

Tanker Q&As and CIs on the IACS CSR Knowledge Centre that have led to a Common Interpretation Procedure (CIP)

CIP No.	KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer
1	574 attc	Text B/2.7.3.7	CI	Buckling assessments for corrugated bulkheads in the cargo tank	2008/3/28	The requirement of the buckling assessments for corrugated bulkheads in the cargo tank FE analysis are particularly given in 10/3.5.2 and B/2.7.3.7. However the rules does not fully address the detail procedure of the buckling assessment particularly with regard to the location to be taken and the average procedure of the element stresses. Please clarify.	Please see CI-T1
2	575 attc	7/4, 8/2, App.B & App.C	CI	Tank approval procedure for cargo tanks	2008/3/28	Please clarify CSR tank approval procedure for cargo tanks design for carriage of high density cargo with partial filling and restriction on max filling height.	Please see CI-T2
3	576 attc	App.B	CI	Procedures of stress assessment and buckling assessments	2008/3/28	Depending on the actual opening and stiffening arrangement, or whether the openings are modelled or not in cargo tank FE or local fine mesh FE model, procedures of stress assessment and buckling assessments could be different. However, the current Rules do not specifically address these different procedures. Please clarify.	Please see CI-T3
4	577 attc	Text 4/2	CI	Evaluation of shear strength of primary support member	2008/3/28	Please clarify how to evaluate shear strength of primary support member with curved or shallow brackets	Please see CI-T4
5	578 attc	3/5.3.3.4	CI	Inertia / Stiffness when web depth is less than rule minimum	2008/3/28	Please clarify how to calculate equivalent moment of inertia /stiffness when web depth is less than rule minimum.	Please see CI-T5
6	573 attc	8/2 & 8/7	Question	Scantling requirements	2008/3/28	Please clarify which prescriptive scantling requirements apply to deck transverse fitted above upper deck.	Please see CI-T6

CIP No.	KCID No.	Ref.	Type	Topic	Date completed	Question/CI	Answer
7	438 attc	1/1.1.1.2, 2/3.1.7.1 & 1/1.1.1.1	Question	unrestricted worldwide navigation	2009/11/2	<p>The following rules, 1/1.1.1.1. and 1/1.1.1.2 of CSR/Tanker do not clearly specify that the Rules are applicable for unrestricted worldwide navigation as clearly specified in 1-1/1.1.2 of the CSR/Bulker Carrier. The Rules basis for worldwide operation (i.e. unrestricted) can only be assumed from the rules of 2/3.1.7.1 " To cover worldwide trading operations.... the CSR/Tanker should be designed based on the North Atlantic wave environment for its entire design life".</p> <p>[QUOTE] CSR/Tanker 1/1.1.1.1 These Rules apply to double hull oil tankers of 150m, L, length and upward classed with the Society and contracted for construction(1) on or after 1 April 2006. The definition of the rule length, L, is given in Section 4/1.1.1.1. 1/1.1.1.2 Generally, for double hull tankers of less than 150m, L, in length, the Rules of the individual Classification Society are to be applied.</p> <p>2/3.1.7 External environment 2/3.1.7.1 To cover worldwide trading operations and also to deal with the uncertainty in the future trading pattern of the ship and the corresponding wave conditions that will be encountered, a severe wave environment is used for the design assessment. The rule requirements are based on a ship trading in the North Atlantic wave environment for its entire design life.</p> <p>CSR/Bulk Carrier 1-1/1.1.2 These Rules apply to the hull structures of single side skin and double side skin bulk carriers with unrestricted worldwide navigation, having length L of 90 m or above. [UNQUOTE]</p> <p>Q1: Does this difference in application of the Rules between CSR/Tanker and CSR/Bulk Carrier intentionally provide for CSR/Tanker in order to cover a restricted service double hull oil tanker (L>150m) by the CSR/Tanker? Q2: Or, is IACS considering to modify the CSR/Tanker text in order to harmonise to CSR/Bulk Carrier?</p> <p>Q3: If the answer of Q1 is affirmative, CSR notation will be provided for oil tanker regardless its intended service, unrestricted or restricted. Has this policy ever discussed within IACS and firmly decided? Q4: If the answer of Q2 is affirmative, CSRs cover only oil tankers and bulk carriers, of which general configurations are specified in each Rules, intended to operate unrestricted worldwide navigation only and these ships for restricted service operation are not within the scope of CSRs. Hence, the applicable requirements for these ships are to be referred to each society's Rules. Is this understanding correct? Please confirm.</p>	<p>Please see CI-T7</p>
8 (Corr .1)	-	-	CI	Taper of Scantlings Outside the Midship 0.4L	2010/3/2		<p>Please see CI-T8</p>

CI-T 1 Buckling assessment of corrugated bulkheads

(Mar. 2008)

Rule Section

- 9/2.2.5 Acceptance Criteria
- Table 9.2.2 Maximum Permissible Utilisation Factor against Buckling
- 10/3.2 Buckling of plates
- Table 10.3.1 Buckling Factor and Reduction Factor for Plane Plate Panels
- 10/3.5.1 Struts, pillars and cross ties
- 10/3.5.2 Corrugated bulkheads
- B/2.7.3.7 Buckling assessment

Description

Procedure and specific instructions for the buckling assessment of corrugated bulkheads in cargo tank FE analysis.

Common Procedure

1. General

In the absence of suitable advanced buckling method, the following two buckling modes are to be assessed on vertically or horizontally corrugated longitudinal or transverse bulkheads in accordance with 9/2.2.5 (Table 9.2.2) and 10/3.5.2:

A. Corrugation flange panel buckling (refer to 9/2.2.5, 10/3.5.2.1, B/2.7.3.7):

Local buckling of flange panel of corrugated bulkheads is to be checked for uni-axial plate buckling using Case 1 in Table 10.3.1 with applying stress ratio $\psi = 1.0$ (i.e. constant applied stress) and the criteria given in 9/2.2.5 (Table 9.2.2).

B. Corrugation overall column buckling (refer to 9/2.2.5 and 10/3.5.2.2):

Corrugated bulkheads subjected to axial compression is to be checked for overall column buckling failure mode in accordance with 10/3.5.1 and the criteria given in 9/2.2.5 (Table 9.2.2).

Application of buckling assessment to corrugated bulkheads:

	Corrugation orientation	
	Horizontal	Vertical
Longitudinal bulkhead	Required	Required, only if subject to localised vertical forces
Transverse bulkhead	Required	

2. Procedure

- Overall procedure of each buckling assessment is indicated in Figure PR1.
- Details of each buckling assessment are summarized in Table PR1.
- Example procedure of averaging and interpolation of element stresses for flange panel buckling on vertically corrugated bulkhead is indicated in Figure PR2.

The buckling assessments are to be done for all corrugation units subjected to compressive forces and for all applicable load cases.

