第 104/2014 號行政長官公告

中華人民共和國於一九九九年十二月十三日以照會通知聯合國秘書長，經修訂的《1974年國際海上人命安全公約》自一九九九年十二月二十日起適用於澳門特別行政區；

國際海事組織海上安全委員會於二零零四年十二月九日透過第MSC.168（79）號決議通過了《單舷側結構散貨船的舷側結構標準和準則》，該標準和準則自二零零六年七月一日起適用於澳門特別行政區；

基於此，行政長官根據澳門特別行政區第3/1999號法律第六條第一款的規定，命令公佈包含上指標準和準則的第MSC.168（79）號決議的中文及英文文本。

二零一四年十一月二十七日發佈。

行政長官　崔世安

Aviso do Chefe do Executivo n.º 104/2014

Considerando que a República Popular da China, por nota datada de 13 de Dezembro de 1999, notificou o Secretário-Geral das Nações Unidas sobre a aplicação da Convenção Internacional para a Salvaguarda da Vida Humana no Mar de 1974, tal como emendada, na Região Administrativa Especial de Macau a partir de 20 de Dezembro de 1999;

Considerando igualmente que, em 9 de Dezembro de 2004, o Comité de Segurança Marítima da Organização Marítima Internacional, através da resolução MSC.168(79), adoptou as Normas e Critérios relativos às Estruturas Laterais de Graneleiros de Construção Lateral Simples, e que tais Normas e Critérios são aplicáveis na Região Administrativa Especial de Macau, a partir de 1 de Julho de 2006;

O Chefe do Executivo manda publicar, nos termos do n.º 1 do artigo 6.º da Lei n.º 3/1999 da Região Administrativa Especial de Macau, a resolução MSC.168(79), que contém as referidas Normas e Critérios, nos seus textos em línguas chinesa e inglesa.

Promulgado em 27 de Novembro de 2014.

O Chefe do Executivo, *Chui Sai On*.

第 MSC.168（79）號決議

（2004 年 12 月 9 日通過）

單舷側結構散貨船的舷側結構標準和準則

海上安全委員會，

憶及《國際海事組織公約》關於本委員會職能的第 28（b）條，

還憶及 1997 年 SOLAS 公約大會通過的關於散貨船附加安全措施的 SOLAS 公約第 XII 章，旨在提高載運固體散裝貨物船舶的安全，

進一步憶及，認識到進一步改進散貨船在設計、結構、設備和操作等各方面安全的必要性，委員會審查了關於散貨船安全的各種綜合安全評估（FSA）研究的結果，

認識到，禁止未滿足適當舷側結構強度要求的單舷側結構散貨船在滿載狀態下隔艙裝載重貨，通過減小剪力和彎矩會有助於改進這些船舶的安全，

注意到海安會第 MSC.170（79）號決議，委員會以該決議通過了 1974 年 SOLAS 公約的修訂後第 XII 章，特別是第 XII 章第 14 條 – “限制空艙航行”，參照了散貨船為了避免上述限制必須滿足的強制性標準和準則，

注意到國際船級社協會（IACS）已經發佈了下列相關的統一要求：

S12 Rev.2.1 – 單舷側散貨船舷側結構；和

S31 – 按 S12 Rev.1 統一要求或以後的修訂版來建造的單舷側散貨船舷殼骨架更新準則，

考慮到國際船級社協會的上述統一要求分別包含了為確定公約第 XII 章第 14 條是否應適用於某一具體散貨船所需的標準和準則，因此，統一要求應構成所述標準和準則的基礎，

審議了船舶設計和設備分委會在其第 47 次會議上提出的建議，

1. 為適用公約第 XII 章第 14 條，通過了：

.1 單舷側散貨船舷側結構標準，列於本決議附件 1；和

.2 未按單舷側散貨船舷側結構標準建造的單舷側散貨船舷殼骨架和墊板更新準則，列於本決議附件 2；

2. 提請公約締約國政府注意，所附的標準和更新準則將在經修正的公約第 XII 章生效後於 2006 年 7 月 1 日發揮效力；

3. 要求秘書長將本決議及其所附的標準和更新準則正文的核證無誤副本轉送公約的所有締約國政府；

4. 還要求秘書長將本決議及其所附的標準和更新準則正文的核證無誤副本轉送所有非公約締約國政府的本組織成員。

附件 1

單舷側散貨船舷側結構標準

1 適用範圍

就《SOLAS 公約》第 XII 章第 14 條而言，這些要求規定了船長在 150 m 及以上並載運密度為 1,780 kg/m^3 及以上固體散裝貨物的單舷側散貨船為了不受空艙航行限制，要求其貨物區域內舷側結構的最低標準。

2 舷側結構的材料尺寸

2.1 舷殼板的厚度和截面模數及舷側骨架的剪切面積，應按照主管機關根據《安全公約》第 XI-1 章第 1 條的規定認可的某一船級社的標準或根據具有同等安全水準的適用的主管機關國內標準來確定。

2.2 為防止舷殼板過度施壓變形，應增加直接鄰近防撞艙壁的舷艙骨架的材料尺寸。作為替代性措施，應裝配支撐結構，以保持船艏艙內首尖艙縱樑的連續性。

3 骨架腹板的最低厚度

貨物區域內骨架腹板的厚度應不小於 $t_{w,min}$，以 mm 計，由下式得出：

$$t_{w,min} = C\ (7.0 + 0.03\ L)$$

式中：

C = 對於沿着船艏艙的骨架腹板為 1.15；

對於沿着其他艙的骨架腹板為 1。

L = 在夏季載重水線上從船艏桿前側至舵柱後側的距離，或如果沒有舵柱，至舵桿中心的距離，以 m 計。L 不應小於夏季載重水線上最大長度的 96%且不必大於 97%，但不必超過 200 m。

4 下墊板與上墊板

4.1 骨架下墊板的厚度不應小於 t_w 與 $t_{w,min}$ + 2 mm 中的較大者，其中 t_w 是舷側骨架腹板的適合厚度。骨架墊板座的厚度不應小於 t_w 與 $t_{w,min}$ 中的較大者。

4.2 在圖 1 所示位置的骨架和墊板或整體墊板及相關的船殼板的截面模數 SM 不應小於對骨架跨中面積要求的截面模數 SM_F 的兩倍。

4.3 下墊板和上墊板的尺度不應小於圖 2 所示的尺度。

4.4 如圖 3 所示，應通過連接墊板，確保頂邊艙和底開艙內與舷側骨架的上端和下端連接的結構連貫性。應根據主管機關按照《SOLAS 公約》第 XI-1 章第 1 條的規定認可的某一船級社的標準或具有同等安全水準的適用的主管機關國內標準，對墊板沿壓曲部位予以加強。

4.5 支撐連接墊板的舷側縱向構件和傾斜艙壁縱向構件的截面模數，應根據主管機關按照《SOLAS 公約》第 XI-1 章第 1 條的規定認可的某一船級社的要求或具有同等安全水準的適用的主管機關國內標準，以橫材間所取的跨距來確定。如果根據主管機關或經認可的船

