Amendments of Guidance

(External opinion inquiry)

Pt. 7 Ships of Special Service

Annex 7-2 Guideline for Guidance for the Container Securing Arrangements

2018.

Hull Rule Development Team

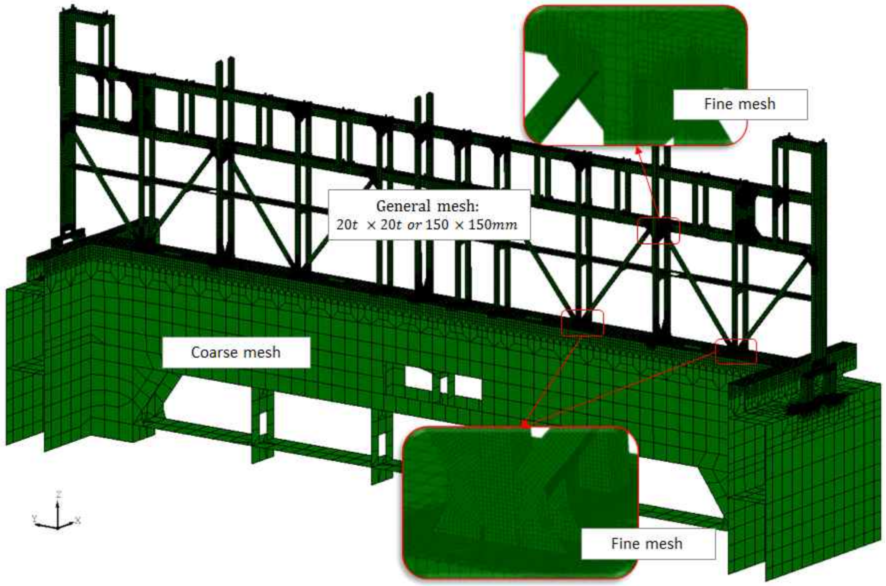
Present	Amendment	Note
Annex 7-2 Guidance for the Container Securing Arrangements **1. ~ 3. <omission>** **4. Arrangements for stowage on exposed decks without cell guides** (1) ~ (3) <omission> (4) Containers in more than three tiers (A) ~ (H) <omission> (I) If the carriage of one or more tiers of 20 ft containers being overstowed with at least one tier of 40 ft containers, so called 'Russian Stow Arrangement' is desired, the following requirements apply. (a) At the 20 ft gap the containers are to be secured by means of midlocks, whereas the fore and aft ends are to be secured by twistlocks and if necessary supplemented by lashing rods. (b) The 40 ft overstow container is to be secured by twistlocks or if necessary with a combination of twistlocks and lashing rods. The stack is to be assessed in a two step procedure as follows: (i) For location at the 40 ft ends the entire mixed stack is to be considered as a 40 ft stack. The weights of the 40 ft containers are to be considered in the calculations. For the tiers of 20 ft containers, the weight of one 20 ft container is to be taken as the basis for the calculation at each tier. (ii) For the location of the 20 ft tiers at the mid bay position the assessment is to be carried out as for an unlashed stack. The 40 ft overstow container does not need to be taken into consideration. (5) , (6) <omission> **5. ,6 <omission>**	**Annex 7-2 Guidance for the Container Securing Arrangements** **1. ~ 3. <same as current>** **4. Arrangements for stowage on exposed decks without cell guides** (1) ~ (3) <same as current> (4) Containers in more than three tiers (A) ~ (H) <same as current> (I) If the carriage of one or more tiers of 20 ft containers being overstowed with at least one tier of 40 ft containers, so called 'Russian Stow Arrangement' is desired, the following requirements apply. (a) At the 20 ft gap the containers are to be secured by means of midlocks or full automatic twistlocks, whereas the fore and aft ends are to be secured by twistlocks and if necessary supplemented by lashing rods. *(2018-2)* (b) The 40 ft overstow container is to be secured by twistlocks or if necessary with a combination of twistlocks and lashing rods. The stack is to be assessed in a two step procedure as follows: (i) For location at the 40 ft ends the entire mixed stack is to be considered as a 40 ft stack. The weights of the 40 ft containers are to be considered in the calculations. For the tiers of 20 ft containers, the weight of one 20 ft container is to be taken as the basis for the calculation at each tier. (ii) For the location of the 20 ft tiers at the mid bay position the assessment is to be carried out as for an unlashed stack. The number of stacks should be determined taking into account the deformation of the hatch cover. The 40 ft overstow container does not need to be taken into consideration. *(2018-2)* (5) , (6) <same as current> **5. ,6 <same as current>**	