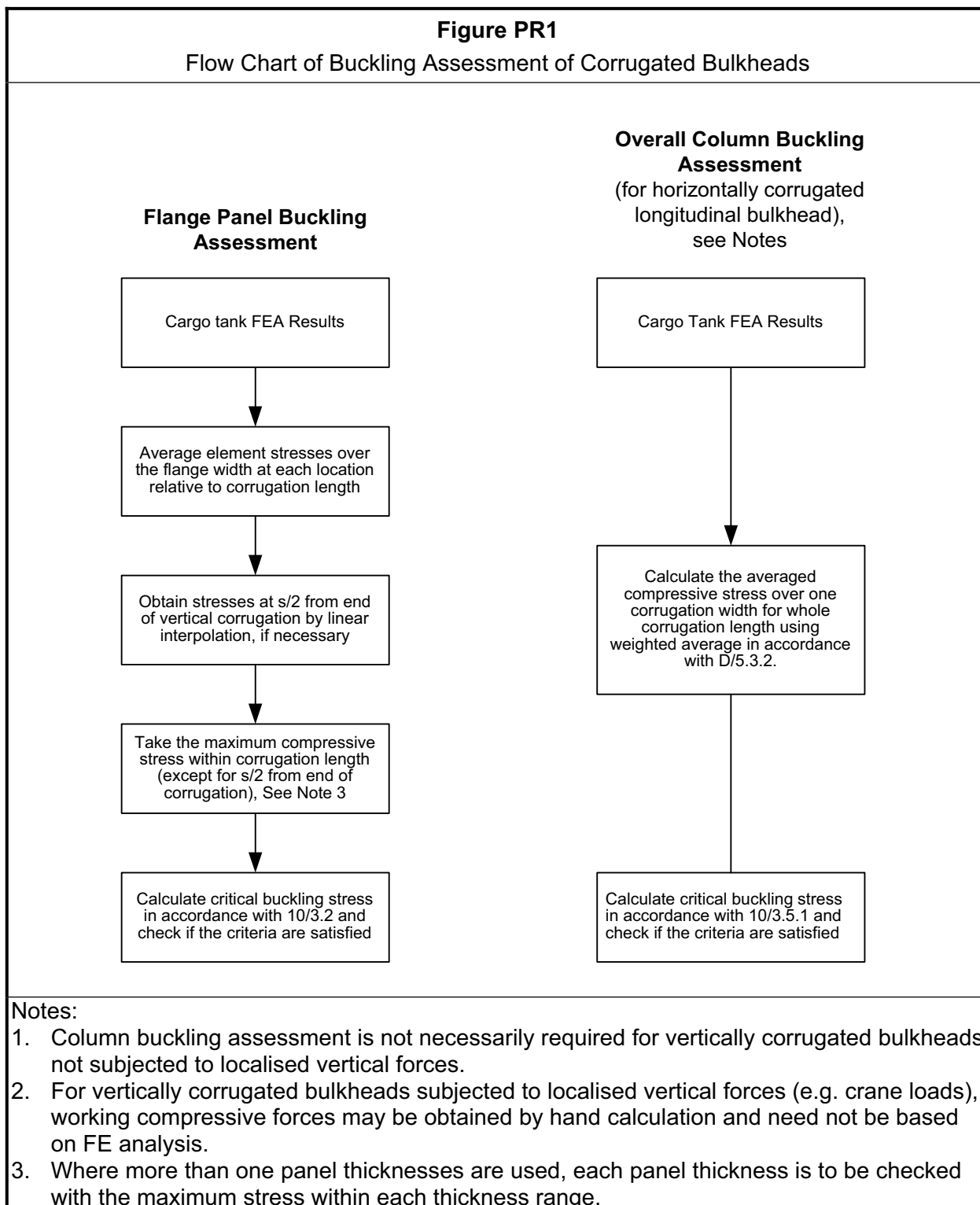
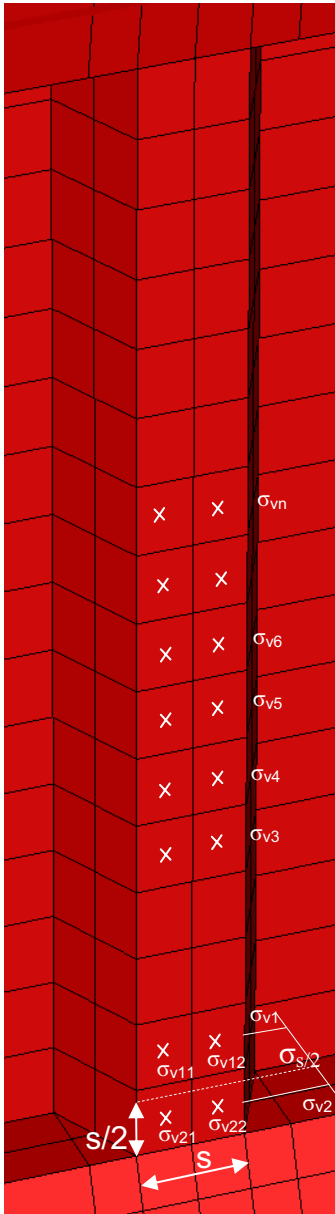


Table PR1 Summary Details of Buckling Assessments for Corrugated Bulkheads

	Failure mode	Flange Panel Buckling	Overall Column Buckling, see Note 1
1	Application	Applicable to all corrugation flanges	See page 1 item B.
2	Structural model to be assessed	Each corrugation flange panel. Where more than one plate thicknesses are used for flange panel, maximum stress is to be obtained for each thickness range and to be checked with the buckling criteria for each thickness.	Each corrugation unit (one corrugation space), i.e. half flange + web + half flange
3	Stress Type	Membrane stress at element centroid	Membrane stress at element centroid
4	Direction of stresses	Stress component parallel to corrugation knuckles Buckling mode for stresses perpendicular to corrugation knuckles is not considered critical, and is not required.	Stress component parallel to corrugation knuckles
5	Location of stresses to be used	For corrugation flange inside or at $s/2$ (s =breadth of the flange) from ends of corrugation, stresses obtained from FE analysis are to be used. For corrugation flange within $s/2$ from each end of corrugation span, stress can be taken as equal to values at $s/2$. See Figure PR2	Stresses within one corrugation space: half flange + web + half flange for whole corrugation span (including locations within $s/2$ from the ends).
6	Averaging stresses - perpendicular to corrugation knuckles	Averaging may be done over the flange width. See Figure PR2.	Averaging is to be done over one corrugation space, i.e., half flange + web + half flange for whole corrugation span including for $s/2$ from the ends
7	Averaging stresses - parallel to corrugation knuckles	Averaging is NOT to be done. See Figure PR2.	(this is a simplification of the process assuming that impact of possible high stresses at ends after the averaging over whole corrugation is negligible) Use weighted average in accordance with D/5.3.2 where element sizes are different and subjected to compressive and tensile stresses.

	Failure mode	Flange Panel Buckling	Overall Column Buckling, see Note 1
8	Final stresses to be used for buckling criteria	<p>Maximum average compressive stress (average stress calculated as per above 6) except within $s/2$ from each end of corrugation span (s = breadth of the flange)</p> <p>Where stress at $s/2$ cannot be obtained directly from a plate element, the stress at $s/2$ is to be obtained by linear interpolation of centroid stress from neighbour elements. Stress at a location within $s/2$ is to be taken as the average compressive stress at $s/2$.</p> <p>Where more than one panel thicknesses are used within a flange panel, maximum stress within each thickness range is to be used.</p>	Averaged compressive stress as per above 6 and 7
9	Critical buckling stress	<p>Table 10.3.1, Case 1 with applying stress ratio $\psi = 1.0$ is to be used (uni-axial compression).</p> <p>Where more than one panel thicknesses are used, each panel thickness is to be checked with the maximum stress within each thickness range.</p>	<p>Column buckling in accordance with 10/3.5.1.3 is to be assessed.</p> <p>Torsional buckling as per 10/3.5.1.4 and 10/3.5.1.5 need not be assessed.</p> <p>Effect of bending due to lateral pressure may be ignored.</p> <p>Where web or flange thickness varies along the corrugation length, the section of the least buckling strength is to be used.</p>
10	Utilisation factors	<p>Section 9/2.2.5 (Table 9.2.2) "flange buckling", i.e. S+D: 0.9, S: 0.72</p>	<p>Section 9/2.2.5 (Table 9.2.2) "column buckling", i.e. S+D: 0.9, S: 0.72</p>
<p>Note</p> <p>Working compressive force of localised vertical forces (e.g. crane loads) for overall column buckling assessment of vertically corrugated bulkheads may be obtained by hand calculation and need not be based on FE analysis. For such case, end constraint factor corresponding to pinned end is to be applied except that fixed end may be applied where stool with width exceeding 2 times the depth of corrugation is fitted or where corrugation is directly connected to the inner bottom without lower stool.</p>			

Figure PR2
 Averaging and Linear Interpolation of Element Stresses for
 Flange Panel Buckling of Vertically Corrugated Bulkhead



- Averaging element stresses in direction perpendicular to corrugation knuckles is to be done first over the flange width.
- Averaging element stresses in direction parallel to corrugation knuckles is NOT to be done.
- The “interpolation” is to be applied where the stress value at $s/2$ from lower end cannot be obtained directly from an element.
- After averaging the stresses over the flange width, and after obtaining the stress at $s/2$ from lower end, the maximum stress is to be used for compliance with the buckling criteria.
- Where more than one plate thicknesses are used for flange panel, maximum stress is to be obtained for each thickness range and to be checked with the buckling criteria for each thickness.