級社的意見作出了其他安排，舷側縱向構件和傾斜艙壁縱向構件的截面模數應根據適用的標準予以確定，以便墊板得到有效的支撐。

5 舷側骨架型材

5.1 骨架應是組合的對稱型材，帶有整體的上墊板和下墊板，並應裝有軟趾腳。

5.2 舷側骨架法蘭應在與端部墊板連接處成為彎曲形（不是彎成肘節形）。彎曲部分的半徑應不小於 r（以 mm 計），由下式得出：

$$r = \frac{0.4\, b_f^2}{t_f}$$

式中 b_f 和 t_f 分別是墊板的寬度和厚度，以 mm 計。法蘭的端部應被剪開。

5.3 在船長小於 190 m 的船上，低碳鋼骨架可以是不對稱的，並可裝配分開的墊板。墊板的面板或法蘭應兩端剪開。墊板應裝配軟趾腳。

5.4 骨架腹板厚度比率不應超過下列數值：

- 對稱的法蘭骨架，$60\ k^{0.5}$
- 不對稱法蘭骨架，$50\ k^{0.5}$

式中：

對於普通船體結構的鋼材，k = 1；

對於屈服應力為 315 N/mm^2 的鋼材，k = 0.78；和

對於屈服應力為 355 N/mm^2 的鋼材，k = 0.72。

突出的法蘭部分不應超過法蘭淨厚度的 $10\ k^{0.5}$ 倍。

6 防歪斜墊板

在不對稱部分的船艏艙舷側骨架的路徑上應在每兩個骨架上裝配防歪斜墊板，如圖 4 所示。

7 骨架與端部墊板的焊接

7.1 對於骨架和墊板與舷側殼板和底邊艙和頂邊艙板以及腹板與面板的連接應採用雙面連續焊接。

7.2 就本條而言，焊接縫（見圖 1）：

- 在“a”區應為 0.44 t
- 在“b”區應為 0.4 t

式中 t 為兩個連接部件的較薄者。

7.3 如果船型不適合採用有效的填角焊縫，為了確保如上所述的同樣有效的焊接，可能需要對骨架和墊板的邊緣預加工。

8 舷側殼板的最小淨厚度

位於底邊艙和頂邊艙之間的舷側殼板的厚度不應小於 $t_{p,min}$（以 mm 計），由下式得出：

$$t_{p,min} = \sqrt{L}$$

圖 1

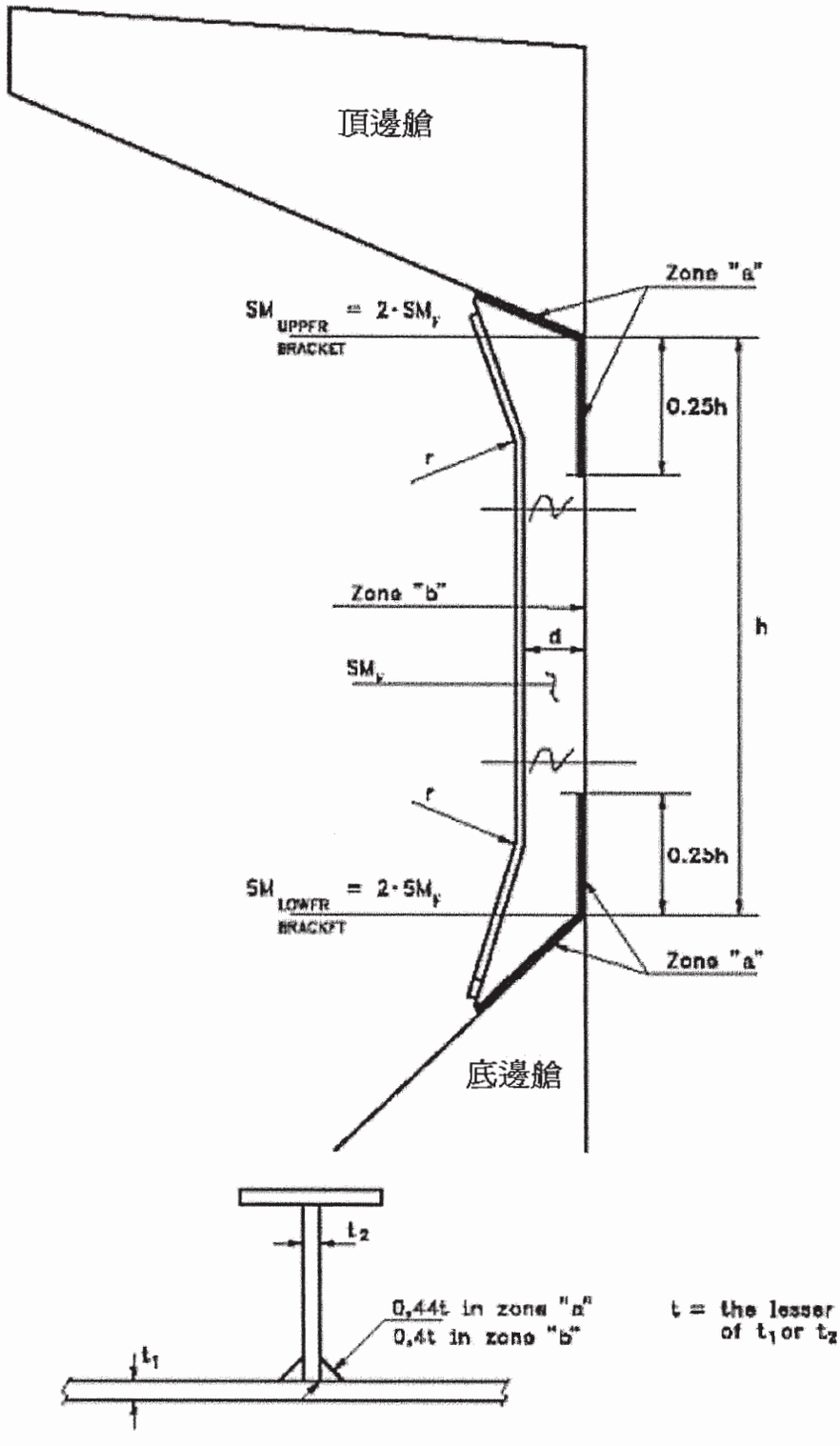

頂邊艙
Zone "a"
$SM_{UPPER\ BRACKET} = 2 \cdot SM_y$
0.25h
r
Zone "b"
d
h
SM_y
r
0.25h
$SM_{LOWER\ BRACKET} = 2 \cdot SM_y$
Zone "a"
底邊艙
t_2
0,44t in zone "a"
0,4t in zone "b"
t = the lesser of t_1 or t_2
t_1

圖 2

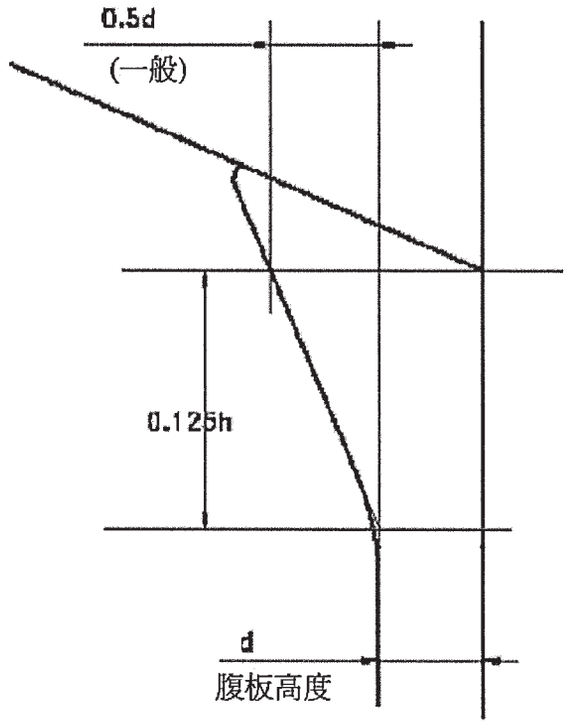


圖 3

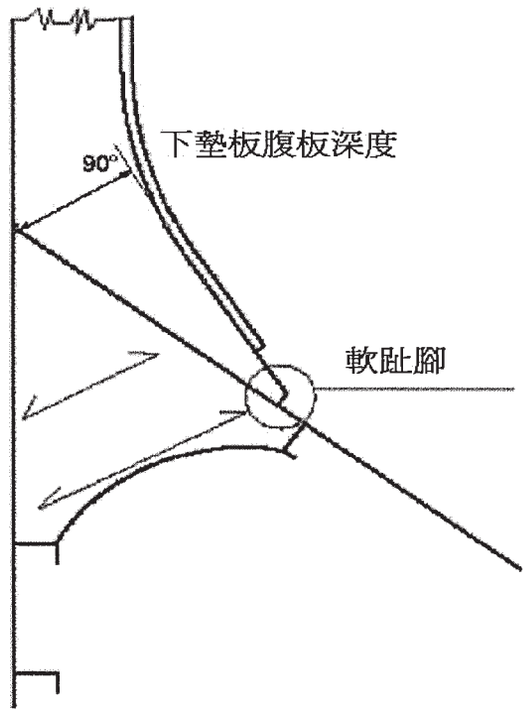
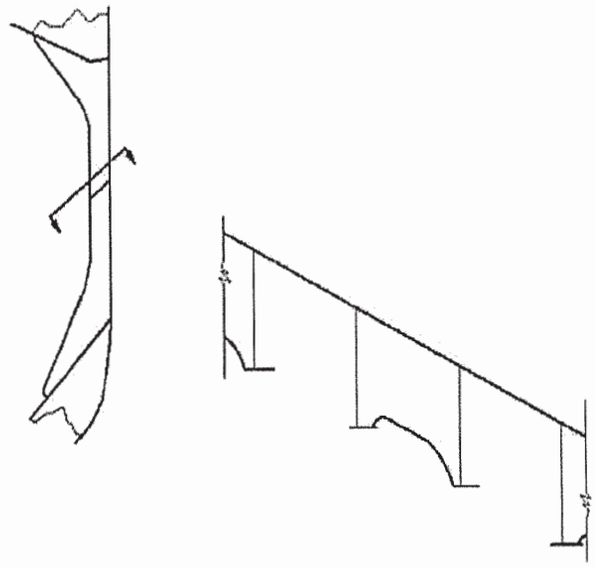


圖 4 – 沿船艏艙要裝配的防歪斜墊板



附件 2

未按照單舷側散貨船舷側結構標準建造的單舷側散貨船舷殼骨架和墊板的更新準則

1 適用範圍和定義

就《SOLAS 公約》第 XII 章第 14 條而言，這些要求適用於未按照附件 1 標準建造的單舷側散貨船的舷殼骨架和貨艙墊板，但不受空艙航行限制的散貨船應達到同等的安全水準。

這些要求規定了如第 2 款所述的對舷殼骨架和墊板的腹板和法蘭應適用的鋼材更新準則或應採取的其他措施。

在第 2.3 款中還對舷側骨架的加強措施做出了規定。

不能採用有限單元法或其他數值分析或直接計算程序作為代替方法來滿足本附件的要求，除非本附件的要求不能直接適用於異常的舷側結構安排或框架。

要在船齡達到 10 年時及隨後的每個期間檢驗和換新檢驗之日進行這些要求的符合評估。

1.1 冰區航行加強船

1.1.1 如果對散貨船進行加強以符合冰區船級符號，那麼，在考慮是否符合本附件要求時，不應包括中間骨架。

1.1.2 對附加結構滿足冰區加強符號所要求的更新厚度，應根據

船級社的要求進行。

1.1.3 如果要求撤消冰區船級符號，除防歪斜墊板外（見第 2.1.2.1.b 段和第 2.3 段），不應將附加的冰區加強結構視為有助於符合本附件。

2 更新或其他措施

2.1 更新或其他措施的標準

2.1.1 第 2.1 段中使用的符號

t_M = 測量的厚度，以 mm 計

t_{REN} = 需要更新的厚度（第 2.1.2 段）

$t_{REN,d/t}$ = 基於 d/t 比率的厚度標準（第 2.1.2.1 段）

$t_{REN,S}$ = 基於強度的厚度標準（第 2.1.2.2 段）

$t_{COAT} = 0.75\ t_{S12}$

t_{S12} = 附件 1 在第 3 段中對骨架腹板和在第 4 段中對上墊板和下墊板所要求的厚度，以 mm 計

t_{AB} = 建造的厚度，以 mm 計

t_C = 見下表 1

表 1 – t_C 值，以 mm 計

船舶長度（m）	除 1 號艙外的貨艙		1 號貨艙	
	跨樑和上墊板	下墊板	跨樑和上墊板	下墊板
≤100	2	2.5	2	3
150	2	3	3	3.5
≥200	2	3	3	4
註：船舶中間長度，t_C 通過上述值之間的線性內插法求得。				

2.1.2 腹板標準（剪力和其他檢查）

當測量厚度（t_M）等於或小於下列規定的厚度（t_{REN}）時，應更新舷殼骨架和墊板的腹板：

t_{REN} 是下列中的最大者：

.1 $t_{COAT} - t_C$

.2 0.75 t_{AB}

.3 $t_{REN,d/t}$

.4 $t_{REN,S}$（第 2.1.2.2 段所要求）

2.1.2.1 基於 d/t 比的厚度標準

根據下列 b）和 c），$t_{REN,d/t}$ 可用下面公式得出：

$t_{REN,d/t}$ = （腹板深度，mm）/R

式中：

R = 對於骨架

對於對稱的法蘭骨架，為 65 $k^{0.5}$

對於不對稱的法蘭骨架，為 $55\ k^{0.5}$

對於下墊板（見下文 a））：

對於對稱的法蘭骨架，為 $87\ k^{0.5}$

對於不對稱的法蘭骨架，為 $73\ k^{0.5}$

對於普通船體結構鋼材，$k = 1$，

對於屈服應力為 315 N/mm^2 的鋼材，$k = 0.78$，和

對於屈服應力為 355 N/mm^2 的鋼材，$k = 0.72$。

對於下整體墊板的 $t_{REN,d/t}$，在任何情況下都不應取小於它們所支撐的骨架的 $t_{REN,d/t}$ 的值。

a） 下墊板

在計算下墊板腹板深度時，應適用下列：

.1 可從污水底艙的傾斜艙壁與舷殼板的交點處垂直於下墊板的面板（見圖 3）量得下墊板的腹板深度。

.2 如果在下墊板板上安裝了加強材，可取腹板深度為舷殼與加強材之間、加強材之間或最外端加強材與墊板的面板之間的距離，取最大者。

b） 替代性防歪斜墊板

當 t_M 小於舷側骨架的 b）部分 $t_{REN,d/t}$ 時（見圖 2），可安裝符合第 2.3 段的防歪斜墊板，代替腹板深度與舷側骨架厚度比所要求的墊板，在這種情況中，在根據第 2.1.2 段確定 t_{REN} 時可不必考慮 $t_{REN,d/t}$。

