m, of the ship rotation centre, to be taken as: $$R = \min\left(\frac{D}{4} + \frac{T_{LC}}{2},\ \frac{D}{2}\right)$$ T_{SC} : Scantling draught f_{β} : Heading correction factor, to be taken as: $f_{\beta} = 0.8$ for BSR and BSP load cases for the extreme sea loads design load scenario. (b) The accelerations due to ship motion are follows; Surge acceleration due to surge, in $\mathrm{m/s^2}$, is to be taken as: $a_{surge} = 0.25\ a_0\ g$ Sway acceleration due to sway, in $\mathrm{m/s^2}$, is to be taken as: $a_{sway} = 0.55\ a_0\ g$ Heave (vertical) acceleration due to heave, in $\mathrm{m/s^2}$, is to be taken as: $a_{heave} = a_0\ g$ Roll acceleration, a_{roll}, in $\mathrm{rad/s^2}$, is to be taken as: $$a_{roll} = \theta \frac{\pi}{180}\left(\frac{2\pi}{T_{\theta}}\right)^2$$

Present	Amendments
	Table 6 Ship responses for BSR and BSP load cases

Table 6 Ship responses for BSR and BSP load cases

Loadcase	BSR-1P	BSR-2P	BSR-1S	BSR-2S	BSP-1P	BSP-2P	BSP-1S	BSP-2S
EDW	BSR				BSP			
Heading	Beam				Beam			
Effect	Max. roll				Max. pressure at waterline			
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	Stbd tensile	Port tensile	Port tensile	Stbd tensile	Stbd tensile	Port tensile	Port tensile	Stbd tensile
Surge	-	-	-	-	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}	W.S L.S	W.S L.S	L.S W.S	L.S W.S	W.S L.S	W.S L.S	L.S W.S	L.S W.S
Heave	Down	Up	Down	Up	Down	Up	Down	Up
a_{heave}	W.S L.S	W.S L.S	L.S W.S	L.S W.S	W.S L.S	W.S L.S	L.S W.S	L.S W.S
Roll	Portside down	Portside up	Starboard down	Starboard up	Portside up	Portside down	Starboard up	Starboard down
a_{roll}	W.S L.S	W.S L.S	L.S W.S	L.S W.S	W.S L.S	W.S L.S	L.S W.S	L.S W.S
Pitch	Bow up	Bow down	Bow up	Bow down	Bow up	Bow down	Bow up	Bow down
a_{pitch}								

Note)
VWBM & VWSF : Vertical bending moment and shear force are to be taken as defined in Pt. 3, Ch 3.
HWBM : Horizontal bending moment is to be taken as defined in (B)
WS : Weather side, side of the ship exposed to the incoming waves.
LS : Lee side, sheltered side of the ship away from the incoming waves.

Present	Amendments

Table 9 Load combination factors, LCFs for BSR and BSP load cases

Load component		LCF	BSR-1P	BSR-2P	BSR-1S	BSR-2S	BSP-1P	BSP-2P	BSP-1S	BSP-2S
Hull girder loads	M_{wv}	C_{WV}	-0.1	0.1	-0.1	0.1	-0.4	0.4	-0.4	0.4
	Q_{wv}	C_{QW}	0.1	-0.1	0.1	-0.1	0.3	-0.3	0.3	-0.3
	M_{wh}	C_{WH}	0.4	-0.4	-0.4	0.4	0.4	-0.4	-0.4	0.4
Longitudinal accelerations	a_{surge}	C_{XS}	0.0	0.0	0.0	0.0	-0.15	0.15	-0.15	0.15
	$a_{pitch-x}$	C_{XP}	0.4	-0.4	0.4	-0.4	0.45	-0.45	0.45	-0.45
	$g sin\phi$	C_{XG}	-0.3	0.3	-0.3	0.3	-0.25	0.25	-0.25	0.25
Transverse accelerations	a_{sway}	C_{YS}	0.5	-0.5	-0.5	0.5	0.4	-0.4	-0.4	0.4
	a_{roll-y}	C_{YR}	1.0	-1.0	-1.0	1.0	1.0	-1.0	-1.0	1.0
	$g sin\theta$	C_{YG}	-1.0	1.0	1.0	-1.0	-0.9	0.9	0.9	-0.9
Vertical accelerations	a_{heave}	C_{ZH}	-0.25	0.25	-0.25	0.25	0.5	-0.5	0.5	-0.5
	a_{roll-z}	C_{ZR}	1.0	-1.0	1.0	-1.0	1.0	-1.0	-1.0	1.0
	$a_{pitch-z}$	C_{ZP}	0.4	-0.4	0.4	-0.4	0.45	-0.45	0.45	-0.45

