Common Structural Rules for Double Hull Oil Tankers

Corrigenda 1
Rule Editorials

Notes: (1) These Rule Corrigenda enter into force on 1st July-2008.

(2) This document contains a copy of the affected rule along with the editorial change or clarification noted as applicable.

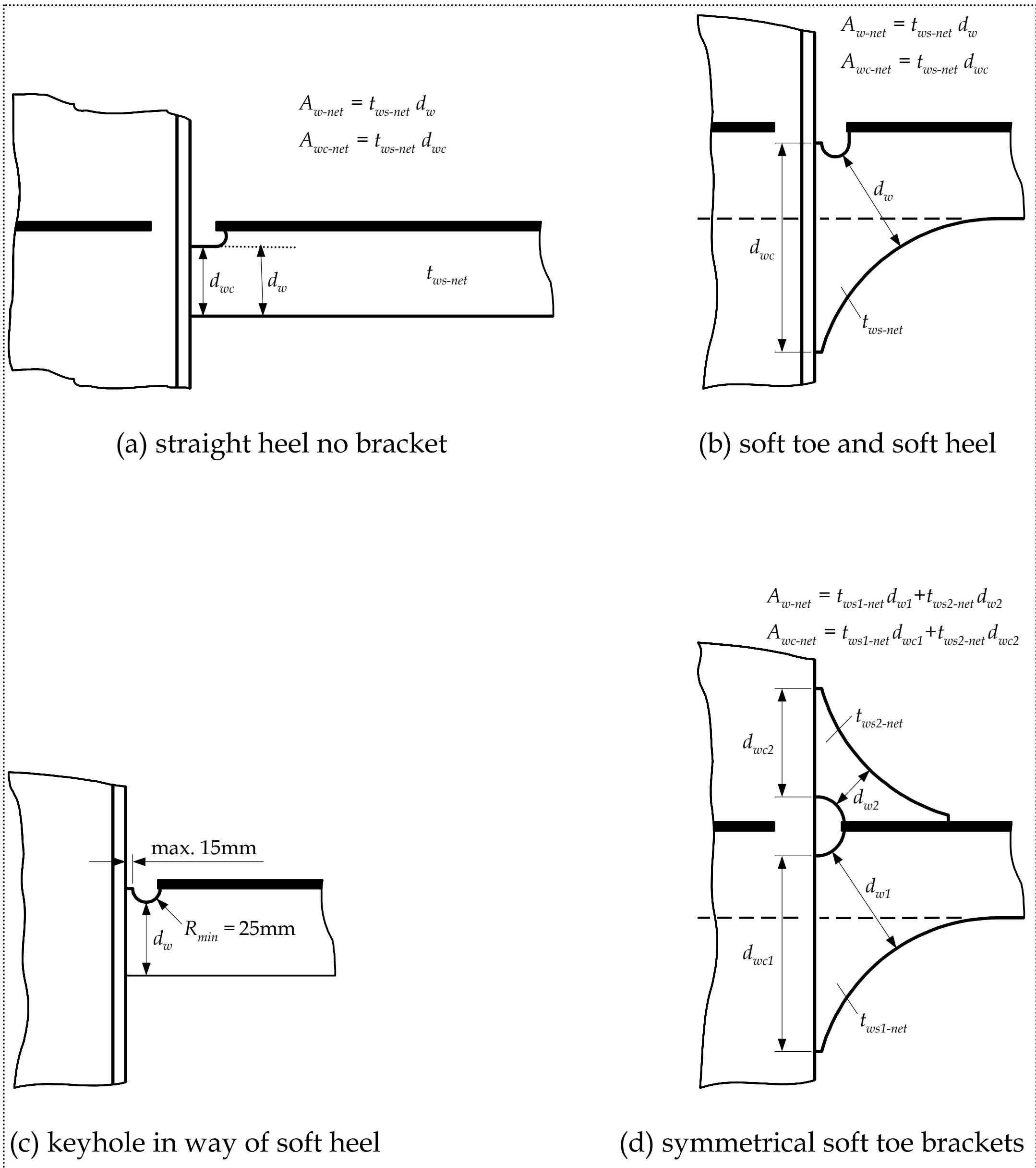
(3) These Rule Corrigenda should be read in conjunction with the 1 July 2008 consolidated edition of Double Hull Oil Tankers CSR (www.iacs.org.uk/publications / common structural rules).