Present	Amendment	Note
7. Ship structure (1) General (A) The ship structure and hatch covers in way of fixed cargo securing fittings are to be strengthened as necessary. (B) A breakwater may be required. (2) Strength (A) The SWL of the fixed cargo securing fitting is to be used as the design load when approving the weld attachments and the support structure of the fixed cargo securing fitting. (B) For container securing arrangements, the design load when approving the weld attachment and supporting structure is to be calculated in accordance with **8**. (C) When considering the loads, all expected directions of operation are to be taken into account. (D) Stresses induced in the weld attachments, supporting structure, cell guides, lashing bridges and other structures serving as fixed cargo securing points, determined using the design loads as defined in (A) to (C), are not to exceed the permissible values given in **Table 18**.	**7. Container support structure (2018-2)** (1) General (A) Drawings for lashing bridges, cell guides, container supports and other container support structures are to be submitted to the Society for approval. (B) The lower part of fixed container securing system of hatch covers and hull structures should be suitably reinforced (C) FE(Finite Element) method or Grillage analysis can be used for the strength evaluation. The modeling and evaluation should be of a gross scantling, and the element size should be such that the behavior of the structure can be faithfully reproduced. (D) The evaluation of the hatch cover strength is to be in accordance with the requirements in **Pt 4, Ch 2** of the Rules. (2) Structural strength evaluation (A) Structure modelling (a) Model extent (i) The model for strength evaluation should include at least hull structure until first stringer in vertical direction and one web frame in longitudinal direction from container support structure. Generally both port and starboard of the lashing bridge structure should be modelled. (ii) The strength evaluation of the lashing bridges on fore part, midship and after part should be carried out. And addition strength evaluations may be required when deemed necessary by the Society. (b) FE model (i) The FE model follows the right-handed coordinate system as shown in **Table 1.**	

Present	Amendment	Note
	Table 1 Coordinate system (2018-2) **Coordinate** / **Direction** / **Note** x / longitudinal / positive forwards y / transverse / positive to port from centerline z / vertical / positive to upward from base line (ii) In general, plate elements should be used and mesh size of the lashing bridge should be approximately $20t \times 20t$ or $150\text{mm} \times 150\text{mm}$ which is smaller.(t is the thinnest plate thickness in mm). (iii) The element size of fine mesh area should not be greater than $50 \times 50\text{mm}$ and should be sufficiently small to be able to represent the shape of the structure and to limit stress concentration. In general, the members which have a stress variation in the depth direction should be meshed into 3 sub depths. The minimum required element size of fine mesh area need not be less than the thickness of the plate.	

Table 1 Coordinate system (2018-2)

Coordinate	Direction	Note
x	longitudinal	positive forwards
y	transverse	positive to port from centerline
z	vertical	positive to upward from base line

Present	Amendment	Note
	 **Fig. 2 Example of element splitting of lashing bridge (2018-2)** (B) Boundary conditions A suitable boundary condition that can express the behavior of an actual structure should be applied to the structural model. (C) Loads (a) Design loads (i) For the supporting structure of the container securing system, the safe working load(SWL) of the container securing system can be used as the design loads. (ii) The design loads can be calculated according to **8.** by applying the container arrangement layout of the container arrangement plan. (iii) When considering the load, all predictable operating directions should be considered.	

Present	Amendment	Note

(b) Combination of design loads

(i) Lashing bridge

The following combinations of design loads shall be considered:

- containers loaded in both forward and aft bays of lashing bridge(transverse load maximum condition)
- containers loaded in the forward bay of the lashing bridge(forward direction maximum load condition)
- containers loaded in the aft bay of the lashing bridge(aft direction maximum load condition)

The design loads should be the value calculated according to the container stowage arrangement. Where SWLs are used as design loads, the values shown in Fig.3 can be used.

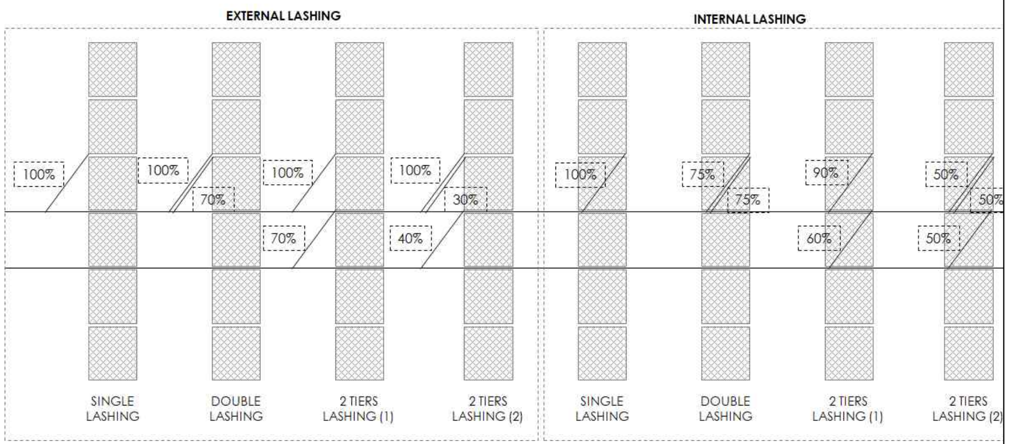


Fig.3 Examples for load distribution of SWLs as design loads (2018-2)

Present	Amendment	Note
	(ii) Cell guide The design load combination shown in **Table 2** below should be considered and the conditions for loading the high cubic container should be considered. For cell guides installed on the deck, wind loads should be taken into account.	

Table 2 Design load combination of cell guide (2018-2)

Load condition	Transverse load	Longitudinal load	Vertical load
Load combination 1	apply	not apply	not apply
Load combination 2	not apply	apply	not apply

(iii) Container stanchion
The design load combinations in **Table 3** below should be considered. For container stanchion in the outermost stack, the wind loads should be considered.