Pitch acceleration, a_{pitch}, in $\mathrm{rad/s^2}$, is to be taken as:

$$a_{pitch} = 1.5\,\phi \frac{\pi}{180}\left(\frac{2\pi}{T_\phi}\right)^2$$

The accelerations used to derive the inertial loads at any position are defined with respect to the ship fixed coordinate system. Hence the acceleration values include the gravitational acceleration components due to the instantaneous roll angles.

The longitudinal acceleration at any position for each dynamic load case, in $\mathrm{m/s^2}$, is to be taken as:

$$a_X = -C_{XG}\, g \sin\phi + C_{XS}\, a_{surge} + C_{XP}\, a_{pitch}(z-R)$$

The transverse acceleration at any position for each dynamic load case, in $\mathrm{m/s^2}$, is to be taken as:

$$a_Y = C_{YG}\, g \sin\theta + C_{YS}\, a_{sway} - C_{YR}\, a_{roll}(z-R)$$

The vertical acceleration at any position for each dynamic load case, in $\mathrm{m/s^2}$, is to be taken as:

$$a_Z = C_{ZH}\, a_{heave} + C_{ZR}\, a_{roll}\, y - C_{ZP}\, a_{pitch}(x - 0.45L)$$

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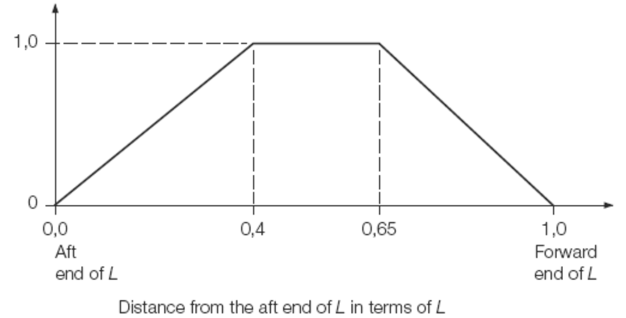
	(c) Hull girder loads The wave induced vertical bending moment and shear force are to be taken as defined in (G) and (H) in (4). The horizontal wave bending moment at any longitudinal position, in kNm, is to be taken as: $$M_{wh} = f_{nlh}\left(0.31+\frac{L}{2800}\right)f_m C_w L^2 T_{SC} C_B$$ where: f_{nlh} : Coefficient considering nonlinear effect to be taken as: $f_{nlh}=0.9$ f_m : Distribution factor is to be taken as;  C_w: Wave coefficient, in m, to be taken as: $C_w = 10.75-\left(\frac{300-L}{100}\right)^{1.5}$ for $90 \le L \le 300$ $C_w = 10.75$ for $300 < L \le 350$ $C_w = 10.75-\left(\frac{L-350}{150}\right)^{1.5}$ for $350 < L \le 500$ (d) Hydrodynamic pressure for BSR load cases The wave 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 10, Fig 13 and 14. Total external pressure is to be calculated by P_S+P_W, P_S means still water hydrostatic pressure for considered loading condition.

Present	Amendments

Table 10 Hydrodynamic pressures for BSR load cases

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

where;

For BSR-1P and BSR-2P load cases:

$$P_{BSR} = f_\beta f_R f_{nl}\, k_a\, k_p \left[9\, y \sin\theta + \left(-0.95 f_{yB} - 2 f_{zT} - 0.2\right) C_W \sqrt{\frac{L + \lambda - 125}{L}}\right]$$

For BSR-1S and BSR-2S load cases:

$$P_{BSR} = f_\beta f_R f_{nl}\, k_a\, k_p \left[-9\, y \sin\theta + \left(-0.95 f_{yB} - 2 f_{zT} - 0.2\right) C_W \sqrt{\frac{L + \lambda - 125}{L}}\right]$$

f_R : Factor related to the operational profile, to be taken as :

$f_R = 0.85$

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

$f_{nl} = 1.0$

$k_a = k_{a-WL}\, f_{yB} + k_{a-CL}\left(1 - f_{yB}\right)$

$k_p = k_{p-WL}\, f_{yB} + k_{p-CL}\left(1 - f_{yB}\right)$

Phase coefficient, k_{a-WL}, k_{a-CL}, k_{p-WL} and k_{p-CL} are to be taken as following;

Intermediate values are to be interpolated.