$\sigma_{V11}, \sigma_{V12}, \sigma_{V21}, \sigma_{V22}$: vertical membrane stress evaluated at element centroid;

σ_{V1} : average stress from σ_{V11} and σ_{V12}

σ_{V2} : average stress from σ_{V21} and σ_{V22}

$\sigma_{s/2}$: stress at $s/2$ obtained by linear interpolation between σ_{V1} and σ_{V2}

$\sigma_{V3}, \sigma_{V4}, \sigma_{V5}, \sigma_{V6}, \dots, \sigma_{Vn}$: average vertical flange stresses

$\sigma_{final} = \max(\sigma_{s/2}, \sigma_{V3}, \sigma_{V4}, \sigma_{V5}, \sigma_{V6}, \dots, \sigma_{Vn})$

Implementation date

This CI is effective from 1 April 2008.

Background

The requirements of the buckling assessments for corrugated bulkheads in cargo tank FE analysis are particularly given in 10/3.5.2 and B/2.7.3.7 with the additional explanations in the corresponding background documents. However, the information contained in the rules and the background document does not fully address the detailed procedure of the buckling assessment particularly with regard to the location to be taken and the averaging procedure of the element stresses from the results of the FE analysis for each buckling mode. This procedure is prepared to summarize the procedures and to provide more clarifications of the buckling assessments of corrugated bulkheads.

CI-T 2 Approval of high density cargo limitation on max filling height

(Mar. 2008)

Rule Section

7/4	Sloshing and impact loads
8/2	Cargo Tank Region
App. B	Structural Strength Assessment
App. C	Fatigue Strength Assessment

Description

What calculation procedure applies for approval of high density cargo with restriction on max filling height?

Common Procedure

Filling height of high density liquid cargo, h_{HL} , is not to exceed the following:

$$h_{HL} = h_{tk} \left(\frac{\rho_{appd}}{\rho_{HL}} \right)$$

where,

h_{tk} :	tank height
ρ_{appd} :	maximum density approved for full filling
ρ_{HL} :	density of intended high density cargo

LSM/PSM pres. requirements (Sec.8/2)

no additional checks (assuming ρ_{HL} results in bottom pressures equal to that resulting from density of sea water)

Sloshing(7/4)

- Density of intended high density cargo at maximum filling height and below to be used
- If multiple densities of heavy cargo are intended, it may be necessary to assess sloshing with multiple densities with each corresponding maximum filling height.

Fatigue assessment

Sec.2/3.1.8.2 cargo density of homogeneous fullload condition at full load design draught, T_{full} , minimum 0.9tonnes/m³.

The cargo density of 0.9 tonnes/m³ or the cargo density of homogeneous full load design draught, T_{full} , whichever is greater, is to be used. 2. As specified in Section 2/3.1.10.1.(g), higher cargo density for fatigue evaluation for ships intended to carry high density cargo in part load conditions on a regular basis is an owner's extra. Such owner's extra is not covered by the Rules, and need not be considered when evaluating fatigue strength unless specified in the design documentation.

FE assessment

Additional load cases for reduced filling height of a tank are to be based on the standard load cases (full tank) with the density modified as:

$$\rho_{appd} = \rho_{HL} \times (h_{HL} / h_{tk})$$

Loading Manual

Maximum permissible filling height of high density liquid cargo is to be indicated in the loading manual.

Implementation date

This CI is effective from 1 April 2008.

Background

LSM/PSM pres. requirements (Sec.8/2):

Based on density of sea water, which gives same pressures (within a small margin) as that of reduced filling, hence no additional calculations necessary

Sloshing

HL filling will give increased sloshing pressures, hence need to be checked

Fatigue assessment

Requirement is given in Sec.2/3.1.8.2. Is normally based on cargo density from loading manual, however it is shown that increased density have no effect on fatigue life (dominated by ballast condition below NA) except from uppermost stiffeners in cargo tank, which will not be subject to pressure due to reduced filling.

FE assessment

The principle in CSR is that there are predefined load cases and additional load cases need to be added if the loading manual shows more severe conditions than that assumed in the CSR load cases.

CI-T 3 Cargo Tank/Local fine mesh FE Analysis Procedure in way of opening

(Mar.
2008)

Rule Section

Table 9.2.1	Maximum Permissible Stresses
Table 9.2.2	Maximum Permissible Utilisation Factor Against Buckling
Table 9.2.3	Maximum Permissible Membrane Stresses for Fine Mesh Analysis
10/3.4.1	Buckling of web plate of primary support members in way of openings
Table 10.3.3	Reduction Factors
B/2.2.1.15	Methods representing openings
Table B.2.2	Representation of Openings in Girder Webs
Figure B.2.8	Openings in Web
B/2.7.2.4	Element shear stress correction in way of openings
B/2.7.2.5	Exception for element shear stress correction in way of openings
B/2.7.3.8	Buckling assessment in way of opening
B/3.1.2	Transverse web frame and wash bulkhead
Figure B.3.1	Areas Requiring Consideration for Fine Mesh Analysis on a Typical Transverse Web Frame, Wash Bulkhead and Web Frame adjacent to Transverse Bulkhead
Figure B.3.2	Areas Requiring Consideration for Fine Mesh Analysis on Horizontal Stringer and Transverse Bulkhead to Double Bottom Connections
D/5.4.1.1	Limitations of the advanced buckling assessment method
Table D.5.2	Requirements to structural elements not covered by advanced buckling assessment

Description

Procedure and specific instructions for the panels with openings in modelling, stress assessment and buckling assessment of cargo tank FE and local fine mesh FE analyses.

Common Procedure

A. General

Depending on the actual opening and stiffening arrangement, or whether the openings are modelled or not in cargo tank FE or local fine mesh FE model, procedures of stress assessment and buckling assessments could be different. However, the current Rules do not specifically address these different procedures. This Common Interpretation is intended to outline these different procedures and to provide additional information, particularly on the following aspects:

1. Overall flow of stress and buckling assessments in cargo tank FE and local fine mesh FE analyses (Refer to Figure PR1)
2. Procedure of element shear stress correction for stress and buckling assessments (Refer to Table PR1)
3. Procedure of averaging element shear stress for buckling assessment (Refer to Table PR1)

Note: Fine mesh analysis screening criteria for openings are not covered in by this Common Interpretation.

B. Notes for element shear stress correction:

1. Element shear stress correction as indicated in B/2.7.2.4, B/2.7.2.5 and Table PR1 are applicable to both stress and buckling assessments.
2. Where minor openings, such as cut-outs for local stiffeners, scallops, drain and air holes, are not included in the cargo tank FE model and local fine mesh FE model, unless exempted by B/2.7.2.5, the element shear stress correction as given in B/2.7.2.4 is to be carried out irrespective of whether the main openings are modelled or not.
3. For application of B/2.7.2.5, all the conditions indicated therein are to be satisfied concurrently.

C. Notes for buckling assessment of the panels with openings:

1. Element shear stress correction is to be carried out in accordance with B/2.7.2.4, B/2.7.2.5 and Table PR1. For axial compression, stress correction is in general not necessary.
2. In accordance with B/2.7.3.8, stresses obtained from either the cargo tank analysis or local fine mesh analysis may be used in the buckling assessment of panels. Buckling assessment is not necessarily required in local fine mesh FE analysis.
3. If openings are not modelled, buckling assessment is to be carried out in accordance with 10/3.4. Advanced buckling assessment cannot be used.
4. If openings are modelled and the opening edges are not stiffened, 10/3.4 should be used for the buckling assessment. Advanced buckling assessment cannot be used. For such case:
 - (a) where $d_a/\alpha l_a \leq 0.7$ and $d_b/l_a \leq 0.7$, Case 6 in Table 10.3.1 should be used for shear buckling.
 - (b) where $d_a/\alpha l_a > 0.7$ or $d_b/l_a > 0.7$, the reduction factor (r-factor) in Table 10.3.1 for shear buckling is not applicable in principle. In such case, other engineering principles should be used on a case -by-case basis (current CSR do not include specific guidance for such case).
 - (c) For buckling assessment against axial compression, Cases 3 and 4 in Table 10.3.1 should be applied.
5. If openings are modelled and the opening edges are stiffened:
 - (a) Small openings surrounded by stiffeners outside the opening are to be assessed for buckling using 10/3.4.
 - (b) The inside panel with the opening needs not be assessed.
6. Also refer to be following excerpts from "Background document" related to buckling assessment of the panels with openings:
 - 2.2.1.n The intention of introducing the thickness correction procedure in Appendix B/Table B.2.2 of the Rules for modelling web plating in way of an opening is to enable correct representation of the overall stiffness of the three cargo tanks FE model to allow correct load transfer within the structure without modelling of all openings. It is to be noted that the cargo tank analysis is only intended for assessing the overall strength of the structure. Local stresses in way of an opening is in addition assessed using fine mesh finite element analysis, as required by Appendix B/3.1 of the Rules, with accurate modelling of the opening geometry.

