GUIDANCE NOTES
GD 03－2004

CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR HULL STRUCTURE OF DOUBLE SIDE SKIN BULK CARRIERS

2004

Beijing

Contents

Chapter 1 General

1.1 Application

1.1.1 Those not covered in the Guidelines are to comply with the relevant provisions of Rules and Regulations for the Construction and Classification of Sea-Going Steel Ships (hereinafter referred to as the Rules).

1.1.2 The Guidelines apply to all double side skin bulk carriers of 90 m or over in length with machinery aft, and longitudinally framed strength decks and double bottoms outside of the line of openings.

1.1.3 The Guidelines apply mainly to determination of structural arrangements and scantlings of structural members of cargo hold space of double side skin bulk carriers. The double skin is constructed of the side shell and bottom connecting ballast tanks or void space.

1.1.4 Requirements in PART TWO of the Rules relating to configurations and scantlings other than those of cargo hold space are to be complied with.

1.2 Survey

1.2.1 Survey of hull structure is to comply with the requirements of PART ONE of the Rules as appropriate.

1.3 Class notations

1.3.1 One of the following class notations may be assigned to double side skin bulk carriers complying with the Guidelines:

(1) Double Side Skin Bulk Carrier;

(2) Double Side Skin Bulk Carrier, Strengthened for Heavy Cargos;

(3) Double Side Skin Bulk Carrier, Strengthened for Heavy Cargos, Holds Nos… may be Empty.

1.3.2 For harmonized notations and related requirements, refer to Chapter 10 of the Guidelines.

1.4 Plans and documents

1.4.1 The following plans and documents are to be submitted to the Society for information in addition to those as specified in Section 1, Chapter 2 of PART TWO of the Rules:

(1) The maximum pressure heads in service on tanks and details of any double bottom tanks

interconnected with hopper tanks, ballast tanks within double side skin and topside tanks;

(2) Details of the proposed depths of any partial fillings where ballast water or liquid cargo is intended to be carried.

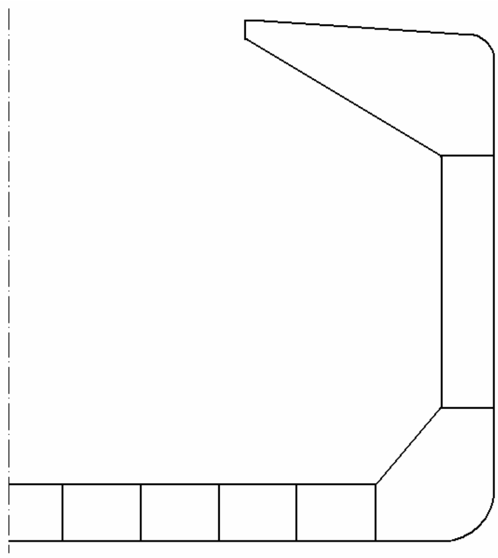
1.5 Ship Arrangement

1.5.1 For the purpose of ensuring to carry out effective surveys to ships throughout their operational life, provision of suitable means of access for inspections is to be considered at the ship design stage and in construction. For bulk carriers of 20,000 gross tonnage and above constructed on or after 1 January 2005, means of access for inspections to the cargo space are to comply with Reg. II-1/3-6 of December 2002 Amendments to SOLAS Convention "Access to and within spaces in the cargo area of oil tankers and bulk carriers" by resolution MSC.134(76), and related requirements in "Technical provisions for means of access for inspections" by resolution MSC.133(76) are to be satisfied.

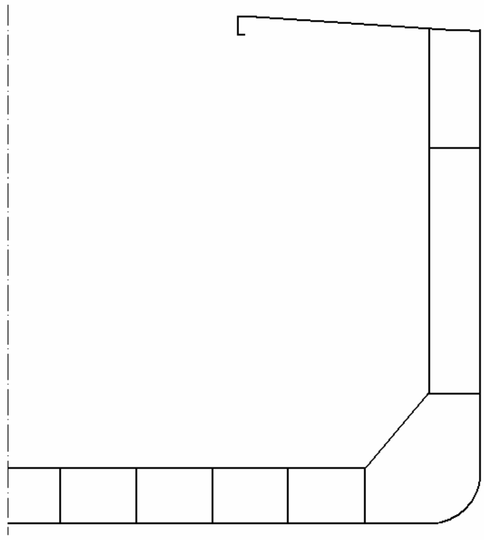
1.5.2 Water-tight transverse bulkheads are to be provided in accordance with requirements of the Rules for aft-engined ship.

1.5.3 Tanks inside double-side skin are to be designed as far as possible to be empty instead of seawater ballast tank. Cargo loading is not to be permitted inside double side skin, and arrangements of inner shell are to ensure all cargo holds to be inside of double side skin.

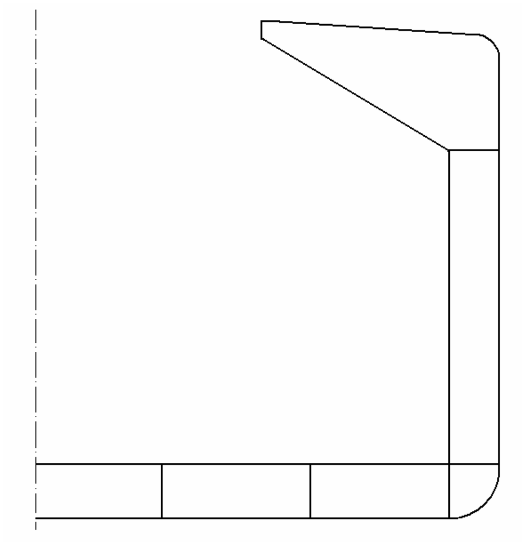
1.5.4 Arrangements of cargo hold include following four types:



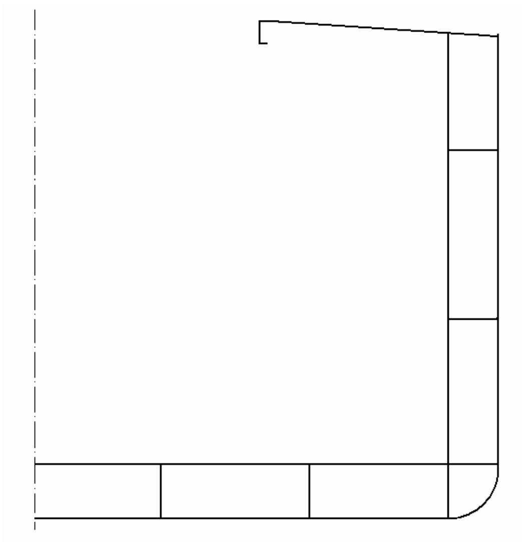
Type 1: Double side skin, hopper tanks and topside tanks



Type 2: Double side skin and hopper tanks



Type 3: Double side skin and topside tanks



Type 4: Double side skin only

1.5.5 The distance between the outer shell and the inner shell at any transverse section are not to be less than 1 m measured perpendicular to the side shell.

1.5.6 The minimum width of the clear passage through the double-side skin space in way of obstructions such as piping or vertical ladders are not to be less than 0.6 m. Where the inner and outer skins are transversely framed, the minimum clearance between the inner surfaces of the frames is not to be less than 0.6 m. Where the inner and outer skins are longitudinally framed, the minimum clearance between the inner surfaces of the frames is not to be less than 0.8 m. Outside the parallel part of the cargo hold length, this clearance may be reduced where necessitated by the structural configuration but in no case are to be less than 0.6 m. Consideration over end bracket of frame is not necessary when measuring the clearance, see Fig. 1.5.6 for methods of measurement.

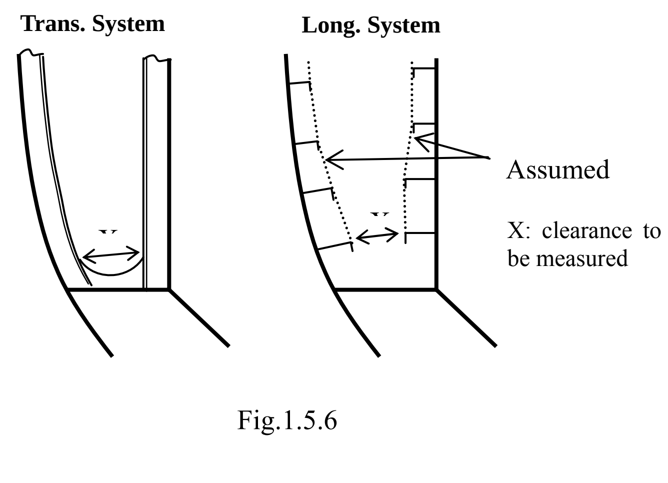


Fig.1.5.6

1.5.7 Access arrangement to double bottom and pipe tunnel

(1) Adequate means of access to the double bottom and the pipe tunnel are to be provided.

(2) Manholes cut in the inner bottom are to be located at a minimum distance of one floor spacing from the lower stool, or transverse bulkhead if no stool is fitted.

(3) The location and size of manholes in floors and girders are to be determined to facilitate the access to double bottom structures and their ventilation. However, they are to be avoided in the areas where high shear stresses may occur.