- Port side of BSR-1P and BSR-2P or starboard side BSR-1S and BSR-2S

f_{xL}	0.0	0.2	0.35	0.5	0.7	1.0
k_{a-WL}	0.4	0.9	1.05	1.0	0.9	0.6

f_{xL}	0.0	0.15	0.3	0.6	0.85	1.0
k_{p-WL}	2.0	2.0	1.6	1.0	1.0	-1.0

Present	Amendments
	- Port side of BSR-1S and BSR-2S or starboard side BSR-1P and BSR-2P

f_{xL}	0	0.3	0.5	0.65	0.8	1.0
k_{a-WL}	0.2	0.75	1.	1.1	1.0	0.8

f_{xL}	0.0	0.1	0.2	0.4	0.6	0.8	1.0
k_{p-WL}	0.95	0.9	0.7	1.0	1.0	0.9	1.0

- Center line

f_{xL}	0.0	0.2	0.4	0.6	0.85	1.0
k_{a-CL}	1.5	1.5	1.0	1.0	2.0	2.0

f_{xL}	0.0	0.2	0.5	0.7	1.0
k_{p-CL}	-0.5	-0.5	1.0	1.0	1.0

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_{zT} : Ratio between Z-coordinate of the load point and T_{SC}, to be taken as:

$f_{zT} = \frac{z}{T_{SC}}$, but not greater than 1.0.

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

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

$f_{yB} = 0$, when $B_x = 0$

B_x : Moulded breadth at the waterline, in m, at the considered cross section.

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

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

$P_{W,WL}$: Wave pressure at the waterline, $\mathrm{kN/m^2}$, for the considered dynamic load case.

$P_{W,WL} = P_{BSR}$ for $y = B_x/2$ and $z = T_{SC}$

h_W : Water head equivalent to the pressure at waterline, in m, to be taken as:

$$h_w = \frac{P_{W,WL}}{\rho g}$$

Present	Amendments
	(see below)

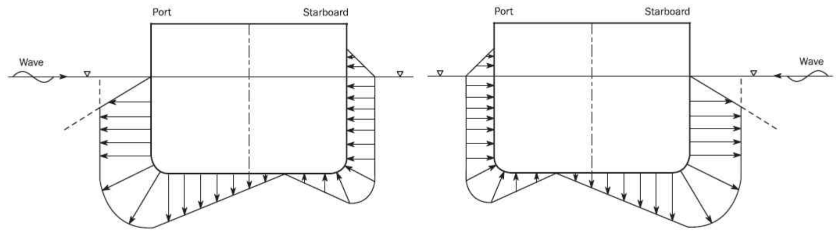


Fig 13 Transverse distribution of dynamic pressure for BSR-1P(left)와 BSR-1S(right) load cases

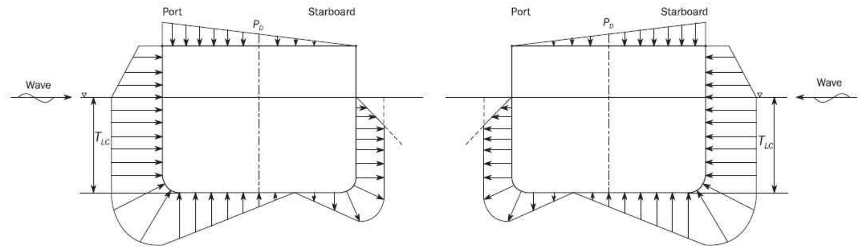


Fig 14 Transverse distribution of dynamic pressure for BSR-2P(left)와 BSR-2S(right) load cases

(e) Hydrodynamic pressure for BSP load cases

The wave pressures, P_W, for BSP-1 and BSP-2 load cases, at any load point, in $\mathrm{kN/m^2}$, are to be obtained from Table 11, Fig 16 and 17. Total external pressure is to be calculated by $P_S + P_W$, P_S means still water hydrostatic pressure for considered loading condition.