Section 4 - Basic Information

3 STRUCTURE DESIGN DETAILS

3.4 Intersections of Continuous Local Support Members and Primary Support Members

Figure 4.3.6
Primary Support Member Web Stiffener Details



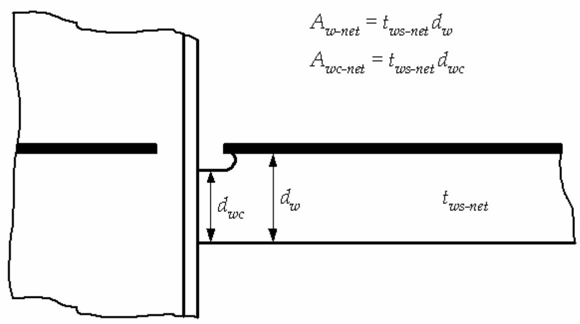
Where:

t_{ws-net}, $t_{ws1-net}$ and $t_{ws2-net}$	net thickness of the primary support member web stiffener/backing bracket, in mm
d_w, d_{w1} and d_{w2}	minimum depth of the primary support member web stiffener/backing bracket, in mm

d_{wc}, d_{wc1} and d_{wc2}	length of connection between the primary support member web stiffener/backing bracket and the local support stiffener, in mm
Note Except where specific dimensions are noted for the details of the keyhole in way of the soft heel, see *3.4.1.4*, the details shown in this figure are only used to illustrate symbols and definitions and are not intended to represent design guidance or recommendations.	

Reason for the Change:

The definition of dw is corrected in (a) (KC ID 466). The correction is not shown in figure above and old figure is therefore inserted below.



(a) straight heel no bracket

SECTION 8 – SCANTLING REQUIREMENTS

1 LONGITUDINAL STRENGTH

1.3 Hull Girder Shear Strength

1.3.3 Shear force correction for longitudinal bulkheads between cargo tanks

1.3.3.4 For ships with a centreline bulkhead between the cargo tanks, the correction factor, K_3, in way of transverse bulkheads is to be taken as:

$$K_3 = \left[0.40\left(1 - \frac{1}{1+n}\right) - f_3\right]$$

Where:

n number of floors between transverse bulkheads~~, excluding the floor in line with the wash bulkhead~~

f_3 shear force distribution factor, see *Figure 8.1.2*

Reason for the Change:

Correction of definition error

1.3.3.6 For ships with two longitudinal bulkheads between the cargo tanks, the correction factor, K_3, in way of transverse bulkhead is to be taken as:

$$K_3 = \left[0.5\left(1 - \frac{1}{1+n}\right)\left(\frac{1}{r+1}\right) - f_3\right]$$

Where:

n number of floors between transverse bulkheads~~, excluding the floor in line with the wash bulkhead~~

r ratio of the part load carried by the wash bulkheads and floors from longitudinal bulkhead to the double side and is given by:

$$r = \frac{1}{\left[\dfrac{A_{3-net50}}{A_{1-net50} + A_{2-net50}} + \dfrac{2\times10^4 b_{80}(n_s+1)A_{3-net50}}{l_{tk}(n_s A_{T-net50} + R)}\right]}$$

Note: for preliminary calculations, r may be taken as 0.5

l_{tk} length of cargo tank, between transverse bulkheads in the side cargo tank, in m

b_{80} 80% of the distance from longitudinal bulkhead to the inner hull longitudinal bulkhead ~~side~~, in m, at tank mid length

$A_{T-net50}$ net shear area of the transverse wash bulkhead, including the double bottom floor directly below, in the side cargo tank, in cm², taken as the smallest area in a vertical section. $A_{T\text{-}net50}$ is to be calculated with net thickness given by t_{grs} - $0.5t_{corr}$