Table 3 Design load combination of container stanchion (2018-2)

Load condition	Transverse load	Longitudinal load	Vertical load
Load combination 1	apply(inside)	not apply	apply(tension)
Load combination 2	apply(outside)	not apply	apply(compression)

(iv) Other container support structures
It shall be deemed appropriate by the Society.

Present	Amendment	Note
Table 1 Permissible stress values Stress / Permissible stress (N/m^2) Normal stress (bending, tension, compression): $0.67\ \sigma_0$ Shear stress: $0.4\ \sigma_0$ Combined stress: $0.86\ \sigma_0$ σ_0 : specified minimum yield stress (N/m^2)	(D) Permissible stress (a) Stresses of container support structures are not to exceed the permissible values given in **Table 4**. **Table 4 Permissible stress values *(2018-2)*** Stress / Permissible stress (N/m^2) Normal stress (bending, tension, compression): $0.8\ \sigma_0$ Shear stress: $0.46\ \sigma_0$ Combined stress: $0.9\ \sigma_0$ (1) σ_0 : specified minimum yield stress (N/m^2) (1) : The permissible stress may be alleviated up to 1.2 σ_0 for stress concentration part of fine mesh area. (E) Buckling strength (a) The buckling strength evaluation should be performed for the members with stress derived from the FE analysis according to Pt13, Ch8 of the Rule. $\eta_{act} < \eta_a$ η_{act} : Buckling usage factor obtained from **Pt13 Ch8 Sec5 [2.2.1] and [3.1]** of the Rule η_a : allowable buckling usage factor plate of platform : 0.9 strut and piller : 0.67	

Present	Amendment	Note
	(F) Stiffness of lashing bridge (a) The maximum transverse displacement of the lashing bridge load operating point should not exceed the following values; - 1 tier lashing bridge : 10 mm - 2 tier lashing bridge : 25 mm - more than 3 tier lashing bridge : 35 mm (3) Vibration analysis (A) FE model (a) The lashing bridge should be properly designed so that the natural frequencies of the structure avoid resonance with the excitation frequencies of the engine and the propeller. (b) Where the ship is expected to operate with no containers secured to the lashing bridges, such as during sea trials, ballast voyages or empty on deck bays, the vibration evaluation of the lashing bridge should be considered. (c) In general, FE model used for the strength assessment may be used. The vibration response of the lashing bridge should be assessed at several locations, among the vessel. In particular, the lashing bridge of the aftermost part is more likely to vibrate because it is close to the propeller and main engine compartment, so the vibration response should be evaluated. (d) The structure modelling and boundary conditions for vibration evaluation are described in (2) (A) and (B). Where a global hull structure FE model is available and a global hull modal analysis is to be carried out, it is recommended that the lashing bridge models are incorporated in the global hull structure model prior to vibration analysis.	

Present	Amendment	Note
	(B) Natural frequency assessment (a) The calculated natural frequencies of the global behaviour of the lashing bridge are to satisfy the following requirements: (i) For lashing bridge structures located aft of the main machinery space, the calculated natural frequencies of the lashing bridge should not be in the range of the propeller blade frequencies associated with: - lower limit : 80% NCR minus 10% of MCR - higher limit : MCR plus 10% MCR where, NCR : the Normal Continuous Rating. In the event that the ship is expected to operate for a prolonged period at a speed lower than that provided by operating at the NCR, then the shaft speed consistent with that speed should be used instead of the NCR. MCR : the Maximum Continuous Rating (ii) For lashing bridge structures adjacent to the engine room of ships with slow speed diesel engines, the calculated natural frequencies should not be in the above range for frequencies associated with large engine forces. (b) A Campbell diagram may be used to assess the potential resonant frequencies. An example Campbell diagram is shown in **Fig. 4**. At the intersection between the first order propeller blade frequency line and the line of natural frequencies of a mode, a possible resonant condition can be found.	

Present	Amendment	Note

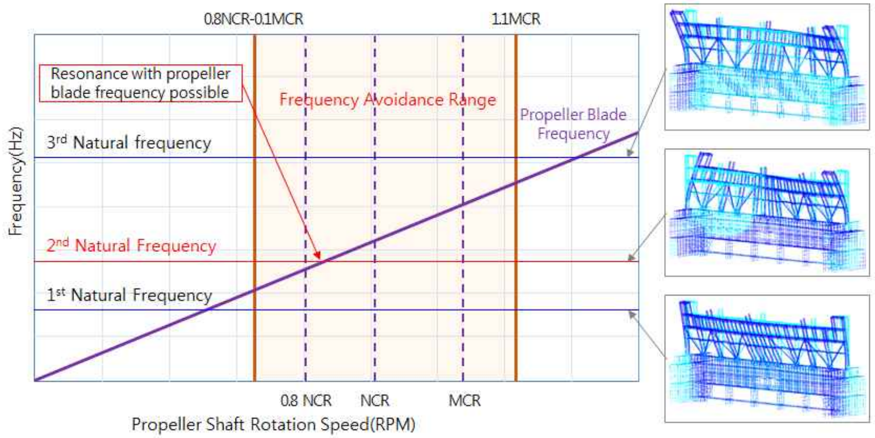
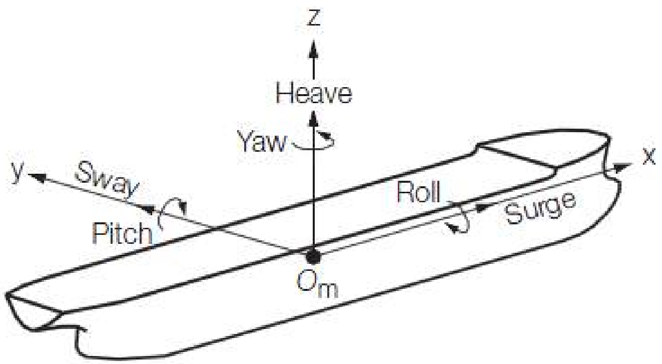