Table 11 Hydrodynamic pressures for BSP load cases

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

Present	Amendments
	where;

$$P_{BSP} = 1.25 f_\beta f_R f_{nl} k_a k_p f_{yz} C_W \sqrt{\frac{L+\lambda-125}{L}}$$

f_R : Factor related to the operational profile, is defined in (d)
f_{nl} : Coefficient considering non-linear effect, is taken as;
- For extreme sea loads design load scenario :
  - $f_{nl} = 0.6$ at $f_{xL} = 0$
  - $f_{nl} = 0.8$ at $f_{xL} = 0.3$
  - $f_{nl} = 0.8$ at $f_{xL} = 0.7$
  - $f_{nl} = 0.6$ at $f_{xL} = 1$

Transverse Position	BSP-1P and BSP-2P	BSP-1S and BSP-2S
$y \geq 0$	$f_{yz} = 10\frac{z}{T_{SC}} + 8.5 f_{yB} + 0.1$	$f_{yz} = -1.3\frac{z}{T_{SC}} - 4 f_{yB} + 0.1$
$y < 0$	$f_{yz} = -1.3\frac{z}{T_{SC}} - 4 f_{yB} + 0.1$	$f_{yz} = 10\frac{z}{T_{SC}} + 8.5 f_{yB} + 0.1$

λ: Wave length of the BSP load case, in m, to be taken as:
$\lambda = 0.5L$

$k_a = k_{a-WL} f_{yB} + k_{a-CL}(1 - f_{yB})$
$k_p = k_{p-WL} f_{yB} + k_{p-CL}(1 - f_{yB})$
Phase coefficient, k_{a-WL}, k_{a-CL}, k_{p-WL} and k_{p-CL} are to be taken as following;
Intermediate values are to be interpolated.
- Port side of BSP-1P and BSP-2P or starboard side BSP-1S and BSP-2S

f_{xL}	0.0	0.2	0.35	0.5	0.6	0.8	0.9	1
k_{a-WL}	0.3	0.9	1.1	1.0	0.9	0.9	0.7	0.5

f_{xL}	0.0	0.2	0.4	0.9	1.0
k_{p-WL}	1.0	0.9	1.0	1.0	0.5

- Port side of BSP-1S and BSP-2S or starboard side BSP-1P and BSP-2P

f_{xL}	0	0.1	0.2	0.3	0.5	0.7	0.8	1.0
k_{a-WL}	0.2	0.3	0.5	0.8	1.0	1.15	1.1	0.9

f_{xL}	0.0	0.05	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0
k_{p-WL}	0.5	1.2	-0.4	-0.1	0.6	1.0	0.9	0.3	0.8	1.0

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- Center line

f_{xL}	0.0	0.2	0.4	0.6	0.85	1.0
k_{a-CL}	1.0	1.0	1.0	1.0	2.0	2.0

f_{xL}	0.0	0.35	0.5	0.8	1.0
k_{p-CL}	1.6	1.6	1.0	1.5	1.0

$P_{W,WL}$: Wave pressure at the waterline, $\mathrm{kN/m^2}$, for the considered dynamic load case.
$P_{W,WL} = P_{BSP}$ for $y = B_x/2$ and $z = T_{SC}$
Other parametric symbols are defined in (d).