- 2.2.1.o For openings with height, h_o , greater or equal to length, l_o , the deflection across the opening is governed by shear deflection and the thickness correction is proportional to the loss of material in a given cross section.
- 2.2.1.p For longer openings the deflection is a result of combined shear and bending deflection. This effect of bending deflection is taken into account by applying the correction factor, g_o , to the pure shear deflection thickness.
- 2.2.1.q For large openings, i.e. with $h_o/h \geq 0.5$ or $g_o \geq 2.0$, it is considered necessary to include the geometry of the opening in the cargo tank model in order to obtain an acceptable result, see Appendix B/Table B.2.2 of the Rules for definitions of l_o , h_o and g_o . In this case, fine mesh finite element analysis is mandatory in order to determine the local stress in way of the opening. See B/3.1.6.b.
- 2.2.1.r In all cases the geometry of an opening can be included in the cargo tank finite element model, even if its size is such that it is acceptable to represent its effect by means of reduced thickness in accordance with Appendix B/Table B.2.2 of the Rules. However, it should be noted that the screening formula, given in Appendix B/3.1.6 of the Rules for determining whether it is necessary to perform a fine mesh analysis of the opening, is only applicable for the cases where the geometry of an opening has not been included in the cargo tank model. If the geometry of an opening is included in the cargo tank model, fine mesh analysis is to be carried out to determine the local stress in way of the opening.

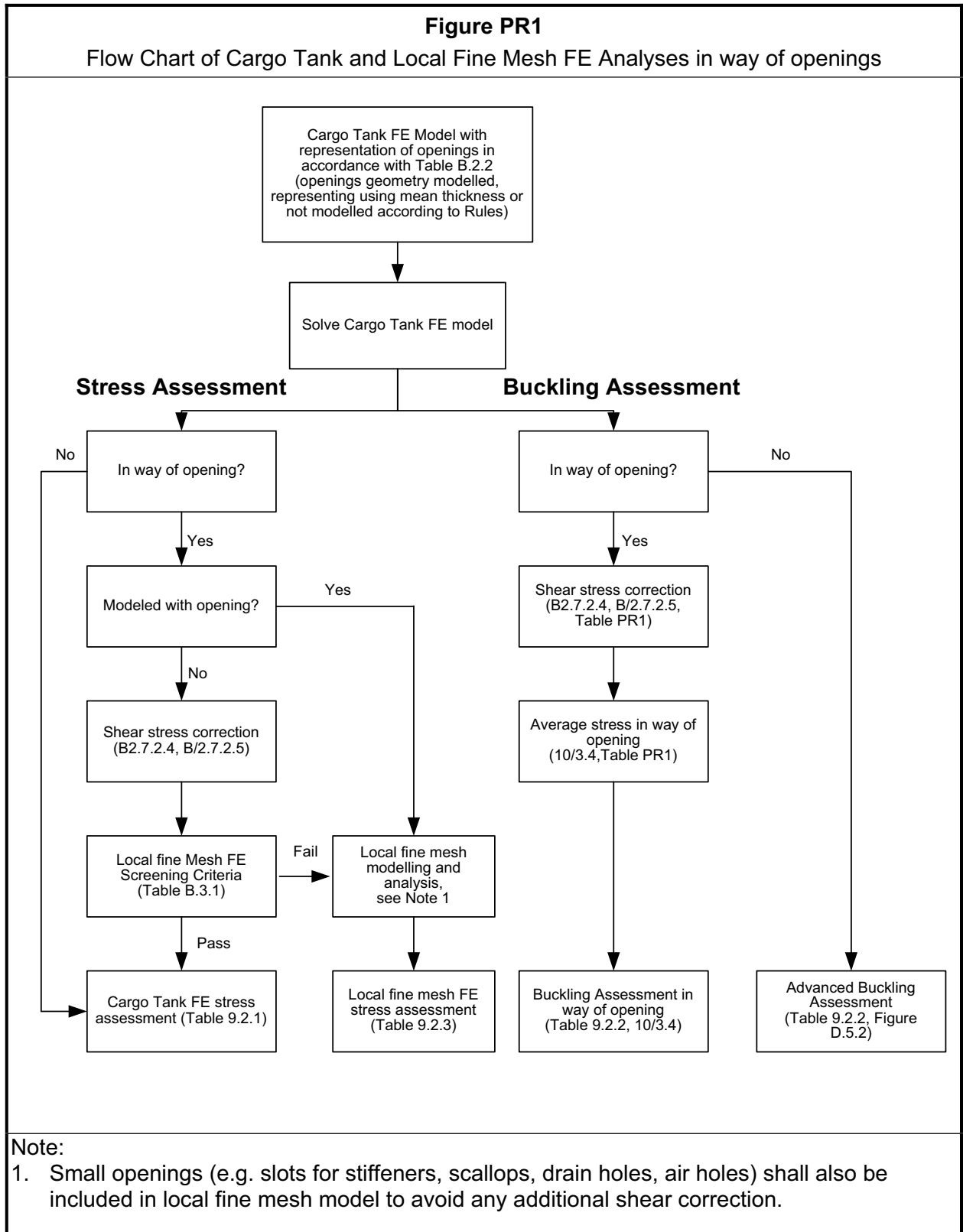


Table PR1				
Stress Correction in way of Opening for Buckling Assessment in accordance with Section 10/3.4				
Opening Arrangement (These are the same arrangements as Table 10.3.3 for Reduction Factors)	Major Opening Modelled?	Axial Compressive Stress	Shear Stress	
			Shear Stress Correction (B/2.7.2.4, see Note 1)	Averaging element shear stresses within panel (calc of working shear stress)
(a) without edge reinforcements 	No	Calculate average stress for each P1 and P2 separately In general, correction of axial compressive stress to account for opening is not necessary.	Shear stress correction, where applicable, is to be done for P1, P2 and in way of opening	Average element shear stresses within the area marked with (same area for the reduction factor C _r in Table 10.3.3.(a)): This includes the elements in way of opening.
	Yes	Same as above	Shear stress correction, where applicable, is to be done for P1, P2 only. Opening part is excluded since there are no elements.	Average element shear stresses within the area marked with (same area for the reduction factor C _r in Table 10.3.3.(a)): Opening part is excluded since there are no elements.
(b) with edge reinforcements 	No	Same as above	Shear stress correction, where applicable, is to be done for P1, P2 and in way of opening	Average element shear stresses within P1 and P2 separately. Opening part needs not be assessed.
	Yes	Same as above	Shear stress correction, where applicable, is to be done for P1, P2 only Opening part is excluded since there are no elements.	Average element shear stress within P1 and P2 separately Opening part needs not be assessed.

<p>(c) example of hole in web</p>	No	Same as above	<p>Shear stress correction, where applicable, is to be done for P1, P2, P3 and in way opening.</p> <p>For P3, correct only the shear stress of elements in way of cross section at the opening.</p>	<p>For the panel of P1 and P2 with opening, average element shear stress within the area marked with:</p> <p>This includes the elements in way of opening.</p> <p>For P3, average element shear stresses within P3.</p>
	Yes	Same as above	<p>Shear stress correction, where applicable, is to be done for P1, P2, P3</p> <p>Opening part is excluded since there are no elements.</p> <p>For P3, correct only the shear stress of elements in way of cross section at the opening.</p>	<p>For the panel of P1 and P2 with opening, average element shear stress within the area marked with:</p> <p>Opening part is excluded since there are no elements.</p> <p>For P3, average element shear stresses within P3.</p>
<p>Note:</p> <p>1. Where modelled shear area and actual shear area are different, including area loss due to minor openings, element shear stresses in way of the cross section of the opening are to be corrected in accordance with B/2.7.2.4.</p>				

Implementation date

This CI is effective from 1 April 2008.

Background

Depending on the actual opening and stiffening arrangement, or whether the openings are modelled or not in cargo tank FE or local fine mesh FE model, procedures of stress assessment and buckling assessments could be different. However, the current Rules do not specifically address these different procedures. This Common Interpretation has been prepared to provide an outline of these different procedures.