Fig. 4 Campbell diagram for Lashing Bridge vibration frequency assessment (2018-2)

(c) In order to reduce excessive vibration response due to resonance, it may be considered to apply measures such as additional structural damper system, temporary messes or the equivalent. Such measures should be discussed with the Society.

Present	Amendment	Note
8. Determination and application of forces (1) Symbols and definitions (A) The co-ordinate system used in this Annex is defined with respect to the right-hand co-ordinate system shown in **Fig 2,** with the origin at the centre of motion. For ship motions and accelerations defined in this Annex, the sign convention shown in **Fig 2** is adopted. The roll, pitch and yaw motions are defined positive clockwise as shown in the Figure.  **Fig 2 Co-ordinate system and sign convention of motions** (B) The following definitions are applicable to this Annex, except where otherwise stated: a_0 : accereration cofficient, is as following formulae : $a_0 = f_c(1.58 - 0.47C_b)\left(\frac{2.4}{\sqrt{L_{BP}}} + \frac{34}{L_{BP}} - \frac{600}{L_{BP}^2}\right)$ (m/sec²) $f_c = -\frac{L_{BP}^2}{1000000} + 0.0011L_{BP} + 0.8064$ for $L_{BP} > 240$ m $= 1.0$ for $L_{BP} \leq 240$ m a_{heave} : acceleration of ship heave motion. is as following formulae $a_{heave} = f_h\, a_0\, g$ (m/sec²)	**8. Determination and application of forces** (1) Symbols and definitions *(2018-2)* (A) Definitions and symbols of terms are as follows. ~~(Unless otherwise specified, are subject to the provisions of **Ch. 4 of** of New Container rules).~~ a_0 : acceleration coefficient, is as following formulae : $a_0 = (1.58 - 0.47C_B)\left(\frac{2.4}{\sqrt{L_{BP}}} + \frac{100}{L_{BP}} - \frac{600}{L_{BP}^2}\right)$ a_{heave} : acceleration of ship heave motion. is as following formulae $a_{heave} = 0.5 f_h a_0 g$ (m/sec²)	

Present	Amendment	Note
a_{sway} : acceleration of ship sway motion, is as following formulae $a_{sway} = 0.56\ a_0 g$ (m/sec^2) a_{surge} : acceleration of ship surge motion, is as following formulae $a_{surge} = a_0 g \left(\frac{30}{L_{BP}} + 0.17 \right)$ (m/sec^2) a_i : breadth of the i-th container (m), (see **Fig 3**) a_x, a_y, a_z : acceleration of x, y, z -direction (m/sec^2) b_i, c_i : length and height of the i-th container (m), (see **Fig 3**) d_i : height of the i-th container fitting between containers in way of vertical direction (m), (see **Fig 3**) f_h, f_p, f_r : route specific reduction factor for heave, pitch, roll motion,(see **Table 5**) g : acceleration due to gravity and is to be taken as 9.81 m/s^2 $h_i = c_i + d_i$, (see **Fig 3**)	a_{sway} : acceleration of ship sway motion, is as following formulae $a_{sway} = 0.29 a_0 g$ (m/sec^2) a_{surge} : acceleration of ship surge motion, is as following formulae $a_{surge} = 0.18 a_0 g$ (m/sec^2) a_{roll} : acceleration of ship roll motion, is as following formulae $a_{roll} = \theta \left(\frac{2\pi}{T_\theta} \right)^2$ (m/sec^2) a_{pitch} : acceleration of ship pitch motion, is as following formulae $a_{pitch} = \left(\frac{3.1}{\sqrt{gL}} + 1.4 \right) \phi \left(\frac{2\pi}{T_\phi} \right)^2$ (m/sec^2) a_i : distance between center of container corner casting (m), (see **Fig 5**) a_x, a_y, a_z : acceleration of x, y, z -direction (m/sec^2) b_i, c_i : length and height of the i-th container (m), (see **Fig 5**) d_i : height of the i-th container fitting between containers in way of vertical direction (m), (see **Fig 5**) f_h, f_p, f_r : route specific reduction factor for heave, pitch, roll motion, (see **Table 8**) g : acceleration due to gravity and is to be taken as 9.81 m/s^2 $h_i = c_i + d_i$, (see **Fig 5**)	