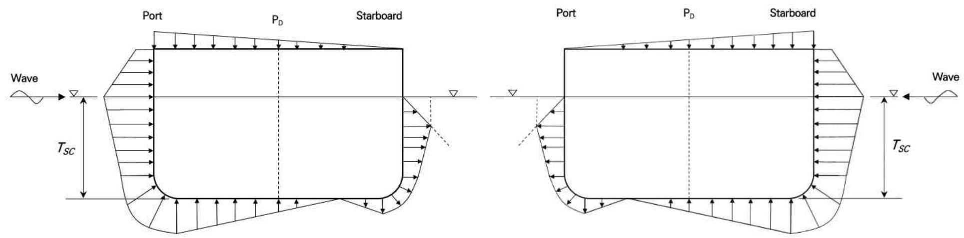


Figure 15 Transverse distribution of dynamic pressure for BSP-1P(left)와 BSP-1S(right) load cases

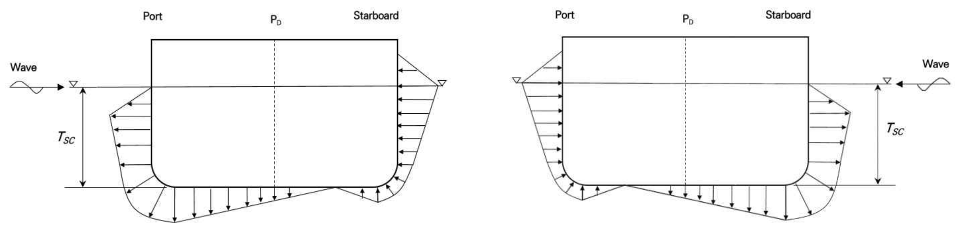


Figure 16 Transverse distribution of dynamic pressure for BSP-2P(left)와 BSP-2S(right) load cases

(e) Internal cargo loads

The cargo pressure due to ore cargo acting on any load point of a cargo hold boundary, in kN/m^2, is to be taken as:

$$P_{in} = w + P_{bd}$$

Static pressure, w in kN/m^2, due to ore cargo is defined in (4), (A), (a) (ii). Dynamic pressure, P_{bd} in kN/m^2, due to ore cargo to be taken as:

Present	Amendments
	$P_{bd} = f_\beta \gamma [0.25 a_x (x_G - x) + 0.25 a_y (y_G - y) + K_C a_z (z_C - z)]$ (kN/m^2) for $z < z_C$ $P_{bd} = 0$ (kNm^2), for $z > z_C$ where; a_x, a_y, a_z : Longitudinal, transverse and vertical accelerations, in m/s^2, at x_G, y_G, z_G. x_G, y_G, z_G : X, Y and Z coordinates, in m, of the volumetric centre of gravity of fully filled cargo hold, i.e. V_{Full}, considered with respect to the reference coordinate system. In case of partially filled cargo hold, x_G, y_G, z_G to be taken as follows: x_G, y_G : Volumetric centre of gravity of the cargo hold. $z_G = h_{DB} + h_C/2$, h_{DB} and h_c are defined in (4), (A), (a). V_{Full} : Volume, in m^3, of cargo hold up to top of the hatch coaming, taken as: $V_{Full} = V_H + V_{HC}$, V_H and V_{HC} are defined in (4), (A), (a). z_c : Height of the upper surface of the cargo above the baseline in way of the load point, in m, to be taken as: $z_c = h_{DB} + h_c$ K_C : Coefficient is defined in (4), (A), (a) (ii). The shear load pressures, $P_{bs-s} + P_{bs-d}$, are to be considered for the hopper tank and the lower stool plating in addition to the ore cargo pressures when the load point elevation, z, is lower or equal to z_c. Static shear load, P_{bs-s}, due to gravitational forces acting on hopper tanks and lower stools plating, is defined as w_{sh} of (4), (A), (a) (ii). The dynamic shear load pressure, P_{bs-d} (positive downward to the plating) due to ore cargo forces on the hopper tank and lower stool plating, in kN/m^2, is to be taken as: $P_{bs-d} = f_\beta \gamma a_z \dfrac{(1-K_C)(z_C - z)}{\tan\beta}$ Additionally, the dynamic shear load pressures, P_{bs-dx} and P_{bs-dy}, due to ore cargo forces acting along the inner bottom plating, in kN/m^2, are to be taken as: $P_{bs-dx} = -0.75 f_\beta \gamma a_x h_C$, in the longitudinal direction (positive to bow) $P_{bs-dy} = -0.75 f_\beta \gamma a_y h_C$, in the transverse direction (positive to port)