$A_{1\text{-}net50}$ net area, as shown in *Figure 8.1.2,* in m²

$A_{2\text{-}net50}$ net area, as shown in *Figure 8.1.2,* in m²

$A_{3\text{-}net50}$ net area, as shown in *Figure 8.1.2,* in m²

f_3 shear force distribution factor, as shown in *Figure 8.1.2*

n_S number of wash bulkheads in the side cargo tank

R total efficiency of the transverse primary support members in the side tank

$$R = \left(\frac{n - n_s}{2} - 1\right)\frac{A_{Q-net50}}{\gamma} \quad \sout{R = \left(\frac{n}{2} - 1\right)\frac{A_{Q-net50}}{\gamma}} \quad \text{cm}^2$$

γ $$= 1 + \frac{300 {b_{80}}^2 A_{Q-net50}}{I_{psm-net50}}$$

$A_{Q\text{-}net50}$ net shear area, in cm², of a transverse primary support member in the wing cargo tank, taken as the sum of the net shear areas of floor, cross ties and deck transverse webs. $A_{Q\text{-}net50}$ is to be calculated using the net thickness given by t_{grs} - $0.5t_{corr.}$ The net shear area is to be calculated at the mid span of the members.

$I_{psm\text{-}net50}$ net moment of inertia for primary support members, in cm⁴, of a transverse primary support member in the wing cargo tank, taken as the sum of the moments of inertia of transverses and cross ties. It is to be calculated using the net thickness given by t_{grs} - $0.5t_{corr.}$ The net moment of inertia is to be calculated at the mid span of the member including an attached plate width equal to the primary support member spacing

t_{grs} gross plate thickness, in mm

t_{corr} corrosion addition, in mm, as defined in *Section 6/3.2*

Reason for the Change:

Correction of definition error of “n” and Editorial

1.4 Hull Girder Buckling Strength

1.4.2 Buckling assessment

1.4.2.6 The compressive buckling strength, of plate panels, is to satisfy the following criteria:

$$\eta \leq \eta_{allow}$$

Where:

η buckling utilisation factor

$$\frac{\sigma_{hg-net50}}{\sigma_{cr}}$$

$\sigma_{hg\text{-}net50}$ hull girder compressive stress based on net hull girder sectional properties, in N/mm² as defined in *1.4.2.3*

σ_{cr} critical compressive buckling stress, σ_{xcr} or σ_{ycr} as appropriate, in N/mm², as specified in *Section 10/3.2.1.3*. The critical compressive buckling stress is to be calculated for the effects of hull girder compressive stress only. The effects of other membrane stresses and lateral pressure are to be ignored. The net thickness given as $t_{grs} - t_{corr}$ as described in Section 6/3.3.2.2 is to be used for calculation of σ_{cr}

η_{allow} allowable buckling utilisation factor:

= 1.0 for plate panels at or above 0.5*D*

= 0.90 for plate panels below 0.5*D*

Reason for the Change:

Editorial (KC ID 167)

1.4.2.8 The compressive buckling strength of longitudinal stiffeners is to satisfy the following criteria:

$$\eta \leq \eta_{allow}$$

Where:

η greater of the buckling utilisation factors given in *Section 10/3.3.2.1* and *Section 10/3.3.3.1*. The buckling utilisation factor is to be calculated for the effects of hull girder compressive stress only. The effects of other membrane stresses and lateral pressure are to be ignored.

η_{allow} allowable buckling utilisation factor:

= 1.0 for stiffeners at or above 0.5*D*

= 0.90 for stiffeners below 0.5*D*

Reason for the Change:

Editorial (KC ID 167)

2 CARGO TANK REGION

2.1 General

2.1.4 General scantling requirements

2.1.4.8 Enlarged stiffeners (with or without web stiffening) used for Permanent Means of Access (PMA) are to comply with the following requirements:

a) Buckling strength including proportion (slenderness ratio) requirements for primary support members as follows:

- For stiffener web, see *Section 10/2.3.1.1(a), 10/3.2*.
- For stiffener flange, see *Section 10/2.3.1.1(b), 10/2.3.3.1*.
- For web stiffeners, see *Section 10/2.3.2.1, 10/2.3.2.2, 10/3.3*.