1.5.8 Access arrangement to cargo holds

(1) As far as practical, Permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

(2) Each cargo hold is to be provided with at least two ladders as far apart as practicable longitudinally. If possible these ladders are to be arranged diagonally, e.g. one ladder near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side, from the ship's centerline.

Ladders are to be so designed and arranged that the risk of damage from the cargo handling gear, e.g. forklift and grab buck is minimized.

Vertical ladders may be permitted provided they are arranged above each other in line with other ladders to which they form access and resting positions are provided at not more than 9 m apart.

Where it may be necessary for work to be carried out within a cargo hold preparatory to loading, consideration is to be given to suitable arrangements for the safe handling of portable staging or movable platforms.

(3) Access to passage provided in (2) is to have a clear opening of at least 600 mm×600 mm.

Access and ladders are to be so arranged that personnel equipped with self-contained breathing apparatus may readily enter and leave the cargo hold.

1.6 Direct strength calculation and fatigue assessment of hull structure

1.6.1 Scantlings of primary members and structural arrangements may be determined by direct calculation.

1.6.2 Direct calculation is to be carried out to primary members (longitudinal and transverse) in cargo hold space of double side skin bulk carriers of 150 m or over in length.

1.6.3 Direct calculation is to comply with the requirements of Guidelines for Direct Strength Analysis of Double Side Skin Bulk Carriers by the Society. Thickness of the members determined by means of direct calculation is also to comply with the requirements of 6.3 of the Guidelines.

1.6.4 The structure in cargo hold space of double side skin bulk carriers of 150 m or over in length is to be subjected to fatigue assessment in accordance with the requirements of Guidelines for Fatigue Strength of Ship Structure by the Society.

1.6.5 CCSS (software for hull structure analysis and solution) by the Society may be used for direct calculation and fatigue assessment that include appraisal of structure design (yield and buckling) and fatigue design. A notation CCSS may be assigned after a satisfactory fatigue assessment.

1.7 Structural Details

1.7.1 Structural details, end connection of secondary members and end connection of primary members of double side skin bulk carriers are to comply with the applicable requirements of Chapter 1, PART TWO of the Rules.

1.7.2 The use of high tensile steel for large bulk carriers will result in a large area of local high stress. Due to the non-continuity of structural details, such structural details in way of the local high stress area will cause very high stress concentration, which is the main factor of fatigue damages to the ship structure. Therefore fatigue strength is a key problem for large bulk carriers of high tensile steel.

1.7.3 The structural details selected are typical ones in way of high stress area of double side skin bulk carriers and liable to fatigue damages. The Appendix Table 1.7.3 gives example typical structural details of double side skin bulk carriers, for providing guidance to designers, so as to improve the fatigue life of structure.

1.7.4 Design of structural details is to consider the location and stress sustained and the principle of transition in order to avoid stress concentration in way of structural details.

1.7.5 Brackets in high stress area are to use circular or symmetrical face plate. For bracket toes at end of primary member, web thickness is to be strengthened appropriately, and face plate of bracket is to be inclined by scarfing to end and be provided with soft toes.

1.7.6 Construction of typical connection is to ensure good alignment, and deflection of center of plate thickness is not to be greater than one third of plate thickness (taking lesser of the plate thickness).

1.7.7 Unless provided otherwise, welding of typical structural details is to comply with the applicable requirements of Section 4, Chapter 1 of PART TWO of the Rules.

Chapter 2　Materials and Protection

2.1　General requirements

2.1.1　Materials and steel grades are to comply with the relevant requirements contained in Chapter 1, PART TWO of the Rules.

2.1.2　Structure and anticorrosion are to comply with the relevant requirements contained in Section 6, Chapter 1 of PART TWO of the Rules.

Chapter 3 Longitudinal Strength

3.1 General requirements

3.1.1 Longitudinal strength is to comply with the relevant requirements of Section 2, Chapter 2 of PART TWO of the Rules.

3.1.2 Where cargo hold deck is of large opening, longitudinal strength of combination of bending moment and torque are to be checked in accordance with the relevant requirements of Section 2, Chapter 7 of PART TWO of the Rules, in which torque of cargo is to take zero in general.

3.1.3 For double side skin bulk carriers of less than 150 m in length, the loading manual and loading instrument are to comply with the requirements of Section 2, Chapter 2 of PART TWO of the Rules.

3.1.4 For double side skin bulk carriers of 150 m or over in length, the loading manual and loading instrument are to comply with the requirements of 3.2 and 3.3 of this Chapter.

3.2 Loading manual

3.2.1 The loading manual is to describe:

(1) the loading condition on which the design of the ship has been based, including still water bending moment and shear force and where applicable, the results of the calculations of torsional loads;

(2) permissible limits of still water bending moment and shear force;

(3) the cargo holds that are empty at full draught. If no cargo hold is allowed to be empty at full draught, this is to be clearly stated in the loading manual;

(4) maximum allowable and minimum required mass of cargo and double bottom contents of each hold as a function of the draught at mid-hold position;

(5) maximum allowable and minimum required mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds. This mean draught is the average of the two mid-hold positions;

(6) maximum allowable tank top loading together with specification of the nature of the cargo for cargoes other than bulk cargoes;

(7) maximum allowable load on deck and hatch covers. If the vessel is not approved to carry load on deck or covers, this is to be clearly stated in the loading manual;

(8) the maximum rate of ballast change together with the advice that a load plan is to be agreed with the terminal on the achievable rates of change of ballast.

3.2.2 Conditions of approval of loading manual

In addition to the requirements given in 2.2.8.11 of PART TWO of the Rules, the following conditions, subdivided into departure and arrival conditions as appropriate, are to be included in the loading manual:

(1) alternate light and heavy cargo loading conditions at maximum draught, where applicable;

(2) homogeneous light and heavy cargo loading conditions at maximum draught ;

(3) ballast conditions - for bulk carriers having ballast holds adjacent to topside, hopper and double bottom tanks, it is to be strengthwise acceptable that the ballast holds are filled when the topside, hopper and double bottom tanks are empty;

(4) short voyage conditions where the ship is to be loaded to maximum draught but with limited amount of bunkers;

(5) multiple port loading / unloading conditions, where applicable;

(6) deck cargo conditions, where applicable;

(7) typical loading sequences where the ship is loaded from commencement of cargo loading to reaching full deadweight capacity, for homogeneous conditions, relevant part load conditions and alternate conditions where applicable. Typical unloading sequences for these conditions are also to be included. The typical loading / unloading sequences are to be developed not to exceed applicable strength limitations. These sequences are to be developed paying due attention to loading / unloading rate and deballasting capacity;

(8) typical sequences for change of ballast at sea, where applicable.

3.3 Loading instrument

3.3.1 In addition to complying with the requirements of 2.2.8.4 of PART TWO of the Rules, a loading instrument is to ascertain where appropriate that:

(1) the mass of cargo and double bottom contents in way of each hold as a function of the draught at mid-hold position;

(2) the mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds.

3.3.2 Conditions of approval of loading instrument

The loading instrument is subject to approval. In addition to the requirements given in 2.2.8.12 of PART TWO of the Rules, the approval is to include as applicable:

(1) acceptance of hull girder bending moment limits for all read-out points;

(2) acceptance of hull girder shear force limits for all read-out points;

(3) acceptance of limits for mass of cargo and double bottom contents of each hold as a function of draught;

(4) acceptance of limits for mass of cargo and double bottom contents in any two adjacent holds as a function of draught.

Chapter 4 Hopper Tanks

4.1 General requirements

4.1.1 Watertight bulkheads are to be fitted, as far as practicable, in the hopper tanks in line with the watertight bulkheads in hold. Otherwise wash boards are to be fitted.

4.1.2 Consideration is to be given to efficient structural continuity at both ends of hopper tanks.

4.1.3 Where the hopper tanks are interconnected with the topside tanks, the design head h of the hopper tank structural members is to be measured to the highest point of the topside tank; where the hopper tanks are interconnected with the ballast tank within double side skin, it is to be measured to the highest point of the ballast tank.

4.1.4 The requirements of this Chapter apply to hopper tanks framed longitudinally.

4.2 Sloping plating

4.2.1 The thickness of the sloping plating is not to be less than that of inner bottom plating required in Section 6, Chapter 2 of PART TWO of the Rules. For ships intended to be assigned with a class notation of Bulk Carrier, Strengthened for Heavy Cargoes, the sloping plating is to be increased in thickness in accordance with the requirements of 2.22.3.4 of PART TWO of the Rules, but this increase may be gradually tapered from the intersection of sloping plating and inner bottom plating to nil at the top corner of the tank.

4.2.2 Where the hopper tanks are fitted with watertight side bulkheads, the thickness t of the side bulkhead plating is not to be less than that obtained from the following formula:

$$t = 4s\sqrt{h} + 2.5 \quad \text{mm}$$

where: s ---- spacing of stiffeners, in m;

h ---- vertical distance, in m, measured from the lower edge of the plate in a strake to the top of the hold or half the distance from that to the top of overflow pipe, whichever is the greater.