<table>
<tr><th>Present</th><th>Amendments</th></tr>
<tr><td>(6) Allowable stresses
The stress calculated by the direct strength analysis using the dimension including the corrosion margin should meet the following criteria, and the evaluation range is shown in Fig 13.
$\sigma_{act} < \sigma_{allow}$
$\sigma_{act} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau^2}$
$\sigma_{allow} = \eta \sigma_{yield}$
$\sigma_{yield} = 235/K (\mathrm{N/mm^2})$

where
η : Yield strength correction factor
$\eta = 0.9$, longitudinal strength member at port and navigation condition

$\eta = 0.72$, transverse strength member at port and navigation condition

K : Material factor (see Table 8)
σ_x : Normal stress in x-direction of element coordinate system
σ_y : Normal stress in y-direction of element coordinate system\
τ : Sheer stress on the face in x-y direction of element coordinate system

(7) Buckling

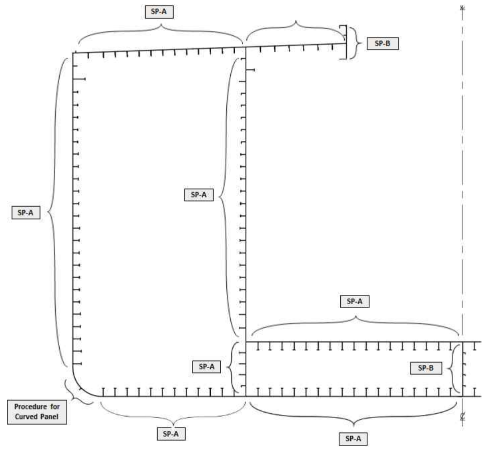
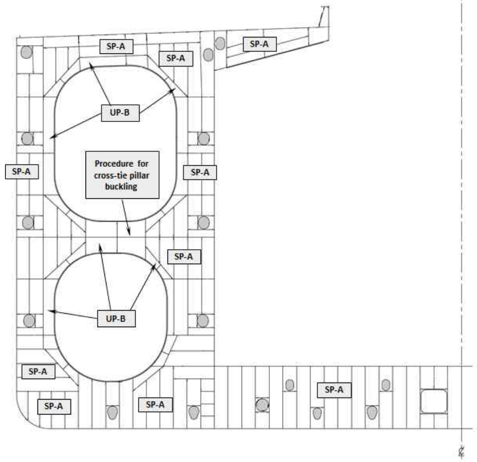
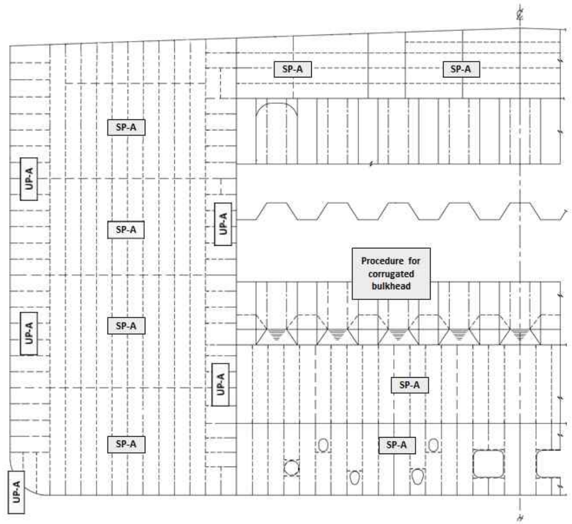
The detailed calculation of buckling strength is to be in accordance with Pt. 11 Ch. 6 Annex 1 of the Rules and the corrosion addition and judgments of buckling strength for buckling evaluation are as follows;

〈omitted〉</td>
<td>(6) Allowable stresses
The stress calculated by the direct strength analysis using the dimension including the corrosion margin should meet the following criteria, and the evaluation range is shown in Fig 17.