c） 緊靠防撞艙壁之後

對於直接位於防撞艙壁之後的舷側骨架，增加其尺寸以便其慣性力矩能避免舷側殼板的不必要柔性，當其腹板的建造厚度 t_{AB} 大於 1.65 $t_{REN,S}$ 時，可用厚度 $t_{REN,d/t}$ 的值通過以下公式求得 $t'_{REN,d/t}$：

$$t'_{REN,d/t} = \sqrt[3]{t_{REN,d/t}{}^2 t_{REN,S}}$$

式中 $t_{REN,S}$ 從第 3.3 段求得。

2.1.2.2 基於剪切強度檢查的厚度標準

如圖 1 中所定義的，如果舷側骨架底部的 t_M 等於或小於 t_{COAT}，那麼，$t_{REN,S}$ 應按照第 3.3 段來確定。

2.1.2.3 更新的骨架腹板和下墊板的厚度

如果鋼材需要更新，被更新的腹板的厚度不應小於 t_{AB}、1.2 t_{COAT} 或 1.2 t_{REN}，取最大者。

2.1.2.4 其他措施的標準

當 $t_{REN} < t_M \leq t_{COAT}$ 時，應採取包括下列所有措施：

.1 噴砂，或等效者，和塗上保護層（見第 2.2 段），

.2 當圖 1 所示的舷側骨架 A、B、C 和 D 區的任何部分出現上述狀態時，安裝防歪斜墊板（見第 2.3 段）；和

.3 在換新檢驗和期間檢驗時，對保護層的維護要達到“如新”的狀態（即，未被損壞或生鏽）。

如果結構部件的厚度相對於建造時的厚度未出現厚度減少且保護層處於“如新”狀態（即，未被損壞或生鏽），則可以免除上述措施。

2.1.3 骨架和墊板的標準（彎曲檢查）

如果下墊板的長度或深度不能滿足附件 1 的要求，應根據第 3.4 段進行抗彎強度檢查，並根據要求對骨架和/或墊板進行更新或加強。

2.2 厚度測量、鋼材更新、噴砂和保護層

就鋼材更新、噴砂和保護層而言，規定了 A、B、C 和 D 四個區，如圖 1 所示。

對每個區都應進行有代表性的厚度測量，並應針對第 2.1 段的標準進行評估。

如果是整體墊板，當第 2.1 段的標準對 A 或 B 區不能滿足時，應適當對 A 和 B 區均進行鋼材更新、噴砂和塗保護層。

如果是分開的墊板，當第 2.1 段的標準對 A 區或 B 區不能滿足時，應適當對這些區的每個區進行鋼材更新、噴砂和塗保護層。

如果根據第 2.1 段的要求需要對 C 區進行鋼材更新，應同時對 B 區和 C 區進行。如果根據第 2.1 段的要求需要對 C 區進行噴砂和塗保護層，應同時對 B、C 和 D 區進行。

如果根據第 2.1 段的要求需要對 D 區進行鋼材更新，只需要對該區進行。如果根據第 2.1 段的要求需要對 D 區進行噴砂和塗保護層，應同時對 C 和 D 區進行。

如果主管機關或主管機關根據《安全公約》第 XI-1 章第 1 條的規定認可的某一船級社認為某區處於“如新”狀態（即，未損壞或生鏽），對原先更新或塗保護層的區可給予特殊的考慮。

如果採用基於第 2.1 段的更新厚度標準，一般情况下，塗的保護層應符合本組織適用的要求。

根據第 2.1 段的要求，如果有限的幾個舷側骨架和墊板表明需要對其全長的某部分塗上保護層，應適用下列標準：

.1 塗保護層的部分包括：

- 舷側骨架和墊板的腹板和面板，
- 舷側殼板的艙面、污水底艙和舷側艙板，如果適用，從舷側骨架的腹板起，寬度應不小於 100 mm。

.2 應採用環氧樹脂塗料或等效物。

在任何情况下，在使用塗料之前，對所有塗層的表面都要進行噴砂。

2.3 加強措施

加強措施由防歪斜墊板構成，位於舷側骨架的下部和中跨（見圖 4）。防歪斜墊板可位於每兩個骨架處，但下墊板和中跨墊板應安裝在任意一對骨架之間的一線上。

防歪斜墊板的厚度應不小於它們所連接的舷側骨架的建造厚度。

對於防歪斜墊板與舷殼骨架和殼板的連接，應採用雙面連續焊接。

2.4 焊接縫厚度

如果更新鋼部件，焊接應符合附件 1 第 7 段的要求。

2.5 點蝕與凹槽

如果點蝕的密度在面積上超過 15%（見圖 5），應進行厚度測量，對點蝕情況進行檢查。

在點蝕或凹槽處，最低可接受的剩餘厚度等於：

.1 對於骨架和墊板腹板及法蘭上的點蝕或凹槽，為建造時厚度的 75%；和

.2 對於附着在舷側骨架上的，且每側寬度超過 30 mm 的舷殼、底開艙和舷側艙板上的點蝕或凹槽，為建造時厚度的 70%。

3 強度檢查標準

一般情況下，應對荷載情況進行計算，並應對每個艙的前、中和後骨架進行強度檢查。中間位置的骨架所需的尺寸應在對上述骨架求得的結果之間通過線性內插法求得。

如果在某一艙內舷側骨架的尺寸不同，那麼，對具有相同尺寸的每組骨架的中骨架所要求的尺寸也應進行計算。對於中間位置骨架所要求的尺寸應從對計算過的骨架的結果之間通過線性內插法求得。

3.1 負荷方式

3.1.1 力

對舷側骨架截面 a）和 b）（圖 2 所規定，如果是分開的下墊板，截面 b）部分是下墊板的頂部）的強度檢查要考慮的力 $P_{fr,a}$ 和 $P_{fr,b}$（以 kN 計）可由下式得出：

$$P_{fr,a} = P_S + \max（P_1，P_2）$$

$$P_{fr,b} = P_{fr,a}\frac{h-2h_B}{h}$$

式中：

Ps = 靜水壓力，以 kN 計

= $sh\left(\frac{P_{S,U}+P_{S,L}}{2}\right)$，當舷側骨架跨度 h 上端（見圖 1）低於載重線時

= $sh'\left(\frac{P_{S,L}}{2}\right)$，當舷側骨架跨度 h 上端（見圖 1）位於或高於載重線時

P_1 = 逆浪波浪壓力，以 kN 計

= $sh\left(\frac{P_{1,U}+P_{1,L}}{2}\right)$

P_2 = 橫浪波浪壓力，以 kN 計

= $sh\left(\frac{P_{2,U}+P_{2,L}}{2}\right)$

h，h_B = 分別如圖 1 和圖 2 中所定義的舷側骨架跨度和下墊板長度，以 m 計

h' = 舷側骨架跨度 h 下端（見圖 1）與載重線之間的距離，以 m 計

s = 骨架間距，以 m 計

$p_{s,U}$，$p_{s,L}$ = 分別為舷側骨架跨度 h（見圖 1）上端和下端處的靜水壓力，以 kN/m^2 計

$p_{1,U}$，$p_{1,L}$ = 如下列第 3.1.2.1 段所定義的分別為舷側骨架跨度 h 上端和下端的波浪壓力，以 kN/m^2 計

$p_{2,U}$，$p_{2,L}$ = 如下列第 3.1.2.2 段所定義的分別為舷側骨架跨度 h 上端和下端的波浪壓力，以 kN/m^2 計

3.1.2 波浪壓力

3.1.2.1 波浪壓力 p_1

.1 水線及以下的波浪壓力 p_1（kN/m^2），由下式得出：

$$p_1 = 1.50\left[p_{11} + 135\frac{B}{2\,(B+75)} - 1.2\,(T-z)\right]$$

$$p_{11} = 3k_S C + k_f$$

.2 水線以上波浪壓力 p_1（kN/m^2），由下式得出：

$$p_1 = p_{1wl} - 7.50\,(z - T)$$

3.1.2.2 波浪壓力 p_2

.1 水線及以下波浪壓力 p_2（kN/m^2），由下式得出：

$$p_2 = 13.0\left[0.5B\frac{50C_f}{2\,(B+75)} + C_B\frac{0.5B+k_f}{14}\left(0.7+2\frac{z}{T}\right)\right]$$

.2 水線以上波浪壓力 p_2（kN/m^2），由下式得出：

$$p_2 = p_{2wl} - 5.0\,(z-T)$$

式中：

p_{1wl} = p_1 處於水線的海水波浪壓力

p_{2wl} = p_2 處於水線的海水波浪壓力

L = 從船艏柱前側至舵柱後側夏季載重線上的距離，或如果沒有舵柱，至舵桿中心的距離，以為 m 計。L 不應小於夏季載重線上最大長度的 96%但不必大於 97%。

B = 最大型寬，以 m 計。

C_B = 相對於夏季載重線的吃水 d 船造型方形系數，基於長度 L 和型寬 B，但所取的數值不應小於 0.6：

$$C_B = \frac{\text{吃水 d 時的型排水量 } [m^3]}{LBd}$$

T = 最大設計吃水，以 m 計

C = 系數

$= 10.75 - \left(\frac{300 - L}{100}\right)^{1.5}$，當 $90 \leq L \leq 300$ m 時

= 10.75，當 300＜L 時

$$Cr = \left(1.25 - 0.025\frac{2k_r}{\sqrt{GM}}\right)k$$

K = 1.2　無舭龍骨的船舶

= 1　有舭龍骨的船舶

k_r = 橫搖回轉半徑。如果得不到 k_r 的實際數值

= 0.39 B，對於橫斷面上質量分佈均勻的船舶（如，重貨隔艙裝載或的輕泡貨均勻裝載）

= 0.25 B，對於橫斷面上質量分佈不均勻的船舶（如，重貨均勻分佈）

GM = 0.12B，如果 GM 實際數值不可得

Z = 從基線到負荷點的垂直距離，以 m 計

$k_s = C_B + \frac{0.83}{\sqrt{C_B}}$ 在 L 的後端

$= C_B$ 從 L 的後端起在 0.2 L 與 0.6 L 之間

$= C_B + \frac{1.33}{C_B}$ 在 L 的前端

在上述規定的點之間，k_s 應為線性變化

$k_f = 0.8\ C$

3.2 允許的應力

在舷殼骨架中允許的法向應力 σ_a 和剪應力 τ_a，以 N/mm^2 計，由下式得出：

$\sigma_a = 0.90\sigma_F$

$\tau_a = 0.40\sigma_F$

式中 σ_F 是材料的最小上屈服應力，以 N/mm^2 計。

3.3 剪切強度檢查

如圖 1 所規定，如果舷側骨架下部中的 t_M 小於或等於 t_{COAT}，應根據下列進行剪切強度檢查。

厚度 $t_{REN,S}$（mm）是對截面 a）和 b）的剪切強度檢查所獲得的厚度 $t_{REN,Sa}$ 和 $t_{REN,Sb}$ 之間的最大值（見圖 2 和圖 3.1），由下式得出，但所取的值不必超過 0.75 t_{S12}。