CI-T 4

Optional shear check for primary support members with curved brackets or shallow brackets

(Mar. 2008)

Rule Section

- 4/2.1.5 Effective shear span of primary support members
 4/2.5 Geometrical Properties of Primary Support Members

Description

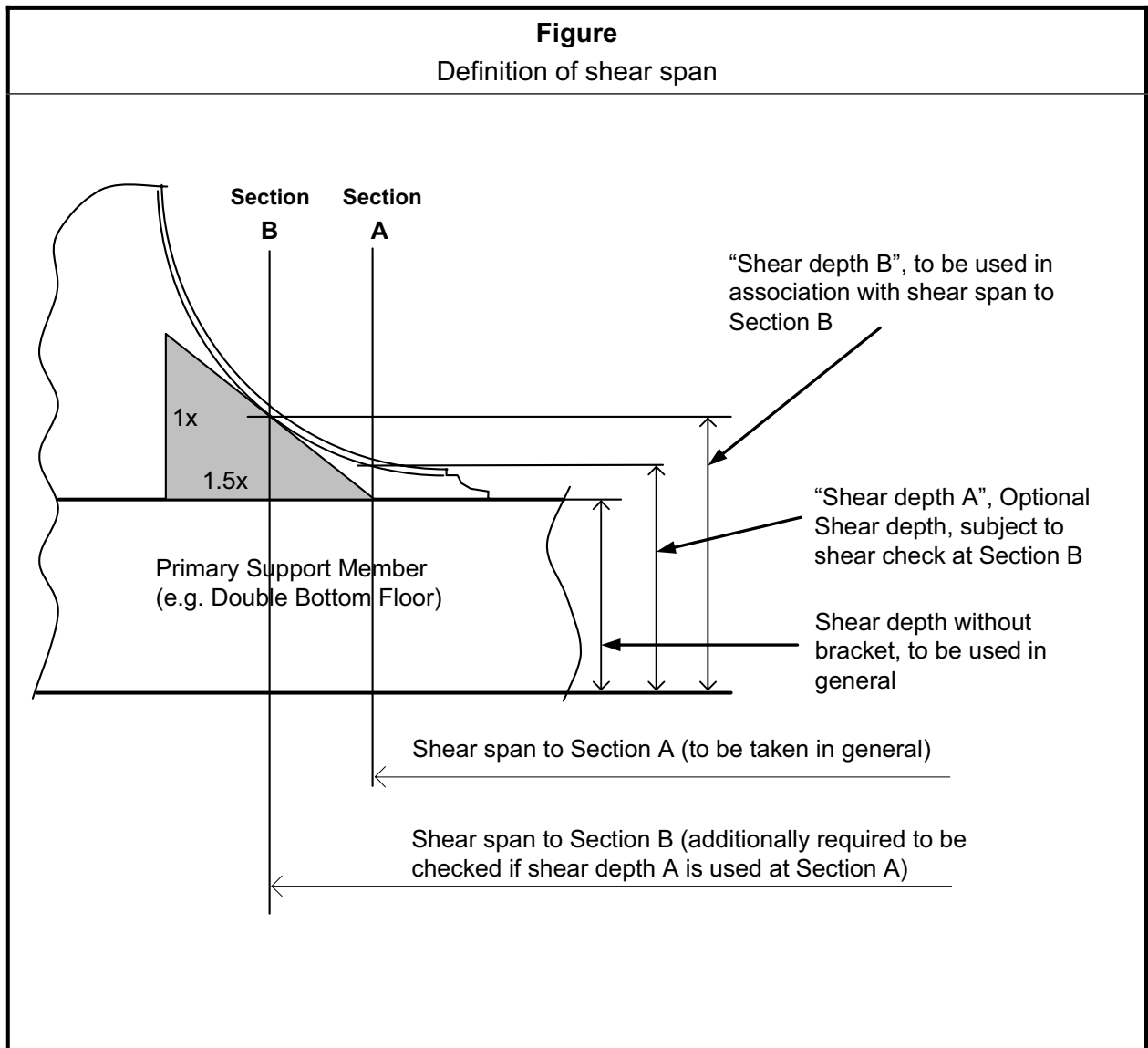
Procedure for the optional shear check for primary support members with curved brackets or shallow brackets.

Common Procedure

1. General

1. In general, shear check is to be carried out at the end of shear span, Section A, with offered shear depth excluding the bracket part in accordance with 4/2.1.5 and Figure 4.2.8.
2. If the shear requirement is satisfied at this section, then no further shear check is necessary. If a curved bracket or a shallow bracket is fitted as shown in the above figure, and the offered shear requirement is NOT satisfied, then the procedure as per item 3 may be applied.
3. The shear requirement is considered to be satisfied if the shear requirement is satisfied by following two additional shear checks concurrently:
 - (a) Check the shear requirement at Section A with the shear span measured to Section A and the offered shear depth including the bracket part web "shear depth A".
 - (b) Check the shear requirement at Section B with the shear span measured to Section B and the offered shear depth including the bracket part "shear depth B". At this section, the effective shear area may be calculated in accordance with 4/2.5.1.4 with the following formula considering the sloping face plate:

$$A_{w-net50} = 0.01 h_n t_{w-net50} + 1.3 A_{f-net50} \sin 2\theta \sin \theta$$



Implementation date

This CI is effective from 1 April 2008.

CI-T 5 Calculation of equivalent moment of inertia/stiffness

(Mar.
2008)

Rule Section

3/5.3.3.4 Bending requirements of primary support members
Knowledge Centre Question No 151

Description

Procedure of calculation of equivalent moment of inertia / stiffness when web depth is less than rule required minimum.

Common Procedure

Where it is impracticable to fit a primary support member with the required web depth, then it is permissible to fit a member with reduced depth provided that the fitted member has:

- (A) the same moment of inertia or
- (B) the same maximum deflection

as that of an imaginary member, which is equivalent to the Rule required member. The following procedure should apply.

1. Create an imaginary member equivalent to that required member with the following properties:
 - Web
 - Web depth is to satisfy the required depth
 - Web thickness is to satisfy the minimum thickness and slenderness (s/t) ratio
 - Shear area is to satisfy the required area
 - Attached Plate
 - Effective width of attached plate is to be taken at mid-span in accordance with Section 4/2.3.2.3
 - Thickness of attached plate is to satisfy the local thickness requirements required at the mid-span
 - Face Plate
 - In association with the above web and attached plate, face plate having sufficient area is to be attached to meet the required section modulus of mild steel. For this purpose, the face plate need not satisfy the minimum thickness and proportion (breadth and thickness) requirements.
 - The required section modulus may be reduced to 85% provided that the reduced scantlings comply with the Finite Element cargo tank structural analysis
2. In case where the offered member has uniform beam properties, then the moment of inertia of the imaginary equivalent member as calculated in item 1 is the required moment of inertia.
3. In case where there is significant variation of beam properties along the length, then it would be adequate to demonstrate that, under the Rule loading, the offered member of non-uniform cross section gives equal or less maximum deflection than that of the imaginary equivalent member as calculated in item 1. Then the moment of inertia of the proposed member may be partially less than the required moment of inertia.
4. The offered member is to satisfy all the requirements except the required depth. The section modulus requirement is to be satisfied with the effective width of attached plate at the ends.

Prepared by: CSR PT2	Revision: 1.0	
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Implementation date

This CI is effective from 1 April 2008.

Background

This procedure is based on the existing ABS practice.