$\sigma_{act} < \sigma_{allow}$
$\sigma_{act} = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau^2}$
$\sigma_{allow} = \eta \sigma_{yield}$
$\sigma_{yield} = 235/K (\mathrm{N/mm^2})$

where;
η : Yield strength correction factor
$\eta = 0.9$: for longitudinal strength member of port condition and sea going condition defined in (4) and for all structural members of load conditions defined in (5).
$\eta = 0.72$: transverse strength member of port condition and sea going condition except load cases defined in (5).
K: Material factor (see Pt.3 Annex 3-2 Table 5)
σ_x: Normal stress in x-direction of element coordinate system
σ_y: Normal stress in y-direction of element coordinate system\
τ : Shear stress on the face in x-y direction of element coordinate system

(7) Buckling
The plate panel of hull structure is to be modelled as stiffened panel, SP or unstiffened panel, UP. Method A and Method B as defined in Pt. 13, Sub-Pt 1, Ch. 8 are to be used according to Fig 18 to Fig 20.
The detailed calculation of buckling strength is to be in accordance with Pt 13, Sub-Pt 1, Ch. 8 and the corrosion addition and judgments of buckling strength for buckling evaluation are as shown in Table 12 and 13. The 1.0 of buckling factor should be applied to all structural members for load cases to reflect dynamic shear loads in beam sea condition defined in (5).
〈same as the current Guidance〉</td></tr>
</table>

Present	Amendments
	 Fig 18 Longitudinal plates in VLOC  Fig 19 Transverse web frame in VLOC  Fig 20 Plate panel of transverse bulkhead in VLOC

Present	Amendments
(8) Local fine mesh analysis (A) The list of structural details of the fine mesh analysis are as follows. (a) hopper knuckle (b) openings (c) connection between transverse bulkhead and longitudinal stiffener of deck and double bottom (d) connection of corrugated bulkhead and the adjacent structure (e) hatch corner (B) For other high stress areas in which the stress (σ_{act}) calculated by direct strength analysis is greater than 95% of the allowable stress (σ_{allow}), additional analysis should be performed at the discretion of the Society. (C) The range of the local fine mesh analysis should be at least 10 elements in all directions from the area under consideration. (D) All plates and stiffeners within the local fine mesh analysis range should be represented by shell elements. (E) For element corners, crooked elements less than 45 degrees or greater than 135 degrees should be avoided. (F) The aspect ratio of the element should be kept as close as possible to 1, and should be less than 3. (G) Mesh size of local fine mesh analysis should be such that it is capable of expressing the structure well and is less than the longitudinal spacing. (H) When performing local .. 〈Omitted〉 (I) Allowable stresses for local fine mesh analysis should meet the following criteria. 〈omitted〉	(8) Local fine mesh analysis (A) Application (a) The list of structural details of the fine mesh analysis are as follows. - hopper knuckle - openings - connection between transverse bulkhead and longitudinal stiffener of deck and double bottom - connection of corrugated bulkhead and the adjacent structure - hatch corner (b) For other high stress areas in which the stress (σ_{act}) calculated by direct strength analysis is greater than 95% of the allowable stress (σ_{allow}), additional analysis should be performed at the discretion of the Society. (B) Fine mesh of the structure (a) The range of the local fine mesh analysis should be at least 10 elements in all directions from the area under consideration. (b) All plates and stiffeners within the local fine mesh analysis range should be represented by shell elements. (c) For element corners, crooked elements less than 45 degrees or greater than 135 degrees should be avoided. (d) The aspect ratio of the element should be kept as close as possible to 1, and should be less than 3. (e) Mesh size of local fine mesh analysis should be such that it is capable of expressing the structure well and is less than the longitudinal spacing. (f) When performing local .. 〈same as the current Guidance〉 (C) Allowable stress for local fine mesh analysis (a) Allowable stresses for local fine mesh analysis should meet the following criteria. 〈same as the current Guidance〉

Present	Amendments
where η: Yield strength correction factor $\eta = 0.9$, longitudinal strength member of port condition and sea going condition $\eta = 0.72$, transverse strength member of port condition and sea going condition η_{allow} : Local fine mesh analysis correction factor 〈omitted〉 (J) When evaluating the corner of the opening, the average stress can be evaluated as follows. 〈omitted〉 (9) Cargo Mass Curves 〈omitted〉	where; η : Yield strength correction factor as defined in (6) η_{allow} : Local fine mesh analysis correction factor 〈same as the current Guidance〉 (b) When evaluating the corner of the opening, the average stress can be evaluated as follows. 〈same as the current Guidance〉 (9) Cargo Mass Curves 〈same as the current Guidance〉

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