Present	Amendment	Note
i : index of i-th container in way of vertical direction	i : index of i-th container in way of vertical direction	
k_r : radius of roll gyration(m), generally $0.39B$	k_r : radius of roll gyration(m), generally $0.35B$	
ℓ_i : <omission>	ℓ_i : <same as current>	
n : <omission>	n : <same as current>	
x : <omission>	x : <same as current>	
y : <omission>	y : <same as current>	
z : <omission>	z : <same as current>	
A_i : <omission>	A_i : <same as current>	
$C_{a1\sim5}$: dynamic motion combination factor of each ships' motion, (see **Table 2**)	$C_{XS}, C_{YS}, C_{ZH}, C_{YR}, C_{ZR}, C_{XP}, , C_{ZP}$: dynamic motion combination factor of each ships' motion, (see **Table 5**)	
C_c :	C_c :	
C_r, C_p : dynamic motion combination factor for roll, pitch motion, (see **Table 2**)	C_{YG} , C_{XG}: dynamic motion combination factor for roll, pitch motion, (see **Table 5**)	
C_{yf}, C_{zf} : dynamic coefficient for at the location of x-direction, (see **Table 3**)	C_{yf}, C_{zf} : dynamic coefficient for at the location of x-direction, (see **Table 7**)	
E_i : elongation of lashing rod at the bottom of i-th container ($\mathrm{kN/mm^2}$)(see **Table 7**)	E_i : elongation of lashing rod at the bottom of i-th container ($\mathrm{kN/mm^2}$)(see **Table 10**)	
	GM : metacentric height (m).	
K_i : a stiffness of lashing rod at the bottom of i-th container, is as following formulae $K_i = \dfrac{E_i A_i \cos^2\theta_i}{\ell_i}$	K_i : a transverse stiffness of lashing rod at the bottom of i-th container, is as following formulae $K_i = \dfrac{E_i A_i \cos^2\theta_i}{\ell_i}$	

Present	Amendment	Note
K_c : spring constant of container's wall (see **Table 6**) L_{BP} : length between fore and after perpendiculars of the ship (m) O_m : centre of motion, to be taken on the centreline at the longitudinal centre of flotation of the ship and at a distance $\min\left(\frac{D}{4}+\frac{T_{LC}}{2},\frac{D}{2}\right)$ above the keel R : the rating, or maximum operating gross weight for which the container is certified, and is equal to the tare weight plus payload of the container (ton) T_{LC} : T_i : T_P , T_R : full period of pitch and roll of the ship (sec) V_w : wind speed (m/sec). For ships with an unrestricted worldwide service area notation a wind speed of 36 m/sec is to be applied . W_i : α : coefficient of wind force, (see **Table 2)** θ_i : lashing angle of lashing device at the bottom of i-th container, (see **Fig 8)** Θ : Angle of roll (radian) Φ : Angle of pitch (radian)	K_c : spring constant of container's wall (see **Table 9**) L_{BP} : length between fore and after perpendiculars of the ship (m) R : centre of motion, to be taken on the centreline at the longitudinal centre of flotation of the ship above the keel, $R=\frac{1}{2}(0.35B+1.4T_{LC})$ CR : the rating, or maximum operating gross weight for which the container is certified, and is equal to the tare weight plus payload of the container (ton) T_{LC} : T_i : T_θ, T_ϕ : full period of pitch and roll of the ship (sec) V_w : wind speed (m/sec). For ships with an unrestricted worldwide service area notation a wind speed of 36 m/sec is to be applied at least. W_i : α : coefficient of wind force, (see **Table 5)** θ_i : lashing angle of lashing device at the bottom of i-th container, (see **Fig 9)** θ, ϕ : Angle of roll (radian), Angle of pitch (radian)	

<table>
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(2) Acceleration of ship motion
(A) The following six dynamic motion cases are to be considered;

HSVA : Vertical acceleration in head sea
OSVA : Vertical acceleration in oblique sea
BSRL : Roll motion in beam sea
OSPA : Pitch acceleration in oblique sea
BSHA : Heave acceleration in beam sea
OSPH : Pitch motion in oblique sea

For each dynamic motion case, combination factors, shown in Table 2, are used for to calculate the acceleration. These factor sets represents an incoming wave crest or trough coming from either the port or starboard sides based on Equivalent Design Wave (EDW) that generates response values equivalent to the long-term response values of the critical load components for ship motion forces acting on containers.

(B) The ship motion angle and period for roll and pitch motions are given in Table 3. The accelerations, as below, are to be used to derive the forces for the container securing arrangements. Alternatively, the ship motion values may be derived by direct calculation methods using the same principles as those used to derive the Rule equations. The dynamic coefficients, C_{yf} and C_{zf}, are shown in Table 4 considering influence of location in x-direction.

$$a_x = -g\sin(C_p\Phi) + C_{a1}a_{surge} + C_{a5}\Phi\left(\frac{2\pi}{T_p}\right)^2\{z - O_m\}$$
$$a_y = g\sin(C_r\Theta) + C_{yf}C_{a2}a_{sway} - C_{yf}C_{a4}\Theta\left(\frac{2\pi}{T_R}\right)^2\{z - O_m\}$$
$$a_z = -g + C_{zf}C_{a3}a_{heave} + C_{zf}C_{a4}\Theta\left(\frac{2\pi}{T_R}\right)^2|y| - C_{zf}C_{a5}\Phi\left(\frac{2\pi}{T_P}\right)^2(x - 0.45L_{BP})$$
(2019)
if $|(x - 0.45L_{BP})| < 0.2L_{BP}$, then $|(x - 0.45L_{BP})| = 0.2L_{BP}$
</td>
<td>
(2) Acceleration of ship motion (2018-2)
(A) The following six dynamic motion cases are to be considered;