4.3 Longitudinals

4.3.1 The section modulus W of the sloping plating longitudinals is not to be less than 85% of that of the inner bottom longitudinals, and is not to be less than that obtained from the following formulae:

$$W = 8.5Hsl^2 / \gamma \quad \text{cm}^3$$

$$W = 9shl^2 \quad \text{cm}^3$$

where:

γ — stowage rate, in m³/t;

H — vertical distance, in m, measured from longitudinal to the lower edge of the sloping plating of topside tanks at side; where topside tank is not provided, measured from longitudinal to upper deck;

s — spacing of longitudinals, in m;

l — span of longitudinal, in m;

h — vertical distance, in m, from the longitudinal to the top of the hold, or half the distance from that to the top of the overflow pipe, whichever is the greater.

4.3.2 The section modulus W of ship side and bilge longitudinals in hopper tank is not to be less than that required in Section 7, Chapter 2 of PART TWO of the Rules.

4.3.3 The section modulus W of bottom longitudinals in hopper tanks is not to be less than that required in Section 6, Chapter 2 of PART TWO of the Rules.

4.4 Transverse supporting structural members

4.4.1 Transverse structural members supporting the longitudinals of the hopper tanks are to be fitted in line with the double bottom floors.

4.4.2 The section modulus W and the moment of inertia I of bottom transverses and side shell transverses are not to be less than that obtained from the following formulae:

$$W=12Shl^2 \quad \text{cm}^3$$

$$I=2.5Wl \quad \text{cm}^4$$

where:

S — spacing of bottom or side shell transverses, in m;

l — span of bottom or side shell transverse, in m;

h — vertical distance, in m, obtained from the mid-point of span to the upper deck at side.

4.4.3 The section modulus W and the moment of inertial I of sloping plating transverse are not to be less than that obtained from the following formulae:

$$W = 12Shl^2 \quad \text{cm}^3$$

$$I = 2.5Wl \quad \text{cm}^4$$

where:

S — spacing of transverses, in m;

l — span of transverse, in m;

h — vertical distance, in m, measured from the mid-point of span to the top of hold or half the distance to the top of overflow pipe, whichever is the greater.

The section modulus W and the moment of inertial I of sloping transverse are not to be less than that obtained from the following formulae:

$$W=6.6HSl^2/\gamma \quad \text{cm}^3$$

$$I=1.8Wl \quad \text{cm}^4$$

where:

γ — stowage rate, in m^3/t；

H — vertical distance, in m, from the mid-point of span to the lower edge of the sloping plating of the topside tank;

S — spacing of transverses, in m;

l — span of transverse, in m.

4.4.4 Bottom and side shell transverses, and sloping transverses are to be effectively connected one another. Longitudinals are to be continuous through the bottom and side shell transverses and the sloping transverses, and are to be welded to their web plates. Brackets connecting the face plate of primary supporting members and the longitudinals are to be fitted at alternate longitudinals, and the thickness of brackets is to be the same as that of the web of the primary supporting members.

4.4.5 Where a web ring system is fitted in lieu of the bottom and side shell transverses, and sloping transverses, the scantlings of the web ring system are to comply with the requirements of 4.4.2 and 4.4.3 of this Chapter. The web depth of the ring system is not to be less than 2.5 times the depth of slot for the passage of longitudinals.

Stiffening bars are to be adequately fitted to the web of ring system between the sloping longitudinals, ship side longitudinals and bottom longitudinals. The thickness of these stiffening bars is to be the same as that of the web of the primary supporting members, and the width is not to be less than 150 mm.

4.4.6 Where perforated diaphragms are fitted in lieu of the bottom and side shell transverses, and the sloping transverses, the thickness of such diaphragms is not to be less than that of the double bottom floors. The holes cut in the diaphragms are not to be too large, and stiffening bars are to be fitted between holes to ensure sufficient strength and rigidity.

4.4.7 Where the side shell in way of cargo holds is framed transversely, brackets are to be fitted above the hopper tank at every frame. The thickness of the brackets is to be the same as that of the lower brackets of the hold main frames, and the brackets, measured along the sloping plating and the side shell, are to be welded to the adjacent longitudinals.

4.5 Watertight bulkheads

4.5.1 The thickness t of watertight bulkhead plating is not to be less than that obtained from the following formula:

$$t = 4s\sqrt{h} + 2.5 \quad \text{mm}$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the lower edge of the plate in a strake to the top of the hold or half the distance from that to the top of overflow pipe, whichever is the greater.

4.5.2 The section modulus W of stiffeners on the watertight bulkheads is not to be less than that obtained from the following formula:

$$W=8.2shl^2 \quad \text{cm}^3$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the mid-point of span of the stiffeners to the top of the hold or half the distance from that to the top of overflow pipe, whichever is the greater;

l — span of stiffener, in m.

Stiffeners are to be bracketed at both ends.

4.6 Non-watertight bulkheads and swash bulkheads

4.6.1 The plating thickness t of non-watertight or swash bulkheads is not to be less than that obtained from the following formula, and not to be less than 8 mm:

$$t=12s \qquad \text{mm}$$

where:

s — spacing of stiffeners, in m.

4.6.2 The section modulus of the stiffeners on the non-watertight or swash bulkheads is not to be less than 50% of that obtained from 4.5.2 of this Chapter. Stiffeners are to be bracketed at both ends.

Chapter 5 Topside Tanks

5.1 General requirements

5.1.1 Watertight bulkheads are to be fitted, as far as practicable, in the topside tanks in line with the watertight bulkheads in hold. Otherwise, swash bulkheads are to be fitted.

5.1.2 Consideration is to be given to efficient structural strength continuity at ends of topside tanks.

5.2 Sloping plating and vertical side plating

5.2.1 The thickness t of sloping plating is not to be less than that obtained from the following formula, and is not to be less than 8 mm：

$$t = 4s\sqrt{h} + 2.5 \quad \text{mm}$$

$$t = 12s \quad \text{mm}$$

where:

s — spacing of longitudinals, in m;

h — vertical distance, in m, measured from the lower edge of the plate in a strake to the top of the hold or half the distance to the top of overflow pipe, or when the ship is inclined at an angle of 30° either way, the vertical distance from the lower edge of the plate in a strake to the highest point of the topside tank, whichever is the greatest.

The thickness of the lowest strake is to be increased by 1 mm above that obtained from the above formula.

5.2.2 The thickness of the vertical side plating in line with the hatch side coamings is not to be less than 60% of that of the deck plate outside the line of openings, nor to be less than 18s (s being the spacing of longitudinal, in m). Brackets extending to the deck and sloping plating longitudinals are to be fitted to the vertical side plating in line with the hatch side coamings at intervals not more than 2 frame spaces, and are to be welded to them.

5.3 Longitudinals

5.3.1 The section modulus W of deck, sloping plating and side shell longitudinals are not to be less than that obtained from the following formula:

$$W = 10shl^2 \quad \text{cm}^3$$

where:

s — spacing of longitudinals, in m;

l — span of longitudinal, in m;

h — vertical distance, in m, measured from the longitudinal to the top of the hold, or half the distance to the top of the overflow pipe, or when the ship is inclined at an angle of 30 ° either way, the vertical distance from the longitudinal to the highest point of the topside tank, whichever is the greatest, but not to be less than 1.5 m.

5.3.2 Scantlings of deck longitudinals are also to comply with the relevant requirements of Chapter 2, PART TWO of the Rules.

5.4 Transverse supporting structural members

5.4.1 The section modulus *W* and the moment of inertia *I* of the deck, sloping plating and shell transverses supporting the longitudinals are not to be less than those obtained from the following formulae:

$$W = 7.5Shl^2 \quad \text{cm}^3$$

$$I = 2.5Wl \quad \text{cm}^4$$

where:

S — spacing of deck or shell transverse, in m;

l — span of deck or shell transverse, in m;

h — vertical distance, in m, measured from the mid-point of span to the top of the hold, or half the distance to the top of the overflow pipe, or when the ship is inclined at an angle of 30 ° either way, the vertical distance from the mid-point of span to the highest point of the topside tank, whichever is the greatest, but not to be less than 1.5 m.

5.4.2 The deck or shell transverses are not to be less than that as required in Chapter 2 of PART TWO of the Rules. Their web depth is not to be less than twice the depth of slot for the passage of longitudinals. The web thickness is not to be less than 1% of the depth plus 4 mm.

5.4.3 The deck, sloping plating and shell transverses are to be connected one another by brackets.

5.4.4 Where the longitudinals pass through the deck, shell and sloped bulkhead transverses, arrangements are to be made same as required in 4.4.4 of the Guidelines.

5.4.5 Primary transverse members supporting the longitudinals in topside tank are, in general, to be spaced not greater than (0.006*L*+3.0) m. However, greater spacing may be approved by the Society after direct calculation.

5.4.6 The above primary transverse supporting members may be replaced by perforated diaphragms, and the thickness of the perforated diaphragms is not to be less than that required in 5.7.1 of this Chapter. Such diaphragms are to be efficiently stiffened to ensure sufficient strength and rigidity.