CI-T 6 Prescriptive scantling calculation of deck transverse fitted above deck

(Mar.
2008)

Rule Section

8/2.6.1	Primary Support Members/General
8/2.6.4	Deck transverses
8/7	Application of scantling requirements to other structure

Description

Procedure for the prescriptive scantling calculations of deck transverses fitted above upper deck

Common Procedure

The section modulus and shear area criteria as given in Sections 8/2.6.4.3 and 2.6.4.4 are not applicable to the deck transverses fitted above the upper deck. They are to be obtained by the calculation methods as described in Section 8/7 with the following procedure/guidance:

A. Bending Moment and Shear Force:

- In general Load Model A (fbdg=12, fshr=0.5) in Table 8.7.1 may be used to calculate the bending moment and shear forces at the ends provided that the connection structure between the deck transverse and side transverse (e.g. overlap length and bracket sizes) is considered to be reasonably rigid.
- If the connection structure between the deck transverse and side transverse (e.g. overlap length and bracket sizes) is not considered to be rigid enough, Load Model B (fbdg=8, fshr=0.63) in Table 8.7.1 may need to be applied to calculate the bending moment and shear forces at the ship centreline end. At the ship side end, Load Model A (fbdg=12, fshr=0.5) is to be applied.
- Bending moment as calculated in item 1 or 2 may be reduced by 20% to make the bending moment compatible with that required in Section 8/2.6.4.3.
- The required section modulus and shear area as calculated in item 3 may be reduced to 85% provided that the reduced scantlings comply with the FE cargo tank structural analysis.
- As an alternative to using Section 8/7, the required section modulus and shear area may be obtained by finite element method (FEM). In this connection, finite element analysis as indicated in Section 9/2 and Appendix B may be used with the following corrections to align with loads used in Section 8/2.6:
 - ship draught of 1.0Tsc to have an envelope value of the green sea pressure. For this purpose, Loading Patterns of A1 and A2 in Table B.2.3 and B1 and B2 in Table B.2.4 may be used with modifying the draught from 0.9Tsc to 1.0Tsc.

Note: Part load conditions (e.g. A4 and A6 in Table B.2.3 and B4 through B6 in Table B.2.4) may create slightly greater internal pressures than that obtained by A1, A2, B1 and B2. However, these part load conditions need not be performed for simplification of the procedure since the differences are negligible.

- cargo density of 1.025 tonnes/m³. For this purpose, ρ_{\max_LM} as defined in B/2.4.7.2 is to be taken as 1.025.

B. Distribution of the required scantlings:

1. Deck transverses are forming “transverse ring” of the hull structure together with other transverse primary support members in one cross section. Therefore, in general, the required section modulus and shear area for deck transverses in accordance with Sections 8/2.6.4.3 and 2.6.4.4 are to be constantly applied over the clear of end brackets, i.e. no reduction of the requirements is allowed towards the mid-span except the following cases:
 - In way of centreline, where the scantlings are determined based on the above A.2.
 - Reinforcements are locally applied based on FE cargo tank structural analysis defined in Section 9.2 and Appendix B.

C. Other Criteria:

1. In addition to the section modulus and shear area requirements, the following criteria in Sections 8/2 and 10/2.3 are applicable, and are to be complied with:
 - Minimum thickness (Section 8/2.1.6)
 - Web depth (Section 8/2.6.4.1) (see Note below)
 - Moment of inertia (Section 8/2.6.4.2)
 - Proportion requirements (Section 10/2.3)
2. With regard to the “web depth” requirement (Section 8/2.6.4.1) in item C.1, where it is impractical to fit a deck transverse with the required web depth, then it is permissible to fit a member with reduced depth provided that the fitted member has an “equivalent inertia/stiffness” to that of the required member in accordance with Section 3/5.3.3.4. This “equivalent inertia/stiffness” can be also demonstrated by “equivalent maximum deflection”. See separate Common Interpretation / Procedure” for this process.

Prepared by: CSR PT2	Revision: 1.1	
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Implementation date

This CI is effective from 1 April 2008.

Background

According to Section 8/2.6.1.2, the section modulus and shear area criteria for primary support members contained in Section 8/2.6 apply only to the structural elements listed therein. The section modulus and shear area criteria of other primary support members (including deck transverses fitted above upper deck) are to be obtained by calculation methods as described in Section 8/7, which is a “tool box” type section, and is generally applicable where the basic structural configurations or strength models assumed in Section 8/2 to 8/5 are not appropriate.

Consequently, Section 8/2.6.4.3 (bending requirement) and Section 8/2.6.4.4 (shear requirement) do not apply to the deck transverses fitted above upper deck. The following are the main reasons of not applying the bending and shear requirements in 8/2.6.4.3 and Section 8/2.6.4.4:

1. Section 8/2.6.4.3 includes the considerations for “carry-over” bending moment transmitted from the side transverse or vertical web on longitudinal bulkhead to the deck transverse. Since the deck transverses fitted above the deck has in general less degree of connectivity between the deck transverse and side transverse compared with ordinary deck transverses fitted below the deck, the carry-over bending based requirement is not suitable.
2. For shear, in addition to the local pressure based shear force, there is a consideration against hull deformation is included in Section 8/2.6.4.4. This requirement has been calibrated with the ordinary deck transverses fitted below the deck, but not calibrated with the one fitted above the deck. Therefore, the shear requirement in Section 8/2.6.4.4 is not applicable.

Prepared by: CSR PT2	Revision: 1.1	
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CI-T 7 Application of the Common Structural Rules for Double Hull Oil Tankers

(November 2009)

Rule Section

- 1/1.1.1.1 Applicability
- 2/Figure 3.2.1 Typical arrangements of Double Hull Tankers
- 2/3.1.7.1 External environment
- 3/4.1.2 Novel designs

Knowledge Centre Questions:

- No 142 (Type of cargo)
- No 183 (OBO Carriers)
- No 279 (Ore/Oil Carriers)
- No 432 (Design with no cross ties)
- No 438 (Restricted/Unrestricted Navigation)
- RCP No 562 (Restricted/Unrestricted Navigation)

Description

The Common Structural Rules for Double Hull Oil Tankers (CSR/Tankers) of 150 metres or more have been published and adopted by IACS and became effective from April 1, 2006.

There are a couple issues of concern regarding the applicability of the rules that have become apparent after the adoption of the CSR/Tankers which this interpretation addresses:

- Ship types: do CSR apply to Chemical tankers, combination carriers etc.
- Conversions: vessels converted to tanker for oil
- Novel Designs: application of the CSR/Tankers to novel designs and unusual structural configurations
- Hull shapes outside of normal range L/B or B/D etc
- Service Area: application of the CSR/Tankers for ships on restricted service.

Common Interpretation / Procedure

The purpose of this interpretation is to ensure a unified understanding for which CSR/Tankers shall apply.

This common interpretation is not intended as a detailed procedure for the review and approval of novel concepts or particular structural arrangements not described in the CSR/Tankers.

1. Ship Types

The CSR/Tankers are mandatory for oil tankers with length of 150m and above having integral tanks for carriage of crude oil or oil products in bulk, which is contained in the definition of oil in Annex 1 of MARPOL 73/78.

Exemptions for which CSR/Tankers are not applicable are listed below:

- Combined Ore/Oil Carriers; or
- OBO Carriers; and
- Chemical tankers not having MARPOL certificate for carriage of oil or oil products
- Pure asphalt carrier
- FPSO, FSO
- Ships only carrying oil or oil products in independent tanks.

The class notation CSR may only be assigned for those vessels covered by mandatory application and may not be assigned voluntarily based on preference of Yard or Owner.

2. Conversion to Tanker for Oil

Ships converted to oil tankers should be exempted from complying with CSR for tank unless the whole cargo block (i.e. all the cargo holds) is replaced, in that case, relevant parts of CSR should apply to the cargo block only, and not the rest of the ship.

The exemption will only be applicable for vessels for which the date of the original contract for construction was prior to 1. April 2006.

3. Novel designs and unusual structural configurations

Although the Rules have been formulated for families of double hull tankers of more or less conventional structural configuration, there is no intention of limiting the development of novel designs in the future, or designs having improved local structural arrangements. However, the proposed designs must demonstrate that their structural safety is at least equivalent to that intended by the CSR/Tankers. This may include an independent systematic review/structural risk assessment in order to document equivalence with the Rules.

The individual class society will particularly consider how to apply CSR/Tankers on structural configurations different from those shown in Figure 3.2.1 or on “novel designs” (Section 3/4.1.2).