HSVA : Vertical acceleration in head sea
OSVA : Vertical acceleration in oblique sea
BSRL : Roll motion in beam sea
OSPA : Pitch acceleration in oblique sea
BSHA : Heave acceleration in beam sea
OSPH : Pitch motion in oblique sea

For each dynamic motion case, combination factors, shown in Table 5, are used for to calculate the acceleration.

(B) The ship motion angle and period for roll and pitch motions are given in Table 6. The accelerations, as below, are to be used to derive the forces for the container securing arrangements. Alternatively, the ship motion values may be derived by direct calculation methods using the same principles as those used to derive the Rule equations. The dynamic coefficients, C_{yf} and C_{zf}, are shown in Table 7 considering influence of location in x-direction.

$$a_x = -C_{XG}g\sin\phi + C_{XS}a_{surge} + C_{XP}a_{pitch}(z - R)$$
$$a_y = C_{YG}g\sin\theta + C_{yf}C_{YS}a_{sway} - C_{yf}C_{YR}a_{roll}(z - R)$$
$$a_z = -g + C_{zf}C_{ZH}a_{heave} + C_{zf}C_{ZR}a_{roll}|y| - C_{zf}C_{ZP}a_{pitch}(x - 0.45L)$$
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Present	Amendment	Note
(C) The sea route specific reduction factors for each dynamic component are shown in **Table 5.** The route specific reduction factor is derived from the long-term response analysis with design life 20 years for the various container ship hull form considering environmental conditions on the route. if route pattern is extraordinary, our society may consider for the factor. Specific route examples refer to **Appendix 2** (D) Wind forces are generally to be based on a maximum wind speed of 36 m/sec, acting on the outboard container stack. Wind forces are to be applied increasing ways of transverse force.	(C) The sea route specific reduction factors for each dynamic component are shown in **Table 8.** The route specific reduction factor is derived from the long-term response analysis with design life 20 years for the various container ship hull form considering environmental conditions on the route. If route pattern is extraordinary, the factor may be determined in consultation with the Society. Specific route examples refer to **Appendix 2** (D) Wind forces are generally to be based on a maximum wind speed of 36 m/sec. Wind forces are to be applied increasing ways of transverse force. (E) If a 40ft container is loaded on the outermost stack and 45ft / 48ft / 53ft container is loaded on the inner stack, the wind forces on the longitudinal protrusion is not applied. (F) If the height difference between the top of the container to which the wind forces are applied and the center of the container of the inner stack is less than 1.9 m, wind forces are not applied. For the top container on the inner stack, a wind forces of 80% is to be considered. (refer **Fig. 6)**	

Table 2 Dynamic motion combination factor (current)

		Accelleration					Angle		Wind
		Surge	Sway	Heave	Roll	Pitch	Roll	Pitch	
		C_{a1}	C_{a2}	C_{a3}	C_{a4}	C_{a5}	C_r	C_p	α
HSVA	1	-0.5	0	0.35	0	-1.0	0	0.9	0
	2	-0.5	0	-0.35	0	-1.0	0	0.9	0
	3	0.5	0	-0.35	0	1.0	0	-0.9	0
	4	0.5	0	0.35	0	1.0	0	-0.9	0
OSVA	1	0.25	-0.15	0.4	0	-1.0	0	0.6	-0.5
	2	0.25	-0.15	-0.4	0	-1.0	0	0.6	-0.5
	3	-0.25	0.15	-0.4	0	1.0	0	-0.6	0.5
	4	-0.25	0.15	0.4	0	1.0	0	-0.6	0.5
BSRL	1	0	0.1	-0.1	-0.4	0	1.0	0	1.0
	2	0	0.1	0.1	-0.4	0	1.0	0	1.0
	3	0	-0.1	0.1	0.4	0	-1.0	0	-1.0
	4	0	-0.1	-0.1	0.4	0	-1.0	0	-1.0
OSPA	1	0.25	-0.2	-0.25	0.1	1.0	-0.1	-0.6	-0.5
	2	0.25	-0.2	0.25	0.1	1.0	-0.1	-0.6	-0.5
	3	-0.25	0.2	0.25	-0.1	-1.0	0.1	0.6	0.5
	4	-0.25	0.2	-0.25	-0.1	-1.0	0.1	0.6	0.5
BSHA	1	-0.1	-0.6	1.0	0.15	-0.1	-0.1	0	-1.0
	2	-0.1	-0.6	-1.0	0.15	-0.1	-0.1	0	-1.0
	3	0.1	0.6	-1.0	-0.15	0.1	0.1	0	1.0
	4	0.1	0.6	1.0	-0.15	0.1	0.1	0	1.0
OSPH	1	-0.6	0.4	0.4	-0.1	-1.0	0.1	1.0	0.5
	2	-0.6	0.4	-0.4	-0.1	-1.0	0.1	1.0	0.5
	3	0.6	-0.4	-0.4	0.1	1.0	-0.1	-1.0	-0.5
	4	0.6	-0.4	0.4	0.1	1.0	-0.1	-1.0	-0.5