5.4.7 Where the side shell in way of cargo holds is framed transversely, brackets are to be fitted below the topside tank at every frame. The thickness of the brackets is to be the same as that of the web of the ring system in topside tank, and these brackets are to extend and to be welded to the adjacent longitudinals along the side shell and sloping plating. The brackets are to be in line with the upper brackets of the hold main frames.

5.4.8 Where a rounded gunwale is adopted, brackets are to be fitted every two frames in way of the rounded gunwale at half way between transverses, extending to the adjacent deck and shell longitudinals, and to be welded to these longitudinals.

5.4.9 Transverse structural members are to be arranged in the topside tanks in line with the hatch coamings at the ends of hatchways.

5.5 Shell framing

5.5.1 Where the side shell is framed transversely, the section modulus *W* and the moment of inertia *I* of the frames is not to be less than that obtained from the following formulae:

$$W = 10shl^2 \quad \text{cm}^3$$

$$I = 2.5Wl \quad \text{cm}^4$$

where:

s — spacing of frames, in m;

l — span of frame, in m;

h — vertical distance, in m, measured from the mid-point of span of the frame to the top of the hold, or half the distance to the top of overflow pipe, or when the ship is inclined at an angle of 30º either way, the vertical distance, in m, from the mid-point of span of the frame to the highest point of the topside tank, whichever is the greater.

Arm length of brackets at frame ends is to be 20% additional to that as required in 1.2.6 in Chapter 1, PART TWO of the Rules.

5.5.2 Bracket connections are to be provided at both ends of frames, with the brackets extended and welded to the adjacent deck and sloping plating longitudinals. The thickness of brackets is to be the same as that of the upper end brackets in double skin.

5.6 Watertight bulkheads

5.6.1 The thickness *t* of the watertight bulkheads is not to be less than that obtained from the following formula, and is not to be less than 8 mm:

$$t = 4s\sqrt{h} + 2.5 \quad \text{mm}$$

$$t = 12s \quad \text{mm}$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the lower edge of the plate in a strake to the top of the hold or half the distance from that to the top of overflow pipe, or when the ship is inclined at an angle of 30 ° either way, the vertical distance from the lower edge of the plate in a strake to the highest point of the topside tank, whichever is the greater.

The thickness of the lowest strake is to be increased by 1 mm above that obtained from the above formula.

5.6.2 The section modulus W of stiffeners on the watertight bulkheads is not to be less than that obtained from the following formula:

$$W = 10shl^2 \quad cm^3$$

where:

s — spacing of stiffeners, in m;

l — span of stiffener, in m;

h — vertical distance, in m, from the mid-point of span of the stiffener to the top of the hold, or half the distance to the top of overflow pipe, or when the ship is inclined at an angle of 30 ° either way, the vertical distance from the mid-point of span of the stiffener to the highest point of the topside tank, whichever is the greater.

The stiffeners are to be bracketed at both ends.

5.7 Non-watertight and swash bulkheads

5.7.1 The plating thickness t of non-watertight or swash bulkheads is to be in compliance with 4.6.1 of the Guidelines.

5.7.2 The section modulus of the stiffeners on the non-watertight or swash bulkheads is not to be less than 50% of that obtained from 5.6.2 of this Chapter. The stiffeners are to be bracketed at both ends.

Chapter 6 Double Side Structure

6.1 General requirements

6.1.1 This Chapter is applicable to the determination of arrangements and scantlings of frames in double side skin within cargo space of double side skin bulk carriers.

6.1.2 Manholes are to be provided in transverse bulkheads and horizontal girders. The manholes may either be round or elliptical. The elliptical long axis is vertical to or along the length of the ship. Except the passage openings, the holes in upper and lower adjacent horizontal girders are not to be on the same vertical line. The edge around the holes is to be strengthened.

6.1.3 Horizontal opening that used as passage is not to be less than 600mm×600mm, and vertical opening is not to be less than 800mm×600mm.

6.2 Structural arrangements of double side skin

6.2.1 Transverse bulkheads are to be provided within double side skin in line with the watertight transverse bulkheads of cargo holds. Otherwise, transverse framing is to be provided; and for ballast tank, swash bulkheads are to be provided.

6.2.2 Transverse framing or transverse bulkheads, which are to be provided within double side skin in line with double bottom transverses, together with transverse supporting members in topside tanks and hopper tanks and double bottom transverses, form transverse strength framing.

6.2.3 Horizontal girders must be provided at topside tanks and hopper tanks, manhole may not be provided for the sake of subdivision and stability.

6.2.4 Double side skin is to be provided in all cargo space, and at the same time, the inner shell is to extend as far forward and aft as practicable and is to be effectively connected and transited to the structures in way. Supporting members within inner shell are to be provided in double side skin instead of in one side of the cargo hold.

6.3 Minimum thickness

6.3.1 The minimum thickness t of web plate and face plate, horizontal girders, transverse bulkheads and inner plating of primary members in double side skin are not to be less than that obtained from the following formula:

$$t = 7.5 + 0.015L$$, but need not to be greater than 11mm

6.3.2 Where it is specified void space within double side skin, the minimum thickness as required in 6.3.1 of this Chapter may be reduced by 1mm.

6.4 Inner shell plating

6.4.1 Where it is specified void space within double side skin, in addition to complying with the requirement in 6.3 of this Chapter, the thickness of inner shell plating *t* is not to be less than that obtained from the following formula:

$$t = 4s\sqrt{h} \quad \text{mm}$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the lower edge of the inner shell plating strake to bulkhead deck.

Where hopper tank is not provided, the thickness obtained of strake at the bottom of the inner shell plating is to be increased by 1 mm, the width is not to be less than 900mm. Where thickness of inner shell plating and that of the girder web to which the shell plating connects differs greatly, thickness of the shell plating in way of the connecting area is to be strengthened.

6.4.2 Where it is ballast tank in double side skin, in addition to complying with the requirement in 6.3 of this Chapter, the thickness of inner shell plating *t* is not to be less than that obtained from the following formula:

$$t = 4s\sqrt{h} + 2.5 \quad \text{mm}$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the lower edge of the inner shell plating strake to top of ballast tank, or half the distance to the top of overflow pipe, whichever is the greater.

Where hopper tank is not provided, the thickness obtained of the lowest strake of inner shell plating is to be increased by 1 mm.

6.4.3 Where topside tank is not provided, thickness of inner shell plating within 0.1D of strength deck is not to be less than that obtained from the following formula:

$$t = 4s\sqrt{D} \quad \text{mm}$$

where:

s — spacing of stiffeners, in m;

D — molded depth, in m.

However, thickness of inner shell plating is not to be necessarily greater than that of sheer strakes with same frame spacing.

6.4.4 Stiffener spacing of inner shell plating is to be same with that of side frame or that of side longitudinals.

6.4.5 In specified void space, the section modulus W of inner shell plating stiffeners are not to be less than that obtained from the following formula:

$$W=3shl^2 \quad \text{cm}^3$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the mid-point of span of the stiffener to upper deck, the value is not, however to be less than 2 m;

l — span of stiffener, in m.

6.4.6 In ballast tank, the section modulus W and the moment of inertia I of stiffener in inner shell plating are not to be less than that obtained from the following formulae respectively:

$$W=8.2shl^2 \quad \text{cm}^3$$
$$I=2.3Wl \quad \text{cm}^4$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from the mid-point of span of the stiffener to top of tank, or half the distance to the top of overflow pipe, whichever is the greater;

l — span of stiffener, in m.

6.4.7 In ships over 150 m in length or higher tensile steel is adopted for horizontal stiffener, horizontal stiffeners of inner shell plating within 0.1D from bottom and strength deck are to pass through continuously watertight transverse bulkheads. Where horizontal stiffeners are cut at watertight transverse bulkheads, they are to be bracketed to transverse bulkheads.

6.4.8 Tripping brackets are to be provided at both ends of vertical stiffeners.

6.4.9 Scantlings of tripping brackets are to comply with the requirements in 1.2.6 of Chapter 1, PART TWO of the Rules.

6.5 Transverse Bulkheads

6.5.1 Where watertight transverse bulkheads in double side skin constitute boundary of specified void space, the scantlings are to comply with the requirements in 6.4.1 and 6.4.5 of this Chapter.

6.5.2 Where watertight transverse bulkheads in double side skin constitute boundary of ballast tank, the scantlings are to comply with the requirements in 6.4.2 and 6.4.6 of the Chapter.

6.5.3 Stiffening webs are to be provided in between side longitudinals and inner shell horizontal stiffeners in transverse bulkheads.

6.5.4 Where it is longitudinally framed inside double side skin, non-watertight transverse bulkheads supporting side longitudinals and inner shell horizontal stiffeners are to be provided (or every two frame number) at the same frame of bottom transverse in double side skin. The thickness of non-watertight transverse bulkheads is to comply with the requirements in 6.3 of this Chapter. The side longitudinals and inner shell horizontal stiffeners are to pass through the non-watertight transverse bulkheads. Compensation plates are to be provided at the openings.