4. Designs with main particular outside normal ranges

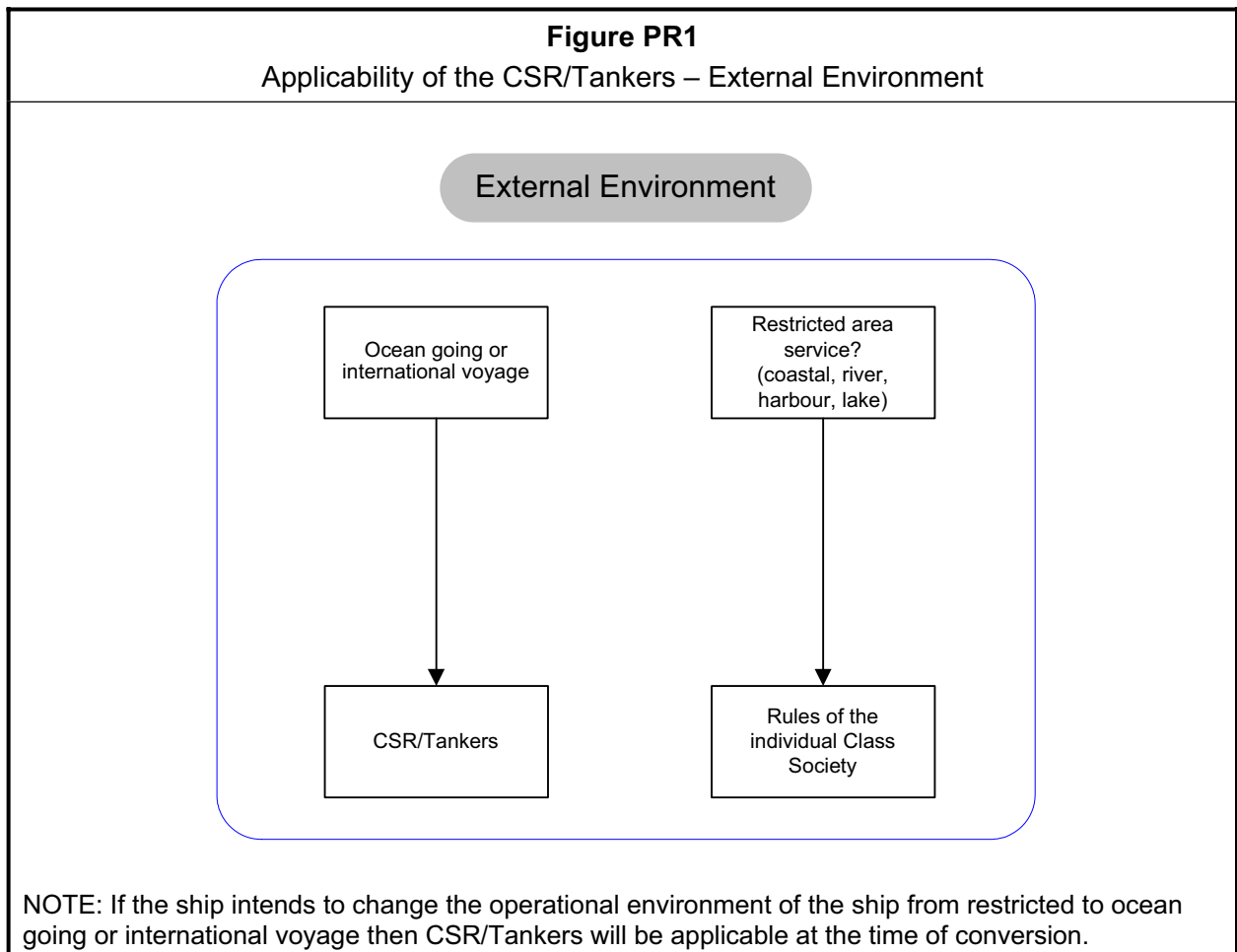
The formulae for loads are tailored for ships of normal proportions. Although most may be applied to vessels of other proportions guidance should be sought from the individual class society when the criteria below are not satisfied. The individual class society will decide how to apply the CSR/Tankers to the ship.

- $L/B > 5$
- $B/D < 2.5$
- $C_b > 0.7$
- $GM < 0.12B$ for homogeneously full load conditions
< $0.33B$ for ballast conditions

5. Service Area

Because there is uncertainty about the actual trading patterns of most ships, it is necessary to choose an arbitrary, but prudently severe, wave environment for the purposes of design assessment. The Rule requirements are therefore based on a ship trading for all of its life in the demanding North Atlantic wave environment. See Figure PR1 for application of CSR/Tankers based on external environment.

Shipowners are naturally concerned about maximising operational flexibility with the loading conditions that are approved and in the Loading Manual. The CSR for Tankers defines loading conditions that envelope the most prevalent in-service cases. This means that actual loading conditions will then fall within the range of draughts and hull girder bending moments (BM) / shear forces (SF) that have been investigated and approved by class. The standard loading conditions in CSR have been carefully selected to give extreme service limits. In some cases they are significantly more onerous than those routinely occurring. Where the shipowner intends actual loading conditions that may be outside the standard draught and BM/SF limits then these must be identified to the shipbuilder in the specification and submitted to Class to ensure the ship meets this enhanced requirement.



Implementation date

This CI is effective from 1 November 2009.

Background

This common procedure has been prepared to ensure a unified understanding on the application of CSR/Tankers.

CI-T 8

(Dec 2009)
 (Corr.1 Feb
 2010)
 (Rev.1 Jun
 2010)

Taper of Scantlings Outside the Midship

0.4L

Rule Section

8/1.2.1.3	Hull girder section modulus application to full length
8/1.4.1.2	Hull girder buckling application to full length
8/1.6	Tapering and structural continuity of longitudinal hull girder elements
8/3.1.3	Forward region structural continuity
8/4.1.3	Machinery space structural continuity
8/4.3.1	Machinery space tapering of side structure
8/5.1.3	Aft region structural continuity

Description

A procedure is developed for applying the structural tapering requirements outside of the midship 0.4 length for longitudinal strength, deck plating and shell plating thickness to address longitudinal strength and structural continuity.

Common Procedure

Longitudinal strength – the intent of the rules is to check that hull girder strength and structural continuity is maintained and properly tapered in way of changes in vessel section arrangement and vessel shape along the entire length taking into account the variation of hull girder loads. The hull girder section modulus taper is to be based on the larger of the required section modulus from 8/1.2.2 or 8/1.2.3. The tapered section modulus along the entire length of the vessel is to be in accordance with 8/1.2.1.3, 8/1.6.1.1 and 8/1.6.1.2. The structural ends of the hull girder are considered at 0.1L forward of the aft perpendicular and 0.1L aft of the forward perpendicular in accordance with Table 8.1.3 and Figure 8.1.9. The vertical and longitudinal extents of higher strength steel (e.g. the transitions between steels of different yield strength) along the entire length of the vessel are to comply with 8/1.6.2 and 8/1.6.3 regardless of which section modulus requirement governs. The hull girder buckling strength along the entire length of the vessel is to comply with 8/1.4.1.2 and the buckling calculations are to consider the actual material yield strength. If applicable, the hull girder plate thickness due to hull girder shear along the length of the vessel is to be in accordance with 8/1.6.4.

Deck plating – the tapering of the deck plate outside of the midship 0.4L is closely associated with the section modulus and buckling requirements. The deck plate thickness typically transitions from longitudinal strength considerations within the midship 0.4L to the local strength considerations toward the ends of the vessel, considered at 0.1L forward of the aft perpendicular and 0.1L aft of the forward perpendicular. The deck plating is to be maintained throughout the midship 0.4L or beyond the end of a superstructure located at or near the midship 0.4L point and then linearly tapered, according to the tapering procedure defined below, to the local strength requirements at the ends of the vessel, but also considering the actual hull girder properties and buckling considerations along the vessel length as noted above in longitudinal strength. Local increases to the deck plating in way of superstructure breaks, foundations, etc. are to be added after the tapering and continuity requirements are considered.

Shell plating – similar to the deck plating, the tapering of the shell plating outside of the midship 0.4L is closely associated with the section modulus and buckling requirements. The shell plating taper should provide a gradual transition, according to the tapering procedure defined below, from the midship 0.4L longitudinal strength considerations to the local strength

requirements at the ends of the vessel and also consider the actual hull girder properties and buckling considerations along the vessel length as noted above in longitudinal strength. The transition of the shell plating is somewhat complicated due to the presence of local increases due to local integrated deep tanks, sea chests, local buckling increases, tug pushing areas, hull girder shear increases, etc. including those items addressed in 9/2.4.5, these local considerations should be generally considered separately from the taper and added after the tapering and continuity requirements are considered.

Tapering procedure

To assist with the uniform application of the taper requirements to the side shell and to the deck, especially regarding 8/4.3.1.1 in way of the machinery space, the following straight line simple tapering procedure is to be used.