Table 5 Dynamic motion combination factor *(2018-2)*

		Accelleration					Angle		Wind
		Surge	Sway	Heave	Roll	Pitch	Roll	Pitch	
		C_{XS}	C_{YS}	C_{ZH}	C_{ZR}, C_{YR}	C_{XP}, C_{ZP}	C_{YG}	C_{XG}	α
HSVA	1	-0.3	0	0.3	0	-1.0	0	0.95	0
	2	-0.3	0	-0.3	0	-1.0	0	0.95	0
	3	0.3	0	-0.3	0	1.0	0	-0.95	0
	4	0.3	0	0.3	0	1.0	0	-0.95	0
OSVA	1	0.25	-0.15	0.4	0	-1.0	0	0.6	-0.5
	2	0.25	-0.15	0.4	0	-1.0	0	0.6	-0.5
	3	-0.25	0.15	-0.4	0	1.0	0	-0.6	0.5
	4	-0.25	0.15	-0.4	0	1.0	0	-0.6	0.5
BSRL	1	0	0.1	-0.1	-1.0	0	1.0	0	1.0
	2	0	0.1	0.1	-1.0	0	1.0	0	1.0
	3	0	-0.1	0.1	1.0	0	-1.0	0	-1.0
	4	0	-0.1	-0.1	1.0	0	-1.0	0	-1.0
OSPA	1	-0.25	-0.2	-0.3	0.2	1.0	0.1	-0.6	-0.5
	2	-0.25	0.2	-0.3	-0.2	1.0	-0.1	-0.6	-0.5
	3	0.25	0.2	0.3	-0.2	-1.0	-0.1	0.6	0.5
	4	0.25	-0.2	0.3	0.2	-1.0	0.1	0.6	0.5
BSHA	1	-0.1	-0.6	1.0	0.15	-0.1	-0.1	0	-1.0
	2	-0.1	-0.6	-1.0	0.15	-0.1	-0.1	0	-1.0
	3	0.1	0.6	-1.0	-0.15	0.1	0.1	0	1.0
	4	0.1	0.6	1.0	-0.15	0.1	0.1	0	1.0
OSPH	1	0.6	0.4	0.4	-0.1	-1.0	0.1	1.0	0.5
	2	0.6	0.4	-0.4	-0.1	-1.0	0.1	1.0	0.5
	3	-0.6	-0.4	-0.4	0.1	1.0	-0.1	-1.0	-0.5
	4	-0.6	-0.4	0.4	0.1	1.0	-0.1	-1.0	-0.5

Table 3 Ship motions (current)

Motion	Angle of radian	Periods (sec)
Roll	$\Theta = f_r \frac{\pi}{180}\left(\frac{4000-65T_R}{B+75}\right)$ but need not exceed 30°(0.524 rad) and is not to be taken less than $f_r \times 22^\circ$ $(fr \times 0.384 rad)$	$T_R = \frac{2.0k_r}{\sqrt{GM}}$
Pitch	$\Phi = f_p\left(\frac{\pi}{180}\right)\left(\frac{6800}{L^{1.2}}\right)$ need not exceed 8°(0.14 rad)	$T_P = \sqrt{\frac{2.6\pi L}{g}}$

Table 6 Ship motions (2018-2)

Motion	Angle of radian	Periods (sec)
Roll	$\theta = f_r \frac{9000(1.25-0.025T_\theta)}{(B+75)\pi}$ but need not exceed 30°(0.524 rad) - if $B < 40$m, not to be taken less than $f_r \times 22^\circ$ $(fr \times 0.384 rad)$ - if $B \geqq 60$m, not to be taken less than $f_r \times 18^\circ$ $(fr \times 0.314 rad)$ (If the B is a median value, θ is determined by linear interpolation)	$T_\theta = \frac{2.3\pi k_r}{\sqrt{g\,GM}}$
Pitch	$\phi = f_p 1350 L^{-0.94}\left\{1.0+\left(\frac{15}{\sqrt{gL}}\right)^{1.6}\right\}$	$T_\phi = \sqrt{\frac{2\pi L}{g}}$

Present	Amendment	Note

Present

Table 4 Dynamic coefficient at the location of x-direction

x-location (x/L_{BP})	C_{yf}	C_{zf}
0.0	2.36	1.13
0.1	2.11	1.12
0.2	1.91	1.07
0.3	1.80	1.00
0.4	1.74	0.98
0.5	1.74	1.03
0.6	1.79	1.14
0.7	1.88	1.31
0.8	2.02	1.42
0.9	2.20	1.42
1.0	2.43	1.43
The interpolation is to be applied considering x-coordinate belong to each range.		