6.6 Deep tank platform

6.6.1 Thickness of deep tank platform t is not to be less than that obtained from the following formulae, and is not to be less than 8 mm：

$$t = 4s\sqrt{h} + 3.5 \quad \text{mm}$$

$$t = 12s \quad \text{mm}$$

where:

s — spacing of stiffeners, in m;

h — vertical distance, in m, measured from deep tank platform to top of deep tank, or half the distance to the top of overflow pipe, whichever is the greater.

6.6.2 Longitudinals or beams of deep tank platform, section modulus W are not to be less than that obtained from the following formula:

$$W = 9shl^2 \quad \text{cm}^3$$

where:

s — spacing of longitudinals or transverse webs, in m;

h — vertical distance, in m, measured from deep tank platform to top of deep tank, or half the distance to the top of overflow pipe, whichever is the greater.

l — span of longitudinal or transverse web, in m.

The moment of inertial I is not to be less than that obtained from the following formula:

$$I = 2.3Wl \quad \text{cm}^4$$

where: W、l same as above.

Chapter 7　Bottom Structures

7.1　General requirements

7.1.1　For double side skin bulk carriers intended to be assigned with class notation of Bulk Carrier, Strengthened for Heavy Cargoes, the bottom structures are to comply with the provisions in Section 22, Chapter 2 of PART TWO of the Rules.

7.1.2　Where the double bottom tanks are interconnected with hopper tanks, the scantlings are to satisfy the requirements of Section 13, Chapter 2 of PART TWO of the Rules for deep tanks.

7.2　Direct calculation

7.2.1　For double side skin bulk carriers intended to be assigned with class notation of Bulk Carrier, Strengthened for Heavy Cargoes, Hold Nos··· May Be Empty, the bottom structures are to comply with the requirements of this Chapter, and in addition, their strength is to be confirmed by direct calculation.

Chapter 8 Watertight Bulkheads

8.1 General requirements

8.1.1 Watertight bulkheads are to comply with the requirements of Section 12, Chapter 2 of PART TWO of the Rules.

8.1.2 Stools, if fitted at the top and bottom of the corrugated watertight bulkhead, are to comply with the following requirements:

(1) The sloping plating of lower stools is to be aligned on solid floors. The thickness of the sloping plating is not to be less than that of bulkhead plating required in Section 12, Chapter 2 of PART TWO of the Rules, also is not to be less than that required in the Guidelines for the sloping plating of hopper tanks.

(2) Where stiffeners are fitted on the sloping plating of bottom stools, their section modulus is not to be less than that required in the Guidelines for the longitudinals on the sloping plating of hopper tanks.

(3) Diaphrams are to be fitted in lower stools in line with the double bottom side girders, their thickness is to be the same as that of the inner bottom longitudinal girders.

(4) The scantlings of the structural members of upper stools are not to be less than those required in Section 12, Chapter 2 of PART TWO of the Rules.

(5) Where stools are situated in liquid tanks, they are also to comply with the requirements of Section 13, Chapter 2 of PART TWO of the Rules for deep tanks.

Chapter 9 Determination of Scantlings of Hatch Covers of Cargo Holds

9.1 General requirements

9.1.1 This Chapter applies to bulk carriers, ore carriers and combination carriers engaged on international voyages and contracted for construction on or after 1 January 2004.

9.1.2 Hatch covers are to comply with the relevant requirements of International Load Line Convention, 1966. In addition, all cargo hatch covers and hatch forward and side comaings of stiffened plate construction on exposed decks in position 1, as defined in ILLC, 1966, are to comply with the requirements of this Chapter.

The secondary stiffeners and primary supporting members of the hatch covers are to be continuous over the breadth and length of the hatch covers, as far as practical. When this is impractical, sniped end connections are not to be used and appropriate arrangements are to be adopted to ensure sufficient load carrying capacity.

The spacing of primary supporting members parallel to the direction of secondary stiffeners is not to exceed 1/3 of the span of primary supporting members.

The secondary stiffeners of the hatch coamings are to be continuous over the breadth and length of the hatch coamings.

9.1.3 The hatch covers are to adopt loading model provided in 9.2 and net minimum scantlings of hatch covers are to fulfill the strength criteria given in:

(1) 9.3.3, for plating,

(2) 9.3.4, for secondary stiffeners,

(3) 9.3.5, for primary supporting members,

The critical buckling stress check in 9.3.6 of this Chapter is to be carried out for hatch cover and the rigidity criteria given in 9.3.7 are to be complied with.

9.1.4 The hatch coamings are to adopt loading model provided in 9.4.1 and net minimum scantlings of hatch coamings are to fulfill the strength criteria given in:

(1) 9.4.2, for plating,

(2) 9.4.3, for secondary stiffeners,

(3) 9.4.4, for coaming stays.

9.1.5 Net thickness, t_{net}, are the member thickness necessary to obtain the minimum net scantlings required by 9.3 and 9.4.

9.1.6 Required gross thicknesses in this Chapter are obtained by adding the corrosion additions, t_s, given in 9.6, to t_{net}.

9.1.7 Material for the hatch covers and coamings are to be of the steel complying with the requirements for ship's hull in Section 3, Chapter 1 of PART TWO of the Rules.

9.2 Hatch cover load model

The pressure p, in kN/m^2, on the hatch covers on freeboard deck is given by and not to be less than 34.3 kN/m^2:

For ships of 100 m in length and above

$$p = 34.3 + \frac{p_{FP} - 34.3}{0.25}(0.25 - \frac{x}{L}) \quad \text{kN/m}^2$$

where: P_{FP} = pressure at the forward perpendicular, in kN/m^2:

P_{FP} = 49.1 + (L-100)a

a = 0.0726 for type B freeboard ships;

a = 0.356 for ships with reduced freeboard;

L = length, in m, as defined in Regulation 3 of Annex I to the 1966 Load Line Convention as modified by the Protocol of 1988, to be taken not greater than 340 m;

x = distance, in m, of the mid length of the hatch cover under examination from the forward end of *L*.

Where a position 1 hatchway is located at least one superstructure standard height higher than the freeboard deck, the pressure *p* may be 34.3 kN/m^2. Definition of one superstructure standard height is same to the International Load Line Convention, 1966.

For ships less than 100 m in length, pressure *p* for hatch ways located at the freeboard deck is to take the greater value obtained from following two formulas:

$$p = 15.8 + \frac{L}{3}(1 - \frac{5x}{3L}) - 3.6\frac{x}{L} \quad \text{kN/m}^2$$

$$p = 0.195L + 14.9 \quad \text{kN/m}^2$$

where: *L* = length, in m, as defined in Regulation 3 of Annex I to the 1966 Load Line Convention as modified by the Protocol of 1988;

x = distance, in m, of the mid length of the hatch cover under examination from the forward end of L.

Where two or more panels are connected by hinges, each individual panel is to be considered separately.

9.3 Hatch cover strength criteria

9.3.1 Allowable stress checks

The normal and shear stresses σ and τ in the hatch cover structures are not to exceed the allowable values given by:

$$\sigma_a = 0.8\sigma_s \quad \text{N/mm}^2$$

$$\tau_a = 0.46\sigma_s \quad \text{N/mm}^2$$

where: σ_s being yield stress, in N/mm^2, of the material.

The normal stress in compression of the attached flange of primary supporting members is not to exceed 0.8 times the critical buckling stress of the structure. The stresses in hatch covers that are designed as a grillage of longitudinal and transverse primary supporting members are to be determined by a grillage or a FE analysis. When a beam or a grillage analysis is used, the secondary stiffeners are not to be included in the attached flange area of the primary members.

In calculating the stresses σ and τ, the net scantlings are to be used.

9.3.2 Effective cross-sectional area of panel flanges for primary supporting members

The effective flange area A_F in cm^2, of the attached plating, to be considered for the yielding and buckling checks of primary supporting members, when calculated by means of a beam or grillage model, is obtained as the sum of the effective flange areas of each side of the girder web as appropriate:

$$A_F = \sum_{nf} \left(10 b_{ef} t\right) \quad \text{cm}^2$$

where: nf = 2 if attached plate flange extends on both sides of girder web, see Fig.9.3.2;

nf = 1 if attached plate flange extends on one side of girder web only, see Fig.9.3.2;

t = net thickness of considered attached plate, in mm;

b_{ef} = effective breadth, in m, of attached plate flange on each side of girder web;

$b_{ef} = b_p$, but not to be taken greater than 0.165 l;

b_p = half distance, in m, between the considered primary supporting member and the adjacent one;

l = span, in m, of primary supporting members.