.1 在截面 a）：$t_{REN,Sa} = \frac{1{,}000 k_s P_{fr,a}}{d_a \sin\phi \tau_a}$

.2 在截面 b）：$t_{REN,Sb} = \frac{1{,}000 k_s P_{fr,b}}{d_b \sin\phi \tau_a}$

式中：

k_s = 剪力分配系數，所取的值等於 0.6

$P_{fr,a}$，$P_{fr,b}$ = 第 3.1.1 中規定的壓力

d_a，d_b = 分別為截面 a）和 b）墊板和骨架深度（見圖 2），以 mm 計，如果是分開墊板（非整體的），所取的 d_b 值應是最小的腹板深度減去可能的扇形部分

ϕ = 骨架腹板與殼板之間的角度

t_a = 第 3.2 段所定義的允許剪應力，以 N/mm^2 計。

3.4 抗彎強度檢查

如果下墊板長度或深度不符合附件 1 中的要求，那麼，截面 a）和 b）處墊板和舷側骨架的實際截面模數（cm^3）不應小於：

.1 在截面 a）：

$$Z_a = \frac{1{,}000\, P_{fr,a}\, h}{m_a \sigma_a}$$

.2 在截面 b）：

$$Z_b = \frac{1{,}000\, P_{fr,a}\, h}{m_b \sigma_a}$$

式中：

$P_{fr,a}$ = 第 3.1.1 中所定義的壓力

h = 圖 1 中所定義的舷側骨架跨度，以 m 計

σ_a = 第 3.2 中所定義的允許法向應力，以 N/mm^2 計

m_a，m_b = 表 2 中所定義的彎矩系數

應基於測量的厚度來計算，墊板和舷側骨架關於平行於附屬板的軸線的實際截面模數。對於預先計算的情況，可使用替代的厚度數值，但它們應不小於：

.1 t_{REN}，對於腹板厚度；

.2 經主管機關根據《SOLAS 公約》第 XI-1 章第 1 條認可的某個船級社的法蘭和附屬板更新標準允許的最小厚度或具有同等安全水準的適用的主管機關國內標準允許的最小厚度。

附屬板寬度等於骨架間距，沿着在中跨 h 上的殼板測量。

如果截面 a）和 b）的實際截面模數小於 Z_a 和 Z_b 值，應更新或加強骨架和墊板以便取得實際截面模數值不小於 1.2 Z_a 和 1.2 Z_b。

在這樣的情況中，如圖 1 所定義，更新或加強的法蘭應伸出舷側骨架的下部。

表 2 – 彎矩系數 m_a 和 m_b

	m_a	m_b		
		$h_B = 0.08\ h$	$h_B = 0.1\ h$	$h_B = 0.125\ h$
經批准的在非均勻裝載狀態下運營的船舶的空艙	10	17	19	22
其他情況	12	20	22	26

註 1：非均勻裝載狀態係指在這樣的裝載狀態中，針對每個艙進行評估，最大和最低充裝比率之間的比率超過 1.20 的，並對不同的貨物密度作校正。

註 2：對於墊板長度 h_B 的中間值，系數 m_b 在表內數值之間通過線性內插法求得。

圖 1 – 舷側骨架的下部

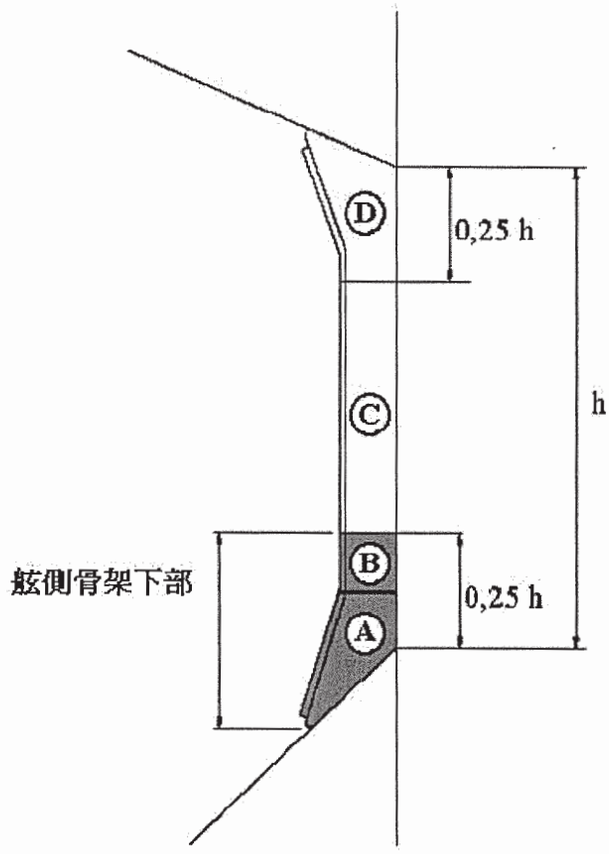
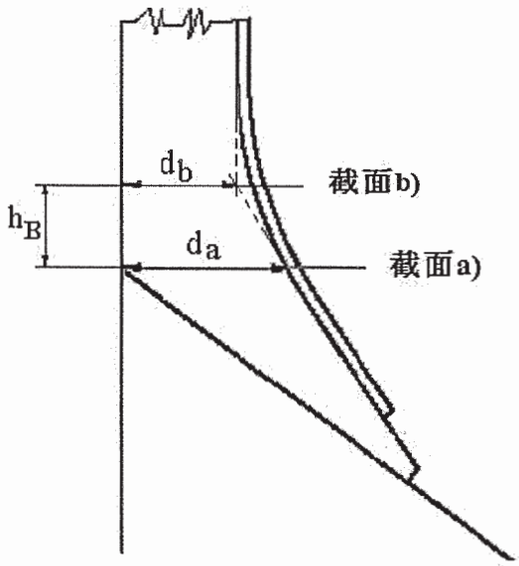


圖 2 – 截面 a）和截面 b）



d_a = 下墊板腹板深度

d_b = 骨架腹板深度

h_B = 下墊板長度

圖 3 – 下墊板腹板深度定義

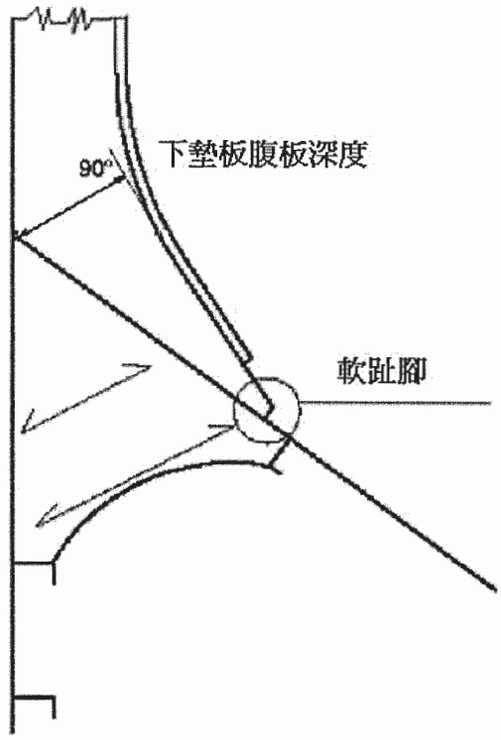


圖 4 – 防歪斜墊板

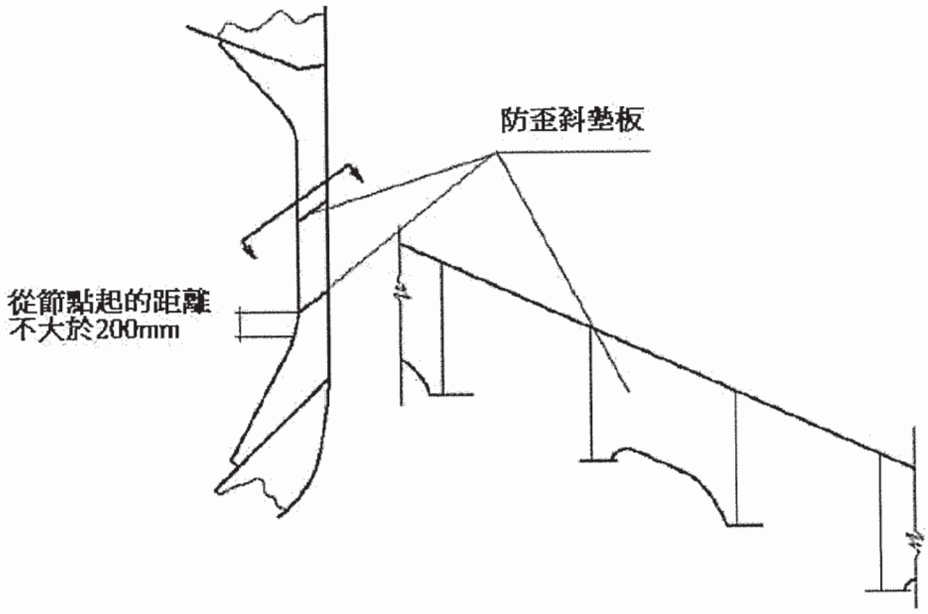
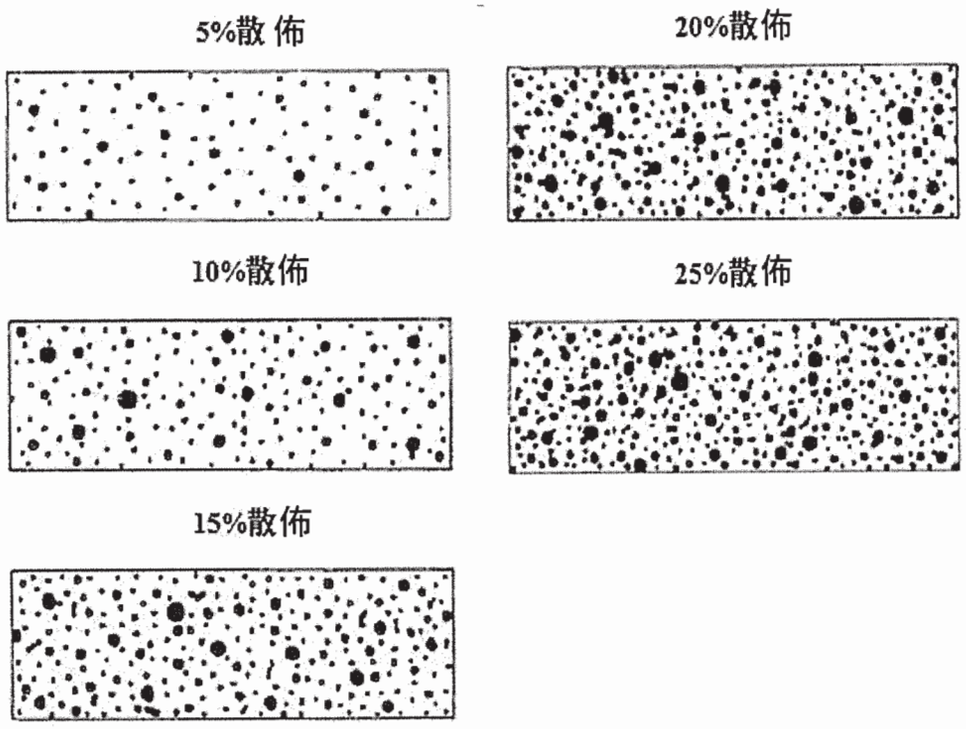