Amendment

Table 7 Dynamic coefficient at the location of x-direction (2018-2)

x-location (x/L_{BP})	C_{yf}	C_{zf}
0.0	1.63	1.11
0.1	1.46	1.11
0.2	1.32	1.05
0.3	1.24	1.04
0.4	1.20	1.02
0.5	1.20	1.06
0.6	1.23	1.18
0.7	1.30	1.29
0.8	1.39	1.40
0.9	1.52	1.40
1.0	1.68	1.40
The interpolation is to be applied considering x-coordinate belong to each range.		

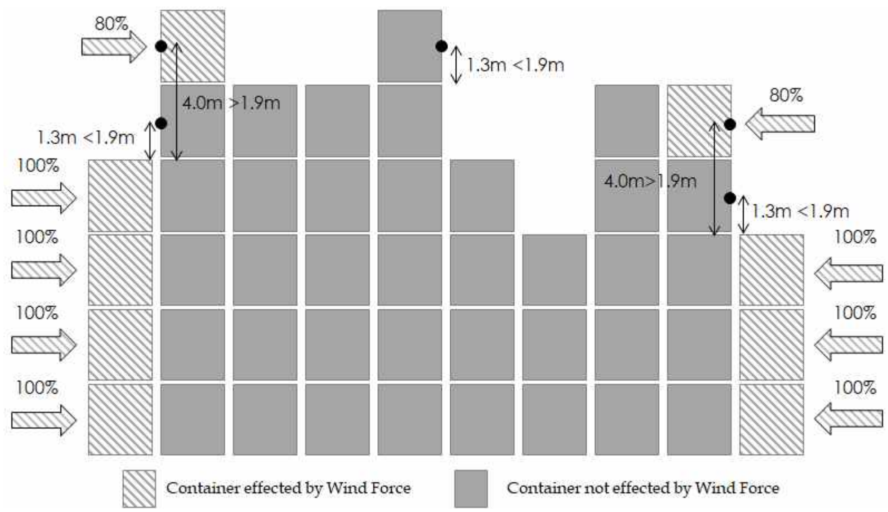

Fig. 6 Wind forces applied area (2018-2)

Present	Amendment	Note
(3) Resultant applied forces for unlashed stack (A) The resultant forces derived for each container in the stack are assumed to be divided equally between the walls of the container as follows: <omission> Q_i = wind force in one transverse end $Q_i = \frac{\alpha\, 8.25\, c\, b\, V_w^2 \cos(C_r \Theta) \times 10^{-4}}{2}$ (kN) (B) ~ (D) <omission> (4) <omission> (5) Resultant forces in an lashed condition (A) <omission> (B) The resultant forces in the containers are not to exceed the allowable values given in (6). The lashing tensions are not to exceed the allowable working loads.	(3) Resultant applied forces for unlashed stack (A) The resultant forces derived for each container in the stack are assumed to be divided equally between the walls of the container as follows: <same as current> Q_i = wind force in one transverse end $Q_i = \frac{\alpha\, 7.33\, c\, b\, V_w^2 \cos(C_r \Theta) \times 10^{-4}}{2}$ (kN) *(2018-2)* (B) ~ (D) <same as current> (4) <same as current> (5) Resultant forces in an lashed condition (A) <same as current> (B) The resultant forces in the containers are not to exceed the allowable values given in (6). The lashing tensions are not to exceed the allowable working loads. The effect of the additional tension by tilting should be taken into account in the top-layer external lashing of the closed ends without doors. However, additional tension may not be taken into consideration when a securing arrangement is used that does not cause additional tension due to application of a spring or the like. $\delta v_{act} = F_{NL\_Trigger} / K_{v\_upper\_eff}$ $F_{NL\_Trigger} = Lt_{i+1} - T_i \sin\theta_i$ $K_{v\_upper\_eff} = C_k \frac{E_i A_i \sin^2\theta_i}{l_i}$ C_k : nonlinear correction coefficient, is to be as specified by the Society δv_{max} : vertical seperation of twistlock between corner castings, generally 20 mm.	

Present	Amendment	Note
	Note 1 In case of fully automatic twistlocks, a functional test report should be submitted to the Society. Where the vertical seperation on the test report exceeds 20 mm, the actual value should be applied. Note 2 If smaller value is to be used, the value may be used in consultation with the Society based on the functional test report. $\delta v_{final} = \max(0, \min(\delta v_{\max}, \delta v_{act}))$ $T_{i-final} = T_i + \frac{K_{v\_upper\_eff}\delta v_{final}}{\sin\theta_i}$ After calculating the tension of the uppermost external lashing using the above equation, the tension of the lower external lashing should be recalculated. At this time, the horizontal tension component of the uppermost external lashing is subtracted from the load model, and the horizontal stiffness of the uppermost external lashing is excluded from the stiffness model. Container loads should be recalculated after calculating the tension of all lashing rod. *(2018-2)*	
(C) <omission>	(C) <same as current>	
(6) <omission>	(6) Allowable forces on containers <same as current>	
9. <omission>	**9. <same as current : S.A.C>**	
Appendix 1 Container Dimensions of each types <omission>	**Appendix 1 Container Dimensions of each types <S.A.C>**	
Appendix 2 Examples of Specific Route <omission>	**Appendix 2 Examples of Specific Route <S.A.C>**	
Appendix 3 Sample Calculation based on equations <omission>	**Appendix 3 Sample Calculation based on equations <S.A.C>**	
⚓	⚓	