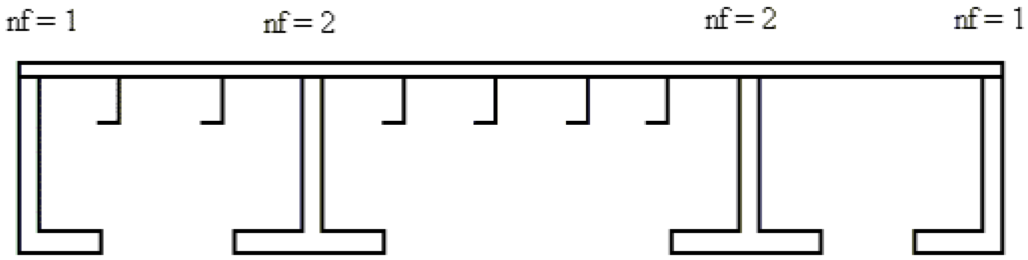


Fig. 9.3.2

9.3.3 Local net plate thickness

The local net plate thickness t, in mm, of the hatch cover top plating is not to be less than:

$$t = F_p 15.8 s \sqrt{\frac{p}{0.95\sigma_s}} \quad \text{mm}$$

but to be not less than 1% of the spacing of the stiffener or 6 mm if that be greater.

where:

F_P = factor for combined membrane and bending response;

= 1.50 in general;

= 1.90 σ/σ_a, for $\sigma/\sigma_a \geq$ 0.8, for the attached plate flange of primary supporting members;

s = stiffener spacing, in m;

p — pressure，in kN/m^2，see 9.2；

σ — see 9.3.5；

σ_a — see 9.3.1；

σ_s — yield stress, in N/mm^2, of the material.

9.3.4 Net scantlings of secondary stiffeners

The required minimum section modulus *W* of secondary stiffeners of the hatch cover top plate, based on stiffener net member thickness, are not to be less than the value obtained from the following formula:

$$W = \frac{1000 l^2 sp}{12\sigma_a} \quad \text{cm}^3$$

where:

l = secondary stiffener span, in m, to be taken as the spacing, of primary supporting members or the distance between a primary supporting member and the edge support, as applicable. When brackets are fitted at both ends of all secondary stiffener spans, the secondary stiffener span may be reduced by an amount equal to 2/3 of the minimum brackets arm length, but not greater than 10% of the gross span, for each bracket;

s = secondary stiffener spacing, in m;

p = pressure, in kN/m^2 , see 9.2;

σ_a = see 9.3.1.

The net section modulus of the secondary stiffeners is to be determined based on an attached plate width assumed equal to the stiffener spacing.

9.3.5 Net scantlings of primary supporting members

The section modulus and web thickness of primary supporting members, based on member net thickness, are to be such that the normal stress σ in both flanges and the shear stress τ , in the web, do not exceed the allowable values σ_a and σ_a , respectively, defined in 9.3.1.

The breadth of the primary supporting member flange is to be not less than 40% of their depth for laterally unsupported spans greater than 3.0 m. Tripping brackets attached to the flange may be considered as a lateral support for primary supporting members.

The flange outstand is not to exceed 15 times the flange thickness.

9.3.6 Critical buckling stress check

(1) Hatch cover plating

The compressive stress σ , in the hatch cover plate panels, induced by the bending of primary supporting members parallel to the direction of secondary stiffeners, is not to exceed 0.8 times the critical buckling stress σ_{C1} , to be evaluated as defined below:

$$\sigma_{C1} = \sigma_{E1} \qquad \text{when } \sigma_{E1} \le \frac{\sigma_s}{2};$$

$$\sigma_{C1} = \sigma_s[1 - \sigma_s/(4\sigma_{E1})] \qquad \text{when} \quad \sigma_{E1} > \frac{\sigma_s}{2}$$

where:

σ_s = yield stress, in N/mm^2, of the material;

$\sigma_{E1} = 3.6E(\frac{t}{1000s})^2$ N/mm^2;

E = modulus of elasticity, in N/mm^2, 2.06×10^5, for steel;

t = net thickness, in mm, of plate panel;

s = spacing, in m, of secondary stiffeners.

The mean compressive stress σ, in each of the hatch cover plate panels, induced by the bending of primary supporting members perpendicular to the direction of secondary stiffeners, is not to exceed 0.8 times the critical buckling stress σ_{C2}, to be evaluated as defined below:

$$\sigma_{C2} = \sigma_{E2} \qquad \text{when} \quad \sigma_{E2} \le \frac{\sigma_s}{2};$$

$$\sigma_{C2} = \sigma_s[1 - \sigma_s/(4\sigma_{E2})] \qquad \text{when} \quad \sigma_{E2} > \frac{\sigma_s}{2}$$

where:

σ_s — yield stress, in N/mm^2, of the material;

$\sigma_{E2} = 0.9mE(\frac{t}{1000s_s})^2$;

$m = c[1 + (\frac{s_s}{l_s})^2]^2 \frac{2.1}{\psi + 1.1}$;

E — modulus of elasticity, in N/mm^2, 2.06×10^5, for steel;

t — net thickness, in mm, of plate panel;

s_s — length, in m, of the shorter side of the plate panel;

l_s — length, in m, of the longer side of the plate panel;

ψ — ratio between smallest and largest compressive stress;

c = 1.3 when plating is stiffened by primary supporting members;

c = 1.21 when plating is stiffened by secondary stiffeners of angle or T type;

c = 1.1 when plating is stiffened by secondary stiffeners of bulb type;

c = 1.05 when plating is stiffened by flat bar.

The biaxial compressive stress in the hatch cover panels, when calculated by means of FEM shell element model, is to be in accordance with the requirements in Guidelines for Direct Strength Analysis of Bulk Carriers by the Society.

(2) Hatch cover secondary stiffeners

The compressive stress σ, in the top flange of secondary stiffeners, induced by the bending of primary supporting members parallel to the direction of secondary stiffeners, is not to exceed 0.8 times the critical buckling stress σ_{CS}, to be evaluated as defined below:

$$\sigma_{CS} = \sigma_{ES} \qquad \text{when } \sigma_{ES} \le \frac{\sigma_s}{2};$$

$$\sigma_{CS} = \sigma_s[1 - \sigma_s/(4\sigma_{ES})] \qquad \text{when } \sigma_{ES} > \frac{\sigma_s}{2}$$

where:

σ_s — yield stress, in N/mm^2, of the material;

σ_{ES} — ideal elastic buckling stress, in N/mm^2, of the secondary stiffener, minimum between σ_{E3} and σ_{E4};

$$\sigma_{E3} = \frac{0.001EI_a}{Al^2} \quad \text{N/mm}^2;$$

E — modulus of elasticity, in N/mm^2, 2.06×10^5, for steel;

I_a — moment of inertia, in cm^4, of the secondary stiffener, including a top flange equal to the spacing of secondary stiffeners;

A — cross-sectional area, in cm^2, of the secondary stiffener, including a top flange equal to the spacing of secondary stiffeners;

l — span, in m, of the secondary stiffener;

$$\sigma_{E4} = \frac{\pi^2 EI_w}{10^4 I_p l^2}\left(m^2 + \frac{K}{m^2}\right) + 0.385E\frac{I_t}{I_p} \quad \text{N/mm}^2;$$

$$K = \frac{Cl^4}{\pi^4 EI_w} \times 10^6;$$

m — number of half waves, given by Table 9.3.6;

I_w — sectorial moment of inertia, in cm^6, of the secondary stiffener about its connection with the plating:

$$I_w = \frac{h_w^3 t_w^3}{36} \times 10^{-6}, \quad \text{for flat bar secondary stiffeners;}$$

$$I_w = \frac{t_f b_f^3 h_w^2}{12} \times 10^{-6}$$, for "Tee" secondary stiffeners;

$$I_w = \frac{b_f^3 h_w^2}{12(b_f + h_w)^2}[t_f(b_f^2 + 2b_f h_w + 4h_w^2) + 3t_w b_f h_w] \times 10^{-6}$$, for angles and bulb secondary stiffener;

I_p — polar moment of inertia, in cm[4], of the secondary stiffener about its connection with the plating:

$$I_p = \frac{h_w^3 t_w}{3} \times 10^{-4}$$, for flat bar secondary stiffeners;

$$I_p = (\frac{h_w^3 t_w}{3} + h_w^2 b_f t_f) \times 10^{-4}$$, for flanged secondary stiffeners;

I_t — St Venant's moment of inertia, in cm[4], of the secondary stiffener without top flange:

$$I_t = \frac{h_w t_w^3}{3} \times 10^{-4}$$, for flat bar secondary stiffeners;

$$I_t = \frac{1}{3}[h_w t_w^3 + b_f t_f^3 (1 - 0.63\frac{t_f}{b_f})] \times 10^{-4}$$, for flanged secondary stiffeners;

h_w — height of the secondary stiffener, in mm;

t_w — net thickness, in mm, of the secondary stiffener;

b_f — width, in mm, of the secondary stiffener bottom flange;

t_f — net thickness, in mm, of the secondary stiffener bottom flange;

s — spacing, in m, of secondary stiffeners;

C — spring stiffness exerted by the hatch cover top plating, to be calculated as follows:

$$C = \frac{k_p E t_p^3}{3s(1 + \frac{1.33 k_p h_w t_p^3}{1000 s t_w^3})} \times 10^{-3};$$

$k_p = 1 - \eta_p$, to be taken not less than zero; for flanged secondary stiffeners, need not be taken less than 0.1;

$$\eta_p = \frac{\sigma}{\sigma_{E1}}$$;

σ — see 9.3.5 ;

σ_{E1} — see 9.3.6(1) ;

t_p — net thickness, in mm, of the hatch cover plate panel.