圖 5 – 蝕點密度圖（從 5%到 25%的密度）



RESOLUTION MSC.168(79)
(adopted on 9 December 2004)

STANDARDS AND CRITERIA FOR SIDE STRUCTURES OF BULK CARRIERS OF SINGLE-SIDE SKIN CONSTRUCTION

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO SOLAS chapter XII on Additional safety measures for bulk carriers, which the 1997 SOLAS Conference adopted with the aim of enhancing the safety of ships carrying solid bulk cargoes,

RECALLING FURTHER that, having recognized the need to further improve the safety of bulk carriers in all aspects of their design, construction, equipment and operation, it examined the results of various formal safety assessment (FSA) studies on bulk carrier safety,

RECOGNIZING that banning of alternate hold loading of heavy cargoes in full load condition for bulk carriers of single-side skin construction not meeting appropriate side structural strength requirements would contribute to improving the safety of these ships by reduction of shear forces and bending moments,

NOTING resolution MSC.170(79) by which it adopted, *inter alia*, the revised chapter XII of the 1974 SOLAS Convention, in particular regulation XII/14 – Restrictions from sailing with any hold empty, where reference is made to mandatory standards and criteria which a bulk carrier has to comply with in order to avoid the above-mentioned restrictions,

ACKNOWLEDGING that the International Association of Classification Societies (IACS) has issued the following relevant Unified Requirements:

S12 Rev.2.1 - Side structure in single side skin bulk carriers; and

S31 - Renewal criteria for side shell frames in single side skin bulk carriers not built in accordance with UR S12 Rev.1 or subsequent revisions,

CONSIDERING that the above IACS Unified Requirements embody respectively the standards and criteria necessary to ascertain whether regulation XII/14 of the Convention should apply to a particular bulk carrier, and, therefore, should form the basis of the said standards and criteria,

HAVING CONSIDERED the recommendation made by the Sub-Committee on Ship Design and Equipment at its forty-seventh session,

1. ADOPTS, for the purposes of the application of regulation XII/14 of the Convention:

.1 the Standards for side structures in single-side skin bulk carriers, set out in Annex 1 to the present resolution; and

.2 the Renewal criteria for side shell frames and brackets in single-side skin bulk carriers not built in accordance with the Standards for side structures in single-side skin bulk carriers, set out in Annex 2 to the present resolution;

2. INVITES Contracting Governments to the Convention to note that the annexed Standards and Renewal criteria will take effect on 1 July 2006 upon the entry into force of the revised chapter XII of the Convention;

3. REQUESTS the Secretary-General to transmit certified copies of this resolution and the text of the annexed Standards and Renewal criteria to all Contracting Governments to the Convention;

4. FURTHER REQUESTS the Secretary-General to transmit certified copies of this resolution and the text of the annexed Standards and Renewal criteria to all Members of the Organization which are not Contracting Governments to the Convention.

ANNEX 1

STANDARDS FOR SIDE STRUCTURES IN SINGLE-SIDE SKIN BULK CARRIERS

1 Application

For the purpose of SOLAS regulation XII/14, these requirements define the minimum required standards for the side structures within the cargo area of single-side skin bulk carriers of 150 m in length and upwards carrying solid bulk cargoes having a density of 1,780 kg/m³ and above, for them not to be subject to restrictions from sailing with any hold empty.

2 Scantlings of side structures

2.1 The thickness of the side shell plating and the section modulus and shear area of side frames shall be determined according to the criteria of a classification society which is recognized by the Administration in accordance with the provisions of SOLAS regulation XI-1/1, or with applicable national standards of the Administration which provide an equivalent level of safety.

2.2 The scantlings of side hold frames immediately adjacent to the collision bulkhead shall be increased in order to prevent excessive imposed deformation on the shell plating. As an alternative, supporting structures shall be fitted which maintain the continuity of forepeak stringers within the foremost hold.

3 Minimum thickness of frame webs

The thickness of frame webs within the cargo area shall not be less than $t_{w,min}$, in mm, given by:

$$t_{w,min} = C(7.0 + 0.03L)$$

where:

C = 1.15 for the frame webs in way of the foremost hold;
1 for the frame webs in way of other holds.

L = the distance, in m, on the summer load waterline from the fore side of stem to the after side of the rudder post, or the centre of the rudder stock if there is no rudder post. L shall not be less than 96%, and need not be greater than 97%, of the extreme length on the summer load waterline but need not be taken greater than 200 m.

4 Lower and upper brackets

4.1 The thickness of the frame lower brackets shall not be less than the greater of t_w and $t_{w,min} + 2$ mm, where t_w is the fitted thickness of the side frame web. The thickness of the frame upper bracket shall not be less than the greater of t_w and $t_{w,min}$.

4.2 The section modulus SM of the frame and bracket or integral bracket, and associated shell plating, at the locations shown in figure 1, shall not be less than twice the section modulus SM_F required for the frame midspan area.

4.3 The dimensions of the lower and upper brackets shall not be less than those shown in figure 2.

4.4 Structural continuity with the upper and lower end connections of side frames shall be ensured within topside and hopper tanks by connecting brackets as shown in figure 3. The brackets shall be stiffened against buckling according to the criteria of a classification society which is recognized by the Administration in accordance with the provisions of SOLAS regulation XI-1/1, or with applicable national standards of the Administration which provide an equivalent level of safety.

4.5 The section moduli of the side longitudinals and sloping bulkhead longitudinals which support the connecting brackets shall be determined with the span taken between transverses according to the requirements of a classification society which is recognized by the Administration in accordance with the provisions of SOLAS regulation XI-1/1, or with applicable national standards of the Administration which provide an equivalent level of safety. Where other arrangements are adopted at the discretion of the Administration or a recognized classification society, the section moduli of the side longitudinals and sloping bulkhead longitudinals shall be determined according to the applicable criteria for the purpose of effectively supporting the brackets.

5 Side frame sections

5.1 Frames shall be fabricated symmetrical sections with integral upper and lower brackets and shall be arranged with soft toes.

5.2 The side frame flange shall be curved (not knuckled) at the connection with the end brackets. The radius of curvature shall not be less than r, in mm, given by:

$$r = \frac{0.4 b_f^2}{t_f}$$

where b_f and t_f are the flange width and thickness of the brackets, respectively, in mm. The end of the flange shall be sniped.

5.3 In ships less than 190 m in length, mild steel frames may be asymmetric and fitted with separate brackets. The face plate or flange of the bracket shall be sniped at both ends. Brackets shall be arranged with soft toes.

5.4 The frame web thickness ratio of frames shall not exceed the following values:

.1 $60\ k^{0.5}$ for symmetrically flanged frames;

.2 $50\ k^{0.5}$ for asymmetrically flanged frames;

where:

k = 1 for ordinary hull structural steel;
k = 0.78 for steel with yield stress of 315 N/mm²; and
k = 0.72 for steel with yield stress of 355 N/mm².

The outstanding flange shall not exceed 10 $k^{0.5}$ times the net flange thickness.

6 Tripping brackets

In way of the foremost hold, side frames of asymmetrical section shall be fitted with tripping brackets at every two frames, as shown in figure 4.

7 Weld connections of frames and end brackets

7.1 Double continuous welding shall be adopted for the connections of frames and brackets to side shell and hopper and top-side tank plating and web to face plates.

7.2 For this purpose, the weld throat shall be (see figure 1):

.1 0.44 t in zone "a";

.2 0.4 t in zone "b";

where t is the thinner of the two connected members.

7.3 Where the hull form is such as to prohibit an effective fillet weld, edge preparation of the web of frame and bracket may be required, in order to ensure the same efficiency as the weld connection stated above.

8 Minimum net thickness of side shell plating

The thickness of side shell plating located between the hopper and top-side tank shall not be less than $t_{p,min}$, in mm, given by:

$$t_{p,min} = \sqrt{L}$$

Figure 1

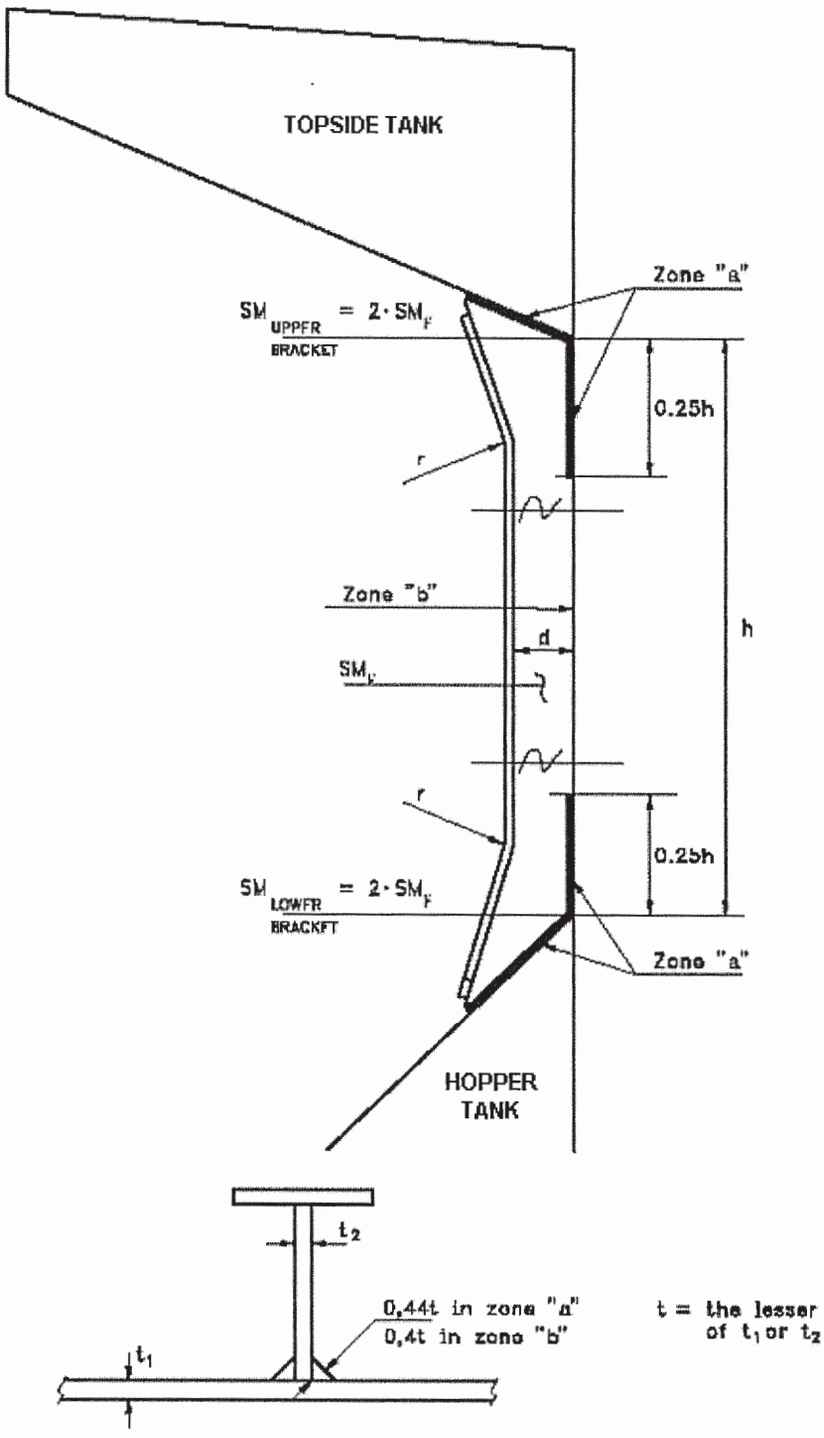

TOPSIDE TANK
Zone "a"
SM UPPER BRACKET = 2·SM
0.25h
r
Zone "b"
d
h
SM
r
0.25h
SM LOWER BRACKET = 2·SM
Zone "a"
HOPPER TANK
t2
0,44t in zone "a"
0,4t in zone "b"
t = the lesser of t1 or t2
t1

Figure 2

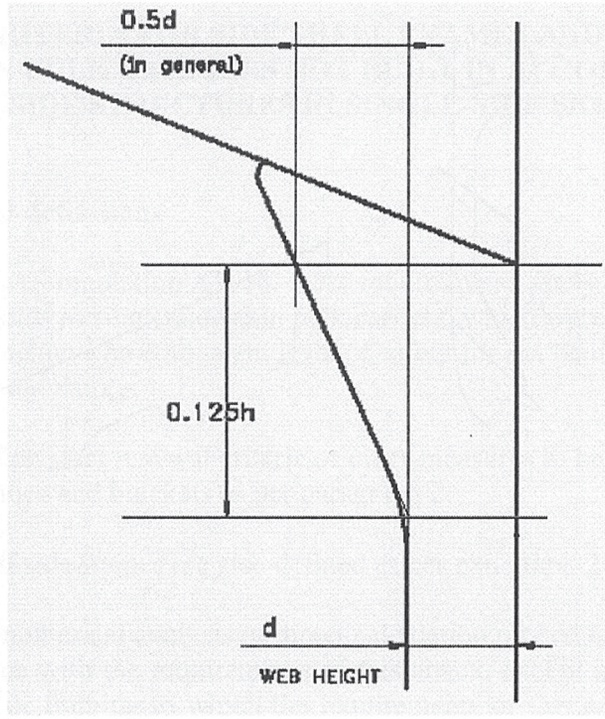


Figure 3

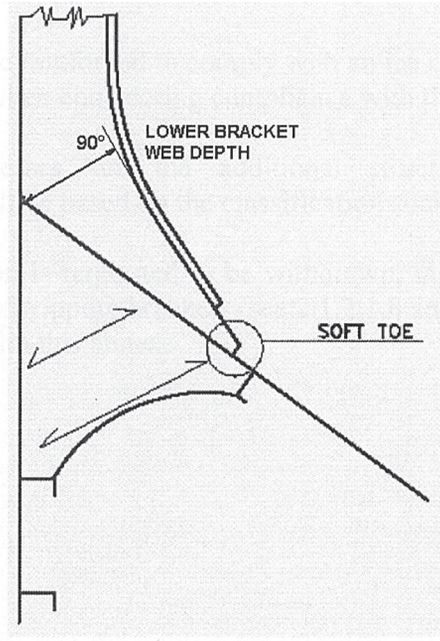
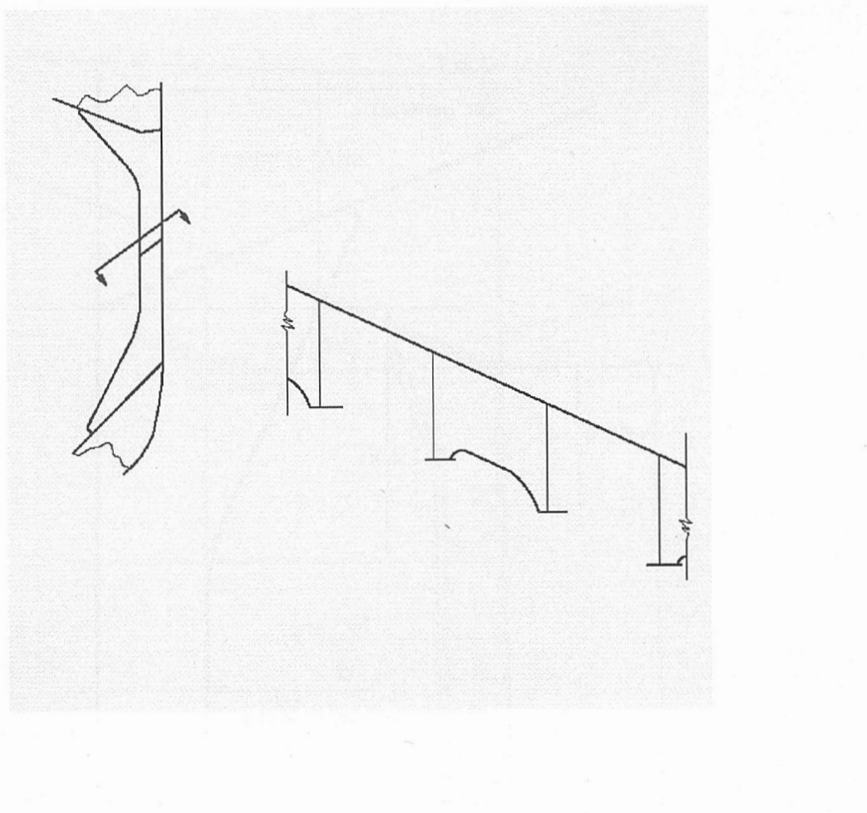


Figure 4 - Tripping brackets to be fitted in way of foremost hold



ANNEX 2

RENEWAL CRITERIA FOR SIDE SHELL FRAMES AND BRACKETS IN SINGLE-SIDE SKIN BULK CARRIERS NOT BUILT IN ACCORDANCE WITH THE STANDARDS FOR SIDE STRUCTURES IN SINGLE-SIDE SKIN BULK CARRIERS

1 Application and definitions

For the purpose of SOLAS regulation XII/14, these requirements apply to the side shell frames and brackets of cargo holds in single-side skin bulk carriers, which were not built in accordance with annex 1, but shall achieve an equivalent level of safety for not being subject to restrictions when sailing with any hold empty.

These requirements define steel renewal criteria or other measures to be taken for the webs and flanges of side shell frames and brackets as per paragraph 2.

Reinforcing measures of side frames are also defined as per paragraph 2.3.

Finite element or other numerical analysis or direct calculation procedures cannot be used as an alternative to compliance with the requirements of this annex, except in cases of unusual side structure arrangements or framing to which the requirements of this annex cannot be directly applied.

Assessment of compliance with these requirements is to be carried out by the date on which the ship reaches 10 years of age and at each subsequent intermediate and renewal survey.

1.1 Ice strengthened ships

1.1.1 Where bulk carriers are reinforced to comply with an ice class notation, the intermediate frames shall not be included when considering compliance with this annex.

1.1.2 The renewal thicknesses for the additional structure required to meet the ice strengthening notation shall be based on the classification society's requirements.

1.1.3 If the ice class notation is requested to be withdrawn, the additional ice strengthening structure, with the exception of tripping brackets (see 2.1.2.1.b and 2.3), shall not be considered to contribute to compliance with this annex.

2 Renewal or other measures

2.1 Criteria for renewal or other measures

2.1.1 Symbols used in 2.1

t_M = thickness as measured, in mm
t_{REN} = thickness at which renewal is required (2.1.2)
$t_{REN,d/t}$ = thickness criteria based on d/t ratio (2.1.2.1)
$t_{REN,S}$ = thickness criteria based on strength (2.1.2.2)
t_{COAT} = 0.75 t_{S12}
t_{S12} = thickness, in mm, as required by annex 1 in paragraph 3 for frame webs and in paragraph 4 for upper and lower brackets
t_{AB} = thickness as built, in mm
t_C = See table 1 below

Table 1 - t_C values, in mm

Ship's length L, in m	Holds other than No.1		Hold No.1	
	Span and upper brackets	Lower brackets	Span and upper brackets	Lower brackets
≤100	2	2.5	2	3
150	2	3	3	3.5
≥ 200	2	3	3	4
Note: For intermediate ship lengths, t_C is obtained by linear interpolation between the above values.				

2.1.2 Criteria for webs (shear and other checks)

The webs of side shell frames and brackets shall be renewed when the measured thickness (t_M) is equal to, or less than, the thickness (t_{REN}) as defined below:

t_{REN} is the greatest of:

.1 $t_{COAT} - t_C$

.2 0.75 t_{AB}

.3 $t_{REN,d/t}$

.4 $t_{REN,S}$ (where required by 2.1.2.2)

2.1.2.1 Thickness criteria based on d/t ratio

Subject to b) and c) below, $t_{REN,d/t}$ is given by the following equation:

$t_{REN,d/t}$ = (web depth in mm)/R

where:

R = for frames

65 $k^{0.5}$ for symmetrically flanged frames
55 $k^{0.5}$ for asymmetrically flanged frames

for lower brackets (see a) below):

87 $k^{0.5}$ for symmetrically flanged frames
73 $k^{0.5}$ for asymmetrically flanged frames

k = 1 for ordinary hull structural steel;
k = 0.78 for steel with yield stress of 315 N/mm²; and
k = 0.72 for steel with yield stress of 355 N/mm².

In no instance shall $t_{REN,d/t}$ for lower integral brackets be taken as less than $t_{REN,d/t}$ for the frames they support.

a) Lower brackets

In calculating the web depth of the lower brackets, the following shall apply:

.1 The web depth of lower bracket may be measured from the intersection of the sloped bulkhead of the hopper tank and the side shell plate, perpendicularly to the face plate of the lower bracket (see figure 3).