First determine t_{end} and t_m then,

For $t_{end} < t_m$:

$$t_{int} = t_{end} + [(t_m - t_{end}) X_{int}/X_m]$$

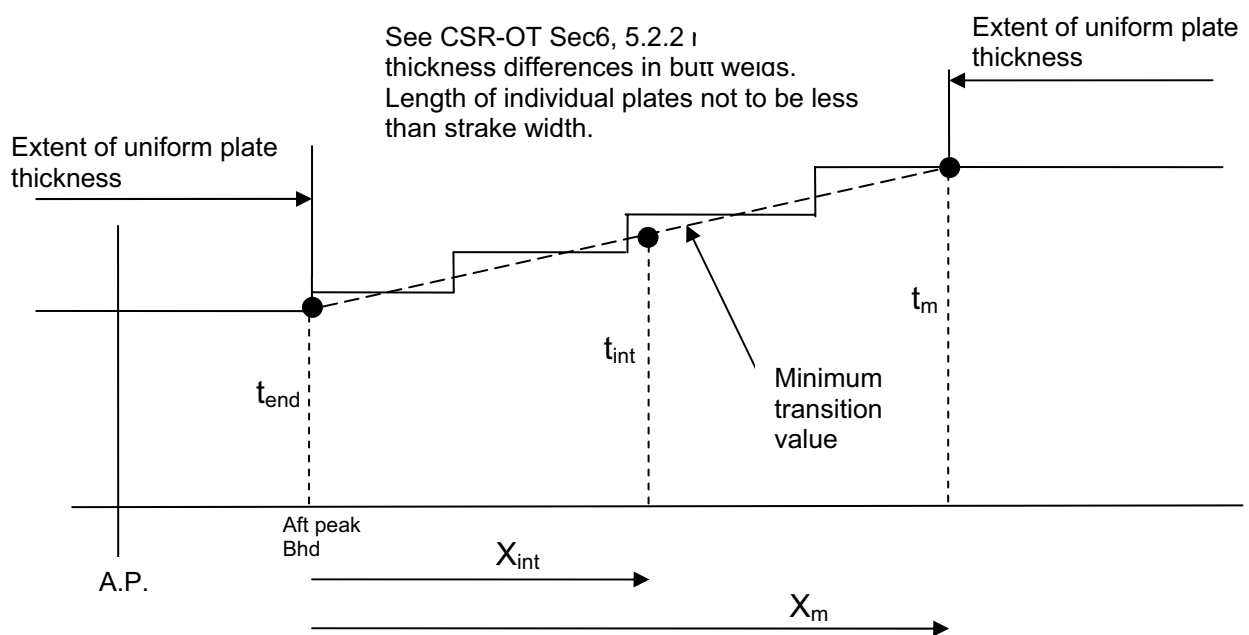
For $t_{end} > t_m$:

$$t_{int} = t_m$$

- t_{int} = net required thickness as defined in Note 1, at the intermediate region (intermediate location being evaluated).
- t_{end} = net required thickness as defined in Note 1, at the aft peak bulkhead or 0.1L from the FP
- t_m = net required thickness as defined in Note 1, at midships.
- X_{int} = distance from the aft peak bulkhead or 0.1L from the FP to the intermediate location being evaluated.
- X_m = distance from the aft peak bulkhead or 0.1L from the FP to the corresponding aft or forward extent of the midship 0.4L.

Notes:

1. The tapering is to be based on the net required thickness, provided that this thickness comply with all requirements, including the minimum thickness, local scantlings, and thickness for quay zone. The net thickness requirements for local reinforcements such as local integrated deep tanks, tug pushing, sea chest opening compensation, vicinity of stern frame, breaks of super structure, buckling requirements and the hull girder shear requirements are to be excluded. These local reinforcement considerations are to be locally applied as necessary after the taper thickness requirement is determined.
2. For tapering, no local adjustment for the actual stiffener spacing and the plate material at the specific locations along the length of the vessel are to be applied. For example, if an area where the actual side frame spacing is different from the midships region between 0.4L amidships and the vessel ends, shell plate tapering in the area should be based on the straight thickness taper line drawn between two points, one end is the required side shell plate thickness at midships assessed based on the actual local spacing at the midship and the other end is the required side shell plate thickness at the vessel end based on the actual local spacing at the vessel end.
3. For tapering, the longitudinal location of the middle of the longitudinal extent of a strake and the vertical location at a line from midship to end region and parallel to baseline should be used to determine the required thickness for each plate that is located in the tapering region.
4. See CSR-OT Sec 6, 5.2.2 regarding thickness difference in butt welds, the length of individual plates is generally not to be less than the strake width.



Structural continuity – the tapering of the scantlings of longitudinal members and the tapering of the hull girder properties in way of changes in vessel arrangements and shape along the length is closely related to the continuity and termination of structural members. It is important to provide continuity of strength and to avoid abrupt structural changes which tend to increase stress concentrations, by providing suitable scarphing arrangements and transition brackets to avoid abrupt changeover of stiffening from longitudinal framing to transverse framing and to properly compensate for openings in the structure. Various aspects of structural continuity are covered in 8/1.6.5., 8/1.6.6, 8/3.1.3, 8/4.1.3, 8/5.1.3.

Implementation date

The Common Interpretation is applicable for the original version of key drawings for approval with submission date 1 January 2010 or later.

Background

Longitudinal structural continuity along a ship's length is a vital aspect in ship design. There is to be sufficient continuity in longitudinal scantlings so as to have the hull girder strength criteria fulfilled all along the ship's length in line with the hull girder bending moments and shear forces.

Hull girder strength, local strength and other applicable rule requirements determine scantlings, which inevitably result in variation in scantlings along the vessel length. Good engineering practice, as well as the historic practice, which has been satisfactory, has been to require a gradual change in scantlings, for example in shell plating thickness between the midship and end regions of the vessel. The plate thickness along the ship is expected to change in a gradual manner, i.e. tapered from midship to the ends of the vessel.

Additionally, continuity and proper transition of longitudinal structure at breaks and changes in structural arrangement are equally important considerations.

In the current CSR for Oil Tankers continuity and proper tapering of scantlings are addressed in the following rule cites:

8/1.2.1.3	Hull girder section modulus application to full length
8/1.4.1.2	Hull girder buckling application to full length
8/1.6	Tapering and structural continuity of longitudinal hull girder elements
8/3.1.3	Forward region structural continuity
8/4.1.3	Machinery space structural continuity
8/4.3.1	Machinery space tapering of side structure
8/5.1.3	Aft region structural continuity
9/1.1.1	Application of hull girder ultimate strength
9/2.4.2	Application of scantlings to deck
9/2.4.5	Application of scantlings to side shell, longitudinal bulkheads and inner hull longitudinal bulkheads.

1. Background and current application

Experience and feedback have highlighted that the rule text of the above rule sections is not clearly described in sufficient detail to facilitate a uniform application of these requirements. This could be attributed to the fact that tapering is mentioned only in general terms in the rules. The main objective of the CI is describing a tapering procedure in accordance with the CSR for Oil Tankers that all parties involved in the design and approval process can apply to ensure a uniform and consistent implementation of the general tapering criteria.

2. Tapering Procedure

To provide a common interpretation within the context of CSR for Oil Tankers on tapering of the shell envelope plating, the procedure in CI-T8 has been developed.

The procedure applies a linear taper using net scantlings at the midship and ends as the basis, since net scantlings form the foundation for scantlings in CSR.

Plating transitions are also complicated by local thickness increases stemming from compensation for openings, heavy plates in the vicinity of rudders and stern frames, local integrated deep tanks, tug pushing areas, compensation for hull girder shear stress, buckling etc. In addition material strength, framing system and spacing may vary along the vessel length.

In this tapering procedure, the following effects on local requirements are to be excluded from the calculation of the reference thickness t_{end} and t_m :

- Hull girder shear
- Tug pushing
- Sea chest opening compensation; heavy plates in way of stern frame; breaks of superstructure
- Buckling
- Local integrated deep tanks, except water ballast tanks in the midship location and peak tank at ends.
- Sloshing
- Bottom slamming
- Bow impact

These effects have to be applied after tapering thickness requirements have been met. No local adjustment for actual stiffener spacing and plate material strength is to be considered at the specific location for which the tapered thickness is being determined.

The required thickness is to be determined at the middle of the longitudinal extent of a strake on a line drawn at the vertical midpoint of the strake from midship to the ends and parallel to the baseline. Thickness difference in butt welds is to be in accordance with 6/5.2.2 of CSR for Oil Tankers and the length of an individual strake is not to be less than the strake width.