Value *m* of number of half waves **Table 9.3.6**

	0<K≤4	4<K≤36	36<K≤144	$(m-1)^2m^2<K\leq m^2(m+1)^2$
m	1	2	3	*m*

For flat bar secondary stiffeners and buckling stiffeners, the ratio between height and thickness of web is to comply with the following requirement:

$$h/t_w \leq 15k^{0.5}$$

where: h — height, in mm, of stiffener web;

t_w — net thickness, in mm, of stiffener web;

$k = 235/\sigma_s$;

σ_s — yield stress, in N/mm^2, of the material.

(3) Web panels of hatch cover primary supporting members

Buckling check is to be carried out for the web panels of primary supporting members, formed by web stiffeners or by the crossing with other primary supporting members, the face plate (or the bottom cover plate) or the attached top cover plate.

The shear stress τ in the hatch cover primary supporting members web panels is not to exceed 0.8 times the critical buckling stress τ_C, to be evaluated as defined below:

$$\tau_C = \tau_E \qquad \text{when } \tau_E \leq \tau_F/2;$$

$$\tau_C = \tau_F[1-\tau_F/(4\tau_E)] \qquad \text{when } \tau_E > \tau_F/2$$

where:

σ_s — yield stress, in N/mm^2, of the material;

$\tau_F = \sigma_s / \sqrt{3}$ N/mm²;

$\tau_E = 0.9 k_t E [\frac{t_{pr,n}}{1000d}]^2$ N/mm²;

E — modulus of elasticity, in N/mm², 2.06×10^5, for steel;

$t_{pr,n}$ — net thickness, in mm, of primary supporting member;

$k_t = 5.35 + 4.0(d/a)^2$;

a — greater dimension, in m, of web panel of primary supporting member, in m；

d — smaller dimension, in m, of web panel of primary supporting member, in m.

For primary supporting members parallel to the direction of secondary stiffeners, the actual dimensions of the panels are to be considered.

For primary supporting members perpendicular to the direction of secondary stiffeners or for hatch covers built without secondary stiffeners, a presumed square panel of dimension *d* is to be taken for the determination of the stress τ_C. In such a case, the average shear stress τ between the values calculated at the ends of this panel is to be considered.

9.3.7 Deflection limit and connections between hatch cover panels

Load bearing connections between the hatch cover panels are to be fitted with the purpose of restricting the relative vertical displacements.

The vertical deflection of primary supporting members is to be not more than 0.0056 *l*, where *l* is the greatest span of primary supporting members.

9.4 Hatch coamings and local details

9.4.1 Load model

The pressure P_{coam}, in kN/m², on the No. 1 forward transverse hatch coaming is given by:

$p_{coam} = 220$ kN/m²，when a forecastle is fitted in accordance with the requirements of Chapter 11 of the Guidelines;

$p_{coam} = 290$ kN/m²，in the other cases;

The pressure P_{coam}, in kN/m², on the other coamings is given by:

$$p_{coam} = 220 \quad \text{kN/m}^2 ;$$

9.4.2 Local net plate thickness

The local net plate thickness t of the hatch coaming plating is calculated by the following formula, but not to be less than 9.5mm:

$$t = 14.9s\sqrt{\frac{p_{coam}}{\sigma_{a,coam}} S_{coam}} \quad \text{mm}$$

where: s — secondary stiffener spacing, in m;

p_{coam} — pressure, in kN/m^2, see 9.4.1;

S_{coam} — safety factor to be taken equal to 1.15;

$\sigma_{a,coam} = 0.95\sigma_s$;

σ_s — yield stress, in N/mm^2, of the material.

9.4.3 Net scantlings of longitudinal and transverse secondary stiffeners

The required section modulus W of the longitudinal or transverse secondary stiffeners of the hatch coamings, based on net member thickness, is given by:

$$W = \frac{1000 S_{coam} l^2 s p_{coam}}{m c_p \sigma_a} \quad \text{cm}^3$$

where: $m = 16$ in general；

$m = 12$ for the end spans of stiffeners sniped at the coaming corners;

S_{coam} — safety factor to be taken equal to 1.15;

l — span, in m, of secondary stiffeners;

s — spacing, in m, of secondary stiffeners;

p_{coam} — see 9.4.1；

c_p — ratio of the plastic section modulus to the elastic section modulus of the secondary stiffeners with an attached plate breadth, in mm, equal to 40 t, where t is the plate net thickness

= 1.16 in the absence of more precise evaluation;

$\sigma_{a,coam} = 0.95\sigma_s$;

σ_s ——yield stress, in N/mm^2, of the material.

9.4.4 Net scantlings of coaming stays

The required minimum section modulus W and web thickness, t_w of coaming stays designed as beams with flange connected to the deck or sniped and fitted with a bracket (see Figures 9.4.4(1) and 9.4.4 (2)) at their connection with the deck, based on member net thickness, are given by:

$$W = \frac{1000 H_C^2 s p_{coam}}{2\sigma_{a,coam}} \quad \text{cm}^3$$

$$t_w = \frac{1000 H_C s p_{coam}}{h \tau_{a,coam}} \quad \text{mm}$$

where: H_C — stay height, in m, see Figs.9.4.4(1) and 9.4.4(2)；

s — stay spacing, in m;

h — stay depth, in mm, at the connection with the deck, see Figs. 9.4.4(1) and 9.4.4(2)；

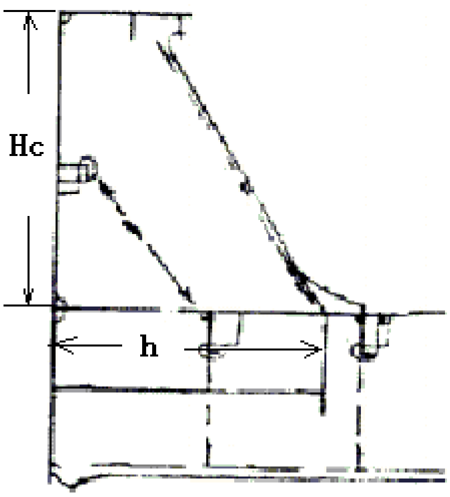
p_{coam} — pressure，in kN/m^2，see 9.4.1；

$\sigma_{a,coam} = 0.95\sigma_s$ ；

$\tau_{a,coam} = 0.50\sigma_s$ ；

σ_s ——yield stress, in N/mm^2, of the material.

For calculating the section modulus of coaming stays, their face plate area is to be taken into account only when it is welded with full penetration welds to the deck plating and adequate underdeck structure is fitted to support the stresses transmitted by it.



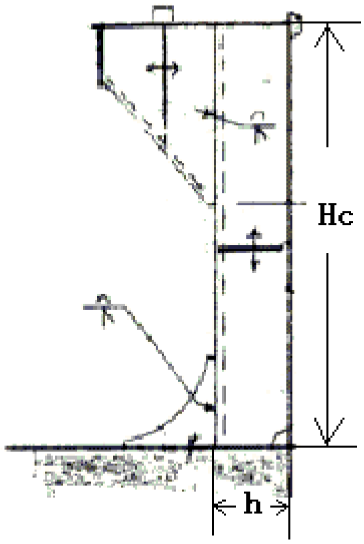


Fig. 9.4.4(1) Fig.9.4.4(2)

For other designs of coaming stays, such as, for examples, those shown in Figures 9.4.4(3) and 9.4.4(4), the stress levels in 9.3.1 apply and are to be checked at the highest stressed locations.

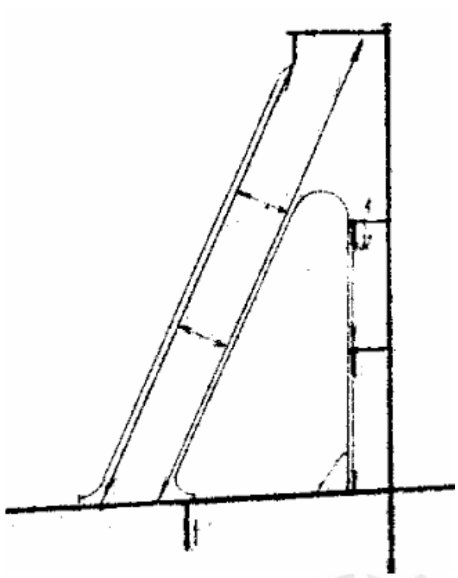


Fig.9.4.4(3)

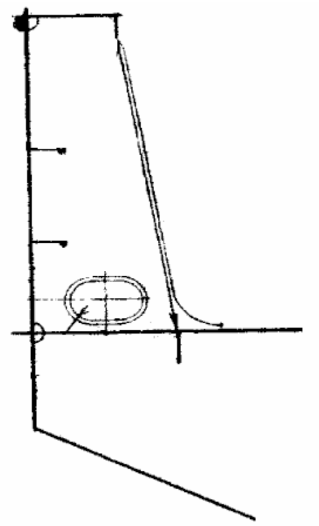


Fig.9.4.4(4)

9.4.5 Local details

The design of local details is to comply with the requirements of Section 2, Chapter 1 of PART TWO of the Rules for the purpose of transferring the pressures on the hatch covers to the hatch coamings and, through them, to the deck structures below. Hatch coamings and supporting structures are to be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions.