.2 Where stiffeners are fitted on the lower bracket plate, the web depth may be taken as the distance between the side shell and the stiffener, between the stiffeners or between the outermost stiffener and the face plate of the brackets, whichever is the greatest.

b) Tripping bracket alternative

When t_M is less than $t_{REN,d/t}$ at section b) of the side frames (see figure 2), tripping brackets in accordance with 2.3 may be fitted as an alternative to the requirements for the web depth to thickness ratio of side frames, in which case $t_{REN,d/t}$ may be disregarded in the determination of t_{REN} in accordance with 2.1.2.

c) Immediately abaft collision bulkhead

For the side frames located immediately abaft the collision bulkhead, whose scantlings are increased in order that their moment of inertia is such as to avoid undesirable flexibility of the side shell, when their web as built thickness t_{AB} is greater than $1.65t_{REN,S}$, the thickness $t_{REN,d/t}$ may be taken as the value $t'_{REN,d/t}$ obtained from the following equation:

$$t'_{REN,d/t} = \sqrt[3]{t_{REN,d/t}^{\ 2}\ t_{REN,S}}$$

where $t_{REN,S}$ is obtained from 3.3.

2.1.2.2 Thickness criteria based on shear strength check

Where t_M in the lower part of side frames, as defined in figure 1, is equal to, or less than, t_{COAT}, $t_{REN,S}$ shall be determined in accordance with 3.3.

2.1.2.3 Thickness of renewed webs of frames and lower brackets

Where steel renewal is required, the renewed webs shall be of a thickness not less than t_{AB}, $1.2t_{COAT}$ or $1.2t_{REN}$, whichever is the greatest.

2.1.2.4 Criteria for other measures

When $t_{REN} < t_M \leq t_{COAT}$, measures shall be taken, consisting of all the following:

.1 sand blasting, or equivalent, and coating (see 2.2);

.2 fitting tripping brackets (see 2.3), when the above condition occurs for any of the side frame zones A, B, C and D, shown in figure 1; and

.3 maintaining the coating in "as new" condition (i.e. without breakdown or rusting) at renewal and intermediate surveys.

The above measures may be waived if the structural members show no thickness diminution with respect to the as-built thicknesses and coating is in "as new" condition (i.e. without breakdown or rusting).

2.1.3 Criteria for frames and brackets (bending check)

Where the length or depth of the lower bracket does not meet the requirements in annex 1, a bending strength check in accordance with 3.4 shall be carried out and renewals or reinforcements of frames and/or brackets effected as required therein.

2.2 Thickness measurements, steel renewal, sand blasting and coating

For the purpose of steel renewal, sand blasting and coating, four zones A, B, C and D are defined, as shown in figure 1.

Representative thickness measurements shall be taken for each zone and shall be assessed against the criteria in 2.1.

In case of integral brackets, when the criteria in 2.1 are not satisfied for zone A or B, steel renewal, sand blasting and coating, as applicable, shall be done for both zones A and B.

In case of separate brackets, when the criteria in 2.1 are not satisfied for zone A or B, steel renewal, sand blasting and coating shall be done for each one of these zones, as applicable.

When steel renewal is required for zone C according to 2.1, it shall be done for both zones B and C. When sand blasting and coating is required for zone C according to 2.1, it shall be done for zones B, C and D.

When steel renewal is required for zone D according to 2.1, it needs only to be done for this zone. When sand blasting and coating is required for zone D according to 2.1, it shall be done for both zones C and D.

Special consideration may be given to zones previously renewed or re-coated, if found in "as new" condition (i.e., without breakdown or rusting) by the Administration or a classification society which is recognized by the Administration in accordance with the provisions of SOLAS regulation XI-1/1.

When adopted, on the basis of the renewal thickness criteria in 2.1, in general coating shall be applied in compliance with the requirements of the organization, as applicable.

Where, according to the requirements in 2.1, a limited number of side frames and brackets are shown to require coating over part of their length, the following criteria apply:

.1 The part to be coated includes:

- the web and the face plate of the side frames and brackets,
- the hold surface of side shell, hopper tank and topside tank plating, as applicable, over a width not less than 100 mm from the web of the side frame.

.2 Epoxy coating or equivalent shall be applied.

In all cases, all the surfaces to be coated shall be sand blasted prior to coating application.

2.3 Reinforcing measures

Reinforcing measures are constituted by tripping brackets, located at the lower part and at midspan of side frames (see figure 4). Tripping brackets may be located at every two frames, but lower and midspan brackets shall be fitted in line between alternate pairs of frames.

The thickness of the tripping brackets shall be not less than the as-built thickness of the side frame webs to which they are connected.

Double continuous welding shall be adopted for the connections of tripping brackets to the side shell frames and shell plating.

2.4 Weld throat thickness

In case of steel renewal, the welded connections shall comply with paragraph 7 of annex 1.

2.5 Pitting and grooving

If pitting intensity is higher than 15% in area (see figure 5), thickness measurement shall be taken to check pitting corrosion.

The minimum acceptable remaining thickness in pits or grooves is equal to:

.1 75% of the as-built thickness, for pitting or grooving in the frame and brackets webs and flanges; and

.2 70% of the as-built thickness, for pitting or grooving in the side shell, hopper tank and topside tank plating attached to the side frame, over a width up to 30 mm from each side of it.

3 Strength check criteria

In general, loads shall be calculated and strength checks shall be carried out for the aft, middle and forward frames of each hold. The scantlings required for frames in intermediate positions shall be obtained by linear interpolation between the results obtained for the above frames.

When scantlings of side frames vary within a hold, the required scantlings shall also be calculated for the mid-frame of each group of frames having the same scantlings. The scantlings required for frames in intermediate positions shall be obtained by linear interpolation between the results obtained for the calculated frames.

3.1 Load model

3.1.1 Forces

The forces $P_{fr,a}$ and $P_{fr,b}$, in kN, to be considered for the strength checks at sections a) and b) of side frames (specified in figure 2; in the case of separate lower brackets, section b) is at the top of the lower bracket), are given by:

$$P_{fr,a} = P_S + \max(P_1, P_2)$$

$$P_{fr,b} = P_{fr,a}\frac{h - 2h_B}{h}$$

where:

P_s = still water pressure force, in kN

$= s\,h\left(\frac{p_{S,U} + p_{S,L}}{2}\right)$ when the upper end of the side frame span h (see figure 1) is below the load water line

$= s\,h'\left(\frac{p_{S,L}}{2}\right)$ when the upper end of the side frame span h (see figure 1) is at or above the load water line

P_1 = wave pressure force, in kN, in head seas

$= s\,h\left(\frac{p_{1,U} + p_{1,L}}{2}\right)$

P_2 = wave pressure force, in kN, in beam seas

$= s\,h\left(\frac{p_{2,U} + p_{2,L}}{2}\right)$

h, h_B = side frame span and lower bracket length, in m, defined in figures 1 and 2, respectively

h' = distance, in m, between the lower end of side frame span h (see figure 1) and the load waterline

s = frame spacing, in m

$p_{S,U}$, $p_{S,L}$ = still water pressure, in kN/m^2, at the upper and lower end of the side frame span h (see figure 1), respectively

$p_{1,U}$, $p_{1,L}$ = wave pressure, in kN/m^2, as defined in 3.1.2.1, below for the upper and lower end of the side frame span h, respectively

$p_{2,U}$, $p_{2,L}$ = wave pressure, in kN/m^2, as defined in 3.1.2.2, below for the upper and lower end of the side frame span h, respectively

3.1.2 Wave pressure

3.1.2.1 Wave pressure p_1

.1 The wave pressure p_1, in kN/m^2, at and below the waterline is given by:

$$p_1 = 1.50\left[p_{11} + 135\,\frac{B}{2\,(B+75)} - 1.2\,(T-z)\right]$$

$$p_{11} = 3k_S\,C + k_f$$

.2 The wave pressure p_1, in kN/m^2, above the water line is given by:

$$p_1 = p_{1wl} - 7.50\,(z-T)$$

3.1.2.2 Wave pressure p_2

.1 The wave pressure p_2, in kN/m^2, at and below the waterline is given by:

$$p_2 = 13.0\left[0.5\,B\,\frac{50\,C_r}{2\,(B+75)} + C_B\,\frac{0.5\,B + k_f}{14}\left(0.7 + 2\frac{z}{T}\right)\right]$$

.2 The wave pressure p_2, in kN/m^2, above the water line is given by:

$$p_2 = p_{2wl} - 5.0\,(z-T)$$

where:

p_{1wl} = p_1 wave sea pressure at the waterline

p_{2wl} = p_2 wave sea pressure at the waterline

L = the distance, in m, on the summer load waterline from the fore side of stem to the after side of the rudder post, or the centre of the rudder stock if there is no rudder post. L shall not be less than 96%, and need not be greater than 97%, of the extreme length on the summer load waterline.

B = greatest moulded breadth, in m

C_B = moulded block coefficient at draught d corresponding to summer load waterline, based on length L and moulded breadth B, but not to be taken less than 0.6:

$$C_B = \frac{\text{moulded displacement [m}^3\text{] at draught d}}{LBd}$$

T = maximum design draught, in m

C = coefficient

$= 10.75 - \left(\frac{300 - L}{100}\right)^{1.5}$ for $90 \leq L \leq 300$ m

$= 10.75$ for $300 < L$

$C_r = (1.25 - 0.025 \frac{2k_r}{\sqrt{GM}})k$

k = 1.2 for ships without bilge keel

= 1 for ships with bilge keel

k_r = roll radius of gyration. If the actual value of k_r is not available

= 0.39 B for ships with even distribution of mass in transverse section (e.g. alternate heavy cargo loading or homogeneous light cargo loading)

= 0.25 B for ships with uneven distribution of mass in transverse section (e.g. homogenous heavy cargo distribution)

GM = 0.12 B if the actual value of GM is not available

z = vertical distance, in m, from the baseline to the load point

$k_s = C_B + \frac{0.83}{\sqrt{C_B}}$ at aft end of L

$= C_B$ between 0.2 L and 0.6 L from aft end of L

$= C_B + \frac{1.33}{C_B}$ at forward end of L

Between the above specified points, k_s shall be varied linearly

k_f = 0.8 C

3.2 Allowable stresses

The allowable normal and shear stresses σ_a and τ_a, in N/mm^2, in the side shell frames are given by:

$$\sigma_a = 0.90\ \sigma_F$$

$$\tau_a = 0.40\ \sigma_F$$

where σ_F is the minimum upper yield stress, in N/mm^2, of the material.

3.3 Shear strength check

Where t_M in the lower part of side frames, as defined in figure 1, is equal to, or less than, t_{COAT}, shear strength check shall be carried out in accordance with the following.

The thickness $t_{REN,S}$, in mm, is the maximum between the thicknesses $t_{REN,Sa}$ and $t_{REN,Sb}$ obtained from the shear strength check at sections a) and b) (see figure 2 and 3.1) given by the following, but need not be taken in excess of $0.75t_{S12}$.