Note: Note 1 of table 10.2.1 is not applicable.

b) Buckling strength of longitudinal PMA platforms without web stiffeners may also be ensured using the criteria for local support members in *Section 10/2.2* and *Section 10/3.3*, including Note 1 of *Table 10.2.1*, provided shear buckling strength of web is verified in line with *Section 10/3.2*.

c) All other requirements for local support members as follows:

- Corrosion additions: requirements for local support members
- Minimum thickness: requirements for local support members
- Fatigue: requirements for local support members

Note: For primary support members (or part of it) used as a PMA platform the requirements for primary support members are to be applied.

Reason for the Change:

New paragraph, is added to clarify applicable requirements for enlarged stiffeners used for permanent means of access. (KC ID 572)

6 EVALUATION OF STRUCTURE FOR SLOSHING AND IMPACT LOADS

6.4 Bow Impact

6.4.7.6 The net shear area of the web, $A_{shrw-net50}$, of each primary support member at the support/toe of end brackets is not to be less than:

$$A_{shr-net50} = \frac{5 f_{pt} P_{im} b_{slm} l_{shr}}{C_t \tau_{yd}} \quad A_{w-net50} = \frac{5 f_{pt} P_{im} b_{slm} l_{shr}}{C_t \tau_{yd}} \quad \text{cm}^2$$

Where:

f_{pt} patch load modification factor

$$= \frac{l_{slm}}{l_{shr}}$$

l_{slm} extent of bow impact load area along the span

$= \sqrt{A_{slm}}$ m, but not to be taken as greater than l_{shr}

l_{shr} effective shear span, as defined in *Section 4/2.1.25*, in m

P_{im} bow impact pressure as given in *Section 7/4.4* and calculated at the load calculation point defined in *Section 3/5.3.2*, in kN/m²

b_{slm} breadth of impact load area supported by the primary support member, to be taken as the spacing between primary support members as defined in *Section 4/2.2.2*, but not to be taken as greater than l_{slm}, in m

C_t permissible shear stress coefficient

= 0.75 for acceptance criteria set AC3

τ_{yd} $= \frac{\sigma_{yd}}{\sqrt{3}}$ N/mm²

σ_{yd} specified minimum yield stress of the material, in N/mm²

Reason for the Change:

Editorial

Section 10 – Buckling and Ultimate Strength

2 STIFFNESS AND PROPORTIONS

2.2 Plates and Local Support Members

2.2.1 Proportions of plate panels and local support members

Table 10.2.1
Slenderness Coefficients

Item		**Coefficient**
plate panel, C	hull envelope and tank boundaries	100
	other structure	125
stiffener web plate, C_w	angle and T profiles	75
	bulb profiles	41
	flat bars	22
flange/face plate[(1)], C_f	angle and T profiles	12

<u>Note</u>

1. The total flange breadth, b_f, for angle and T profiles is not to be less than: $b_f = 0.25 d_w$
2. Measurements of breadth and depth are based on gross scantlings ~~as described in Section 4/2.4.1.2.~~

Where:

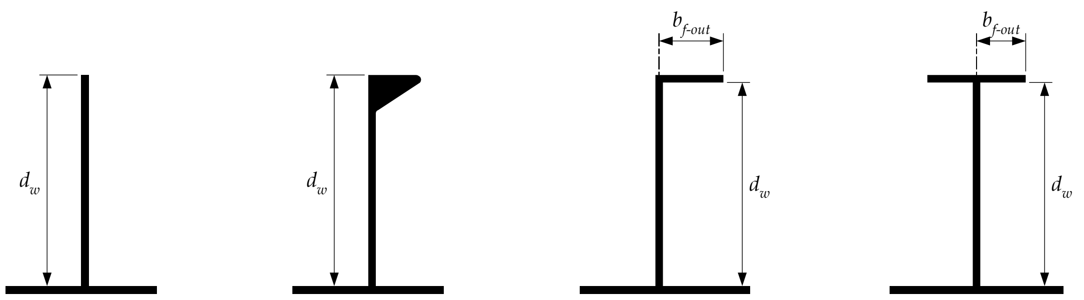
t_{net} net thickness of plate, in mm

d_w depth of web plate, in mm

$t_{w\text{-}net}$ net web thickness, in mm

$b_{f\text{-}out}$ breadth of flange outstands, in mm

$t_{f\text{-}net}$ net flange thickness, in mm

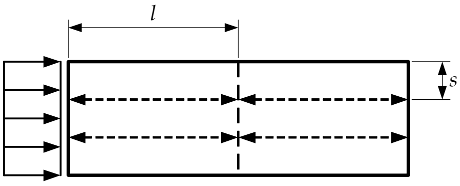
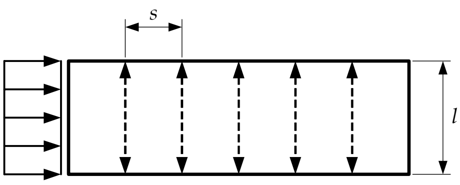


Flat bars Bulb flats Angles T bars

<u>Reason for the Change:</u>

Editorial (Irrelevant cross reference deleted since 4/2.4.1.2 does not describe measuring based on gross scantling)

Table 10.2.2
Stiffness Criteria for Web Stiffening

Mode	Inertia requirements, cm^4
(a) web stiffeners parallel to the ~~compression stresses~~ flanges of the primary support member 	$I_{net} = C l^2 A_{net} \frac{\sigma_{yd}}{235}$
(b) web stiffeners normal to ~~compression stresses~~ flanges of the primary support member 	$I_{net} = 1.14x10^{-5} l\, s^2 t_{w-net}\left(2.5\frac{1000l}{s} - 2\frac{s}{1000l}\right)\frac{\sigma_{yd}}{235}$

Where:

C = 1.43 for longitudinal stiffeners in cargo tank region ~~subject to hull girder stresses~~

= 0.72 for other stiffeners

l length of web stiffener, in m.

For web stiffeners welded to local support members (LSM), the length is to be measured between the flanges of the local support members.

For sniped web stiffeners the length is to be measured between the lateral supports e.g. the total distance between the flanges of the primary support member as shown for Mode (b).

A_{net} net section area of web stiffener including attached plate assuming effective breadth of 80% of stiffener spacing s, in cm^2

s spacing of stiffeners, in mm, as defined in *Section 4/2.2.1*

t_{w-net} net web thickness of the primary support member, in mm

σ_{yd} specified minimum yield stress of the material of the web plate of the primary support member, in N/mm^2

Reason for the change:

Clarification

2.4.3 Requirements to edge reinforcements in way of openings and bracket edges

2.4.3.1 The depth of stiffener web, d_w, of edge stiffeners in way of openings and bracket edges is not to be less than:

~~$$d_w = Cl_{stf}\sqrt{\frac{\sigma_{yd}}{235}}$$~~

$$d_w = Cl\sqrt{\frac{\sigma_{yd}}{235}}$$ mm, or 50 mm, whichever is greater

Where:

l_{stf} length of edge stiffener ~~between effective supports~~, in m

σ_{yd} specified minimum yield stress of the material, in N/mm^2

C slenderness coefficient

75 for end brackets

50 for tripping brackets

50 for edge reinforcements in way of openings

Reason for the change:

Clarification

3 PRESCRIPTIVE BUCKLING REQUIREMENTS

3.3 Buckling of stiffeners

3.3.3 Torsional buckling mode

Table 10.3.2
Moments of Inertia

Section property	Flat bars	Bulb flats, angles and T bars
I_{P-net}	$\dfrac{d_w^3\, t_{w-net}}{3\text{x}10^4}$	$\left(\dfrac{A_{w-net}(e_f-0.5t_{f-net})^2}{3}+A_{f-net}\,e_f^2\right)10^{-4}$
I_{T-net}	$\dfrac{d_w\, t_{w-net}^3}{3\text{x}10^4}\left(1-0.63\dfrac{t_{w-net}}{d_w}\right)$	~~$\dfrac{(e_f-0.5t_{f-net})t_{w-net}^3}{3\text{x}10^4}\left(1-0.63\dfrac{t_{f-net}}{e_f-0.5t_{f-net}}\right)+\dfrac{b_f\,t_{f-net}^3}{3\text{x}10^4}\left(1-0.63\dfrac{t_{f-net}}{b_f}\right)$~~ $\dfrac{(e_f-0.5t_{f-net})t_{w-net}^3}{3\text{x}10^4}\left(1-0.63\dfrac{t_{w-net}}{e_f-0.5t_{f-net}}\right)$ $+$ $\dfrac{b_f\,t_{f-net}^3}{3\text{x}10^4}\left(1-0.63\dfrac{t_{f-net}}{b_f}\right)$
$I_{\omega-net}$	$\dfrac{d_w^3\, t_{w-net}^3}{36\text{x}10^6}$	for bulb flats and angles: $\dfrac{A_{f-net}\,e_f^2\,b_f^2}{12\text{x}10^6}\left(\dfrac{A_{f-net}+2.6A_{w-net}}{A_{f-net}+A_{w-net}}\right)$ for T bars: $\dfrac{b_f^3\,t_{f-net}\,e_f^2}{12\text{x}10^6}$

Reason for the change:
Editorial correction.
In the equation for St. Venant's moment of inertia t_{f-net} is replaced with t_{w-net} to align with CSR-BC.

Appendix A – Hull Girder Ultimate Strength

2 CALCULATION OF HULL GIRDER ULTIMATE CAPACITY

2.2 Simplified Method Based on an Incremental-iterative Approach

2.2.2 Assumption and modelling of the hull girder cross-section

2.2.2.4 The size and modelling of hard corner elements is to be as follows:

(a) it is to be assumed that the hard corner extends up to $s/2$ from the plate intersection for longitudinally stiffened plate, where s is the stiffener spacing

(b) it is to be assumed that the hard corner extends up to $20t_{grs}$ from the plate intersection for transversely stiffened plates, where t_{grs} is the gross plate thickness.

Note

For transversely stiffened plate, the effective breadth of plate for the load shortening portion of the stress-strain curve is to be taken as the full plate breadth, i.e. to the intersection of other plates – not from the end of the hard corner if any. ~~The area is to be taken as the breadth between the intersecting plates~~. The area on which the value of σ_{CR5} defined in 2.3.8.1 applies is to be taken as the breadth between the hard corners, i.e. excluding the end of the hard corner if any.

Reason for the change:

Clarification requested in KC question 427.

Appendix C - Fatigue Strength Assessment

2 FATIGUE DAMAGE CALCULATION

2.4 Hot Spot Stress (FE Based) Approach

2.4.2 Stresses to be used

2.4.2.6 The hot spot stress is defined as the surface stress at 0.5*t* away from the weld toe location, as shown in *Figure C.2.1*. ~~This stress may be~~ The hot spot stress is to be obtained by linear interpolation using the respective stress at the 1st and 2nd element from the structure intersection.

Reason for the change:
Clarification requested in KC question 509.

Appendix D – Buckling Strength Assessment

1.1 ADVANCED BUCKLING ANALYSIS

1.1.1 General

1.1.2.3 Use of alternative buckling procedures to the reference advanced buckling procedure is acceptable provided that the alternative procedure is verified against the test cases specified in the *Background to Appendix D* and where the permissible utilisation buckling factor for the alternative method, $\eta_{all\text{-}alt}$, complies with:

~~$$\eta_{all-alt} \leq \eta_{all} \cdot \left(\frac{\eta_{ref-i}}{\eta_{alt-i}}\right)_{\min}$$~~

$$\eta_{all-alt} \leq \eta_{all} \cdot \left(\frac{\eta_{alt-i}}{\eta_{reft-i}}\right)_{\min}$$