.1 at section a): $$t_{REN,Sa} = \frac{1{,}000\ k_S\ P_{fr,a}}{d_a\ \sin\phi\ \tau_a}$$

.2 at section b): $$t_{REN,Sb} = \frac{1{,}000\ k_S\ P_{fr,b}}{d_b\ \sin\phi\ \tau_a}$$

where:

k_s	=	shear force distribution factor, to be taken equal to 0.6
$P_{fr,a}$, $P_{fr,b}$	=	pressure forces defined in 3.1.1
d_a, d_b	=	bracket and frame web depth, in mm, at sections a) and b), respectively (see figure 2); in case of separate (non integral) brackets, d_b shall be taken as the minimum web depth deducting possible scallops
ϕ	=	angle between frame web and shell plate
τ_a	=	allowable shear stress, in N/mm^2, defined in 3.2.

3.4 Bending strength check

When the lower bracket length or depth do not comply with requirements in annex 1, the actual section modulus, in cm^3, of the brackets and side frames at sections a) and b) shall be not less than:

.1 at section a):

$$Z_a = \frac{1{,}000\ P_{fr,a}\ h}{m_a\ \sigma_a}$$

.2 at section b):

$$Z_b = \frac{1{,}000\ P_{fr,a}\ h}{m_b\ \sigma_a}$$

where:

$P_{fr,a}$ = pressure force defined in 3.1.1

h = side frame span, in m, defined in figure 1

σ_a = allowable normal stress, in N/mm^2, defined in 3.2

m_a, m_b = bending moment coefficients defined in table 2

The actual section modulus of the brackets and side frames shall be calculated about an axis parallel to the attached plate, based on the measured thicknesses. For pre-calculations, alternative thickness values may be used, provided they are not less than:

.1 t_{REN}, for the web thickness;

.2 the minimum thicknesses allowed by the renewal criteria for flange and attached plating of a classification society which is recognized by the Administration in accordance with the provisions of SOLAS regulation XI-1/1, or by applicable national standards of the Administration which provide an equivalent level of safety.

The attached plate breadth is equal to the frame spacing, measured along the shell at midspan h.

If the actual section moduli at sections a) and b) are less than the values Z_a and Z_b, the frames and brackets shall be renewed or reinforced in order to obtain actual section moduli not less than 1.2 Z_a and 1.2 Z_b, respectively.

In such a case, renewal or reinforcements of the flange shall be extended over the lower part of side frames, as defined in figure 1.

Table 2 – Bending moment coefficients m_a and m_b

	m_a	m_b		
		$h_B = 0.08\ h$	$h_B = 0.1\ h$	$h_B = 0.125\ h$
Empty holds of ships approved to operate in non homogeneous loading conditions	10	17	19	22
Other cases	12	20	22	26

Note 1: Non-homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each hold, exceeds 1.2 corrected for different cargo densities.

Note 2: For intermediate values of the bracket length h_B, the coefficient m_b is obtained by linear interpolation between the table values.

Figure 1 – Lower part of side frames

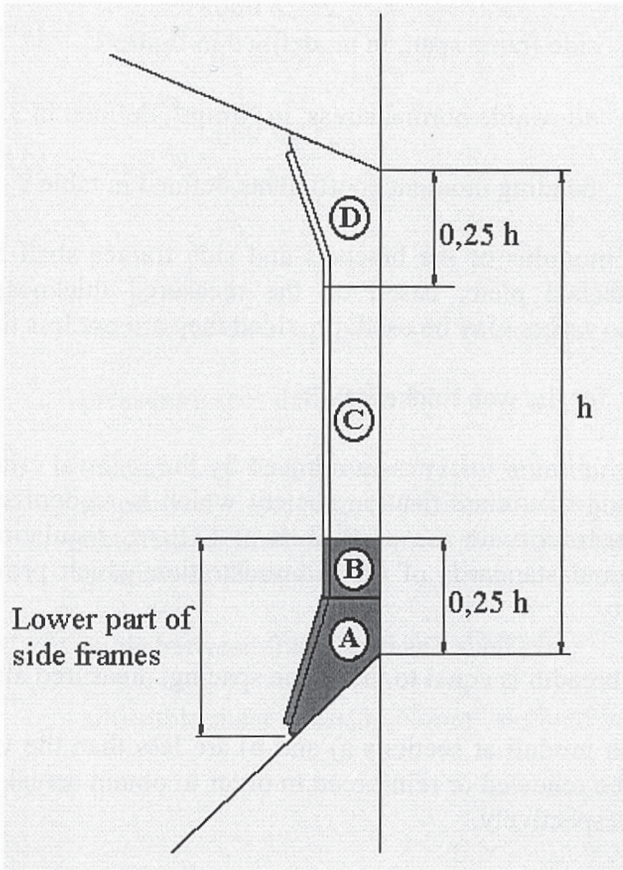


Figure 2 – Sections a) and b)

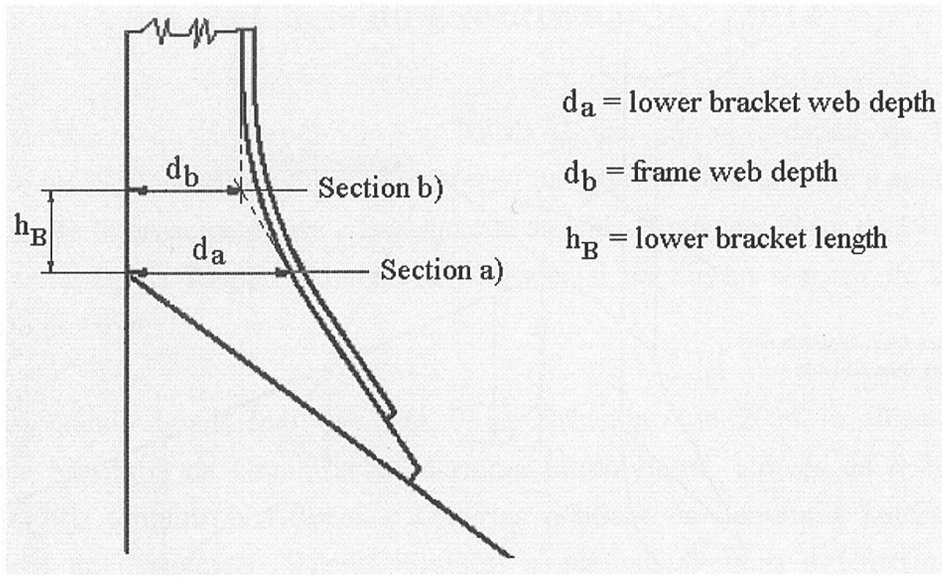


Figure 3 – Definition of the lower bracket web depth

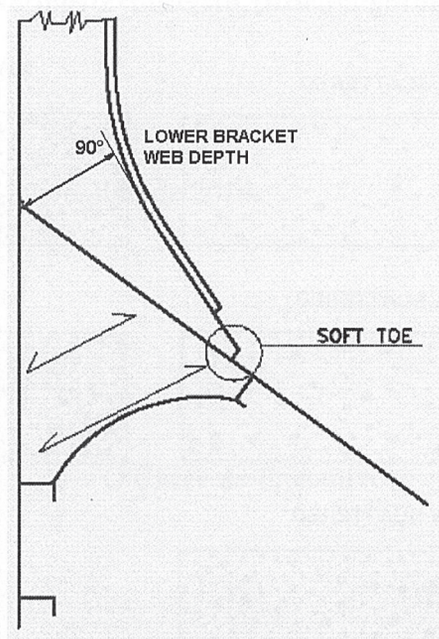


Figure 4 – Tripping brackets

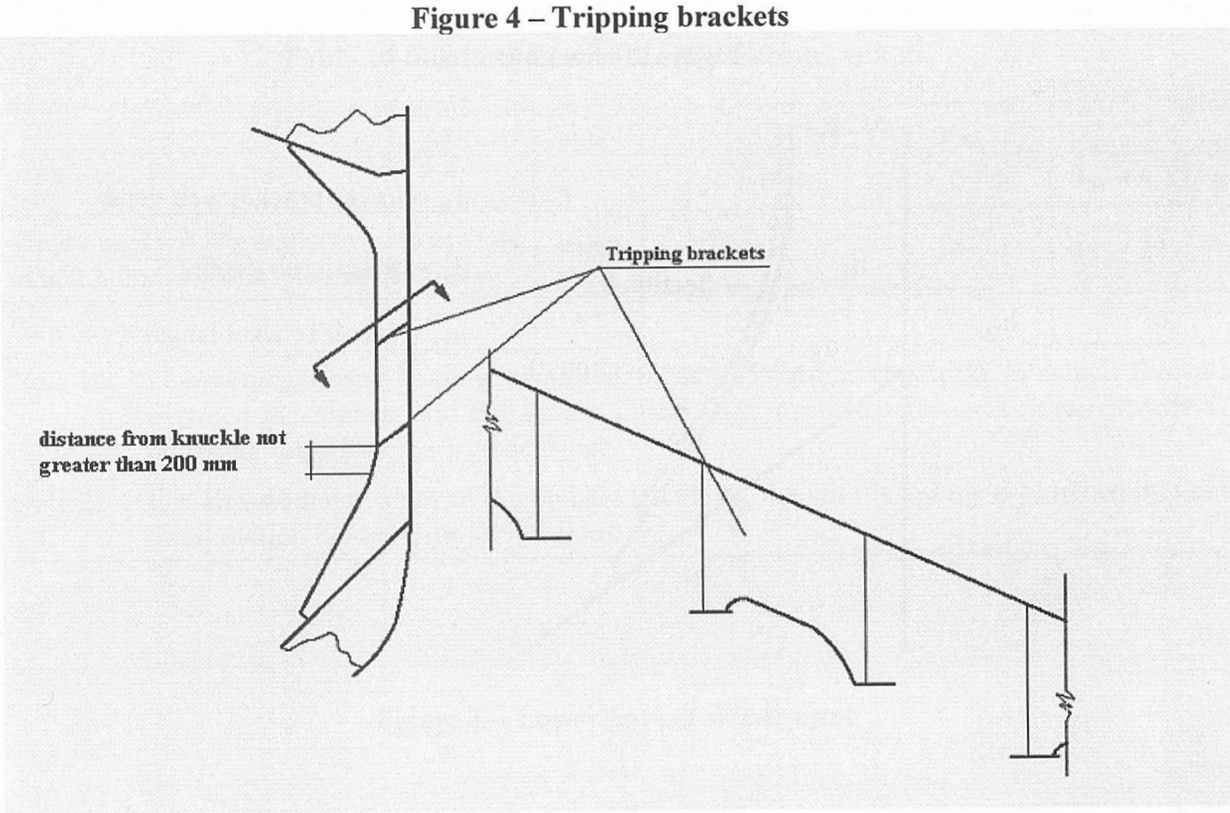


Figure 5 - Pitting intensity diagrams (from 5% to 25% intensity)