Where:

η_{all}	permissible utilisation factor against buckling <u>for plate and stiffened panels</u> as specified in *Section 9/Table 9.2.2*
$\eta_{ref\text{-}i}$	utilisation factor for reference advanced buckling procedure for test case *i* specified in *Background to Appendix D*
$\eta_{alt\text{-}i}$	utilisation factor for alternative buckling procedure for test case *i* specified in *Background to Appendix D*

<u>*Reason for the change:*</u>
Correction of misprint in formula

5 STRENGTH ASSESSMENT (FEM) – BUCKLING PROCEDURE

5.2 Structural Modelling and Capacity Assessment Method

5.2.3 Un-stiffened panels

Table D.5.1
Structural Elements for the Strength Assessment (FEM)

Structural Elements	Idealisation	Assessment method(1)	Normal panel definition(2)
Longitudinal structure, see *Figure D.5.1*			
Longitudinally stiffened panels Shell envelope Deck Inner hull Hopper tank side Longitudinal bulkheads Centreline bulkheads	Stiffened panel	Method 1	Length: between web frames Width: between primary support members (PSM)(2)
Double bottom longitudinal girders in line with longitudinal bulkhead or connected to hopper tank side	Stiffened panel	Method 1	Length: between web frames Width: full web depth
Web of horizontal girders in double side tank connected to hopper tank side	Stiffened panel	Method 1	Length: between web frames Width: full web depth
Web of double bottom longitudinal girders not in line with longitudinal bulkhead or not connected to hopper tank side	Stiffened panel	Method 2	Length: between web frames Width: full web depth
Web of horizontal girders in double side tank not connected to hopper tank side	Stiffened panel	Method 2	Length: between web frames Width: full web depth
Web of single skin longitudinal girders	Un-stiffened panel	Method 2	Between local stiffeners/face plate/PSM
Transverse structure, see *Figure D.5.2*			
Web of transverse deck girders including brackets	Un-stiffened panel	Method 2	Between local stiffeners/face plate/PSM
Vertical web in double side tank	Stiffened panel	Method 2	Length: full web depth Width: between primary support members
All irregularly stiffened panels, e.g. Web panels in way of hopper tank and bilge	Un-stiffened panel	Method 2	Between local stiffeners/face plate/PSM
Double bottom floors	Stiffened panel	Method 2	Length: full web depth Width: between primary support members
Vertical web frame including brackets	Un-stiffened panel	Method 2	Between vertical web stiffeners/face plate/PSM
Cross tie web plate	Un-stiffened panel	Method 2	Between vertical web stiffeners/face plate/PSM
Transverse Oil-tight and Watertight bulkheads, see *Figure D.5.3* and Transverse wash bulkheads, see *Figure D.5.4*			
All regularly stiffened bulkhead panels	Stiffened panel	Method 1	Length: between primary support members Width: between primary support members
Regularly stiffened bulkhead with secondary buckling stiffeners perpendicular to regular stiffeners (3)	Stiffened panel	Method 1	Length: between primary support members Width: between primary support members
All irregularly stiffened bulkhead panels, e.g. web panels in way of hopper tank and bilge	Un-stiffened panel	Method 2	Between local stiffeners/face plate
Web plate of bulkhead stringers including brackets	Un-stiffened panel	Method 2	Between web stiffeners /face plate
Transverse Corrugated bulkheads			
Upper/lower stool including stiffeners	Stiffened panel	Method 1	Length: between internal web diaphragms Width: length of stool side
Stool internal web diaphragm	Un-stiffened panel	Method 2	Between local stiffeners /face plate / PSM

Note

1. The assessment method specifies which buckling strength assessment method is to be used, see *4.1*

2.	See structural idealisation, *3.1.3.*
3.	The secondary stiffener can be modelled as "sniped" or "continuous". The stiffener is considered "sniped" unless rotational end supports are provided at both ends An area stiffened by irregular buckling stiffeners only should be assessed by considering each plate in the panel as Unstiffened panel using Method 2.

Reason for the change:

Clarification

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