Underdeck structures are to be checked against the load transmitted by the stays, adopting the same allowable stresses specified in 9.4.4.

Unless otherwise stated, weld connections and materials are to be dimensioned and selected in accordance with the requirements of Sections 3 and 4, Chapter 1 of PART TWO of the Rules.

Double continuous welding is to be adopted for the connections of stay webs with deck plating and the weld throat is to be not less than $0.44t_w$, where t_w is the gross thickness of the stay web.

Toes of stay webs are to be connected to the deck plating with deep penetration double bevel welds extending over a distance not less than 15% of the stay width.

9.5 Closing arrangements

9.5.1 Securing devices are to comply with the following requirements:

Panel hatch covers are to be secured by appropriate devices (bolts, wedges or similar) suitably spaced alongside the coamings and between cover elements.

Arrangement and spacing are to be determined with due attention to the effectiveness for weather-tightness, depending upon the type and the size of the hatch cover, as well as on the stiffness of the cover edges between the securing devices.

The net sectional area of each securing device is not to be less than:

$$A = 1.4a/f \quad \text{cm}^2$$

where:

a — spacing in m of securing devices, not being taken less than 2 m;

$f = (\sigma_s/235)^e$;

σ_s — specified yield stress, in N/mm^2, of the material, not to be taken greater than 70% of the ultimate tensile strength;

$e = 0.75$, when $\sigma_s > 235$;

$e = 1.0$, when $\sigma_s \leq 235$.

Rods or bolts are to have a net diameter not less than 19 mm for hatchways exceeding 5 m^2 in area.

Between cover and coaming and at cross-joints, a packing line pressure sufficient to obtain weathertightness is to be maintained by the securing devices. For packing line pressures exceeding 5 N/mm, the cross section area is to be increased in direct proportion. The packing line pressure is to be specified.

The cover edge stiffness is to be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, *I*, of edge elements is not to be less than:

$$I = 6pa^4 \quad \text{cm}^4$$

where: p — packing line pressure, in N/mm, minimum 5 N/mm;

a — spacing, in m, of securing devices.

Securing devices are to be of reliable construction and securely attached to the hatchway coamings, decks or covers. Individual securing devices on each cover are to have approximately the same stiffness characteristics.

Where rod cleats are fitted, resilient washers or cushions are to be incorporated.

Where hydraulic cleating is adopted, a positive means is to be provided to ensure that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

9.5.2 Stoppers

Hatch covers are to be effectively secured, by means of stoppers, against the transverse forces arising from a pressure of 175 kN/m^2.

No. 1 hatch cover is to be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 230 kN/m^2. This pressure may be reduced to 175 kN/m^2 when a forecastle is fitted in accordance with requirements of Chapter 11 of the Guidelines.

With the exclusion of No.1 hatch cover, hatch covers are to be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 175 kN/m^2.

The equivalent stress in stoppers and their supporting structures, and calculated in the throat of the stopper welds is not to exceed the allowable value of $0.8\sigma_s$, σ_s being yield stress, in N/mm^2 of the material.

9.5.3 Materials and welding

Stoppers or securing devices are to be manufactured of materials, including welding electrodes, complying with the relevant requirements of Sections 3 and 4, Chapter 1 of PART TWO of the Rules.

9.6 Corrosion addition and steel renewal

9.6.1 Hatch covers

For all the structure (plating and secondary stiffeners) of single skin hatch covers, the corrosion addition t_s is to be 2.0 mm.

For pontoon hatch covers, the corrosion addition is to be 2.0 mm for the top and bottom plating and 1.5 mm for the internal structures.

For single skin hatch covers and for the plating of pontoon hatch covers, steel renewal is required where the gauged thickness is less than $t_{net} + 0.5$ mm . Where the gauged thickness is within the range $t_{net} + 0.5$ mm and $t_{net} + 1.0$ mm, coating (applied in accordance with the coating manufacturer's requirements) or annual gauging may be adopted as an alternative to steel renewal. Coating is to be maintained in GOOD condition, as defined in 4.3.2.2 of Chapter 4, PART ONE of the Rules.

For the internal structure of pontoon hatch covers, thickness gauging is required when plating renewal is to be carried out or when this is deemed necessary, at the discretion of the Surveyor, on the basis of the plating corrosion or deformation condition. In these cases, steel renewal for the internal structures is required where the gauged thickness is less than t_{net}.

9.6.2 Hatch coamings

For the structure of hatch coamings and coaming stays, the corrosion addition t_s is to be 1.5 mm.

Steel renewal is required where the gauged thickness is less than $t_{net} + 0.5$ mm . Where the gauged thickness is within the range $t_{net} + 0.5$ mm and $t_{net} + 1.0$ mm, coating (applied in accordance with the coating manufacturer's requirements) or annual gauging may be adopted as an alternative to steel renewal. Coating is to be maintained in GOOD condition, as defined in 4.3.2.2 of Chapter 4, PART ONE of the Rules.

Chapter 10 Harmonized Notations and Corresponding Design Loading Conditions for Bulk Carriers

10.1 General requirements

10.1.1 This Chapter is not intended to prevent any other loading conditions to be included in the loading manual for which calculations are to be submitted as required by other provisions, nor is it intended to replace in any way the required loading manual/instrument.

10.1.2 A bulk carrier may in actual operation be loaded differently from the design loading conditions specified in the loading manual, provided limitations for longitudinal and local strength as defined in the loading manual and loading instrument onboard and applicable stability requirements are not exceeded.

10.2 Application

10.2.1 This Chapter applies to double side skin bulk carriers of 150 m or over in length engaged on international voyages and contracted for new construction on or after 1 July 2003.

10.2.2 The loading conditions listed in 10.4 are to be used for the checking of rule criteria regarding longitudinal strength, local strength, capacity and disposition of ballast tanks and stability, of which the longitudinal strength is to comply with the requirements of Section 2, Chapter 2, PART TWO of the Rules. The loading conditions listed in 10.5 are to be used for the checking of rule criteria regarding local strength. Direct calculations are to be carried out for the strength of double bottom, transverse bulkhead in way of cargo hold space and primary members in way of deck area. The direct calculations are to comply with the requirements of Guidelines for Direct Strength Analysis of Bulk Carriers by the Society.

10.2.3 "Maximum draught" mentioned in this Chapter is to be taken as moulded summer load line draught.

10.2.4 "Filling rate" mentioned in this Chapter is the rate of cargo mass to hold cubic capacity. The hold cubic capacity is to be taken up to the top of the hatch coaming in calculation.

10.3 Harmonized notations and annotations

10.3.1 Bulk carriers complying with this Chapter may be assigned one of the following notations:

(1) BC-A: for bulk carriers:

- designed to carry dry bulk cargoes of cargo density 1.0 t/m^3 and above,
- with specified holds empty at maximum draught, and
- in addition to BC-B conditions.

(2) BC-B: for bulk carriers:

— designed to carry dry bulk cargoes of cargo density of 1.0 t/m^3 and above,
— with all cargo holds loaded, and
— in addition to BC-C conditions.

(3) BC-C: for bulk carriers:
— designed to carry dry bulk cargoes of cargo density less than 1.0 t/m^3.

10.3.2 Additional notations：

The following additional notations and annotations are to be provided giving further detailed description of limitations to be observed during operation as a consequence of the design loading condition applied during the design in the following cases:

(1) (maximum cargo density (in t/m^3)) for notations BC-A and BC-B if the maximum cargo density is less than 3.0 t/m^3 ;

(2) (no MP) for all notations when the vessel has not been designed for loading and unloading in multiple ports in accordance with the conditions specified in 10.5.3;

(3) (allowed combination of specified empty holds) for notation BC-A.

10.4 Design loading conditions (General)

10.4.1 Harmonized notation BC-C is to include:
Homogeneous cargo loaded condition where the cargo density corresponds to all cargo holds, including hatchways, being 100% full at maximum draught with all ballast tanks empty.

10.4.2 Harmonized notation BC-B is to include:
As required by 8.13.4.1, plus: homogeneous cargo loaded condition with cargo density 3.0 t/m^3, and the same filling rate in all cargo holds at maximum draught with all ballast tanks empty.

In cases where the cargo density applied for this design loading condition is less than 3.0 t/m^3, the maximum density of the cargo that the vessel is allowed to carry is to be indicated with the additional notation (maximum cargo density x.y t/m^3) as specified in 10.3.2(1).

10.4.3 Harmonized notation BC-A is to include:
As required by 10.4.1 and 10.4.2, plus: at least one cargo loaded condition with specified holds empty, with cargo density 3.0 t/m^3, and the same filling rate in all loaded cargo holds at maximum draught with all ballast tanks empty.

The combination of specified empty holds is to be indicated with the annotation (holds a, b,... may be empty) as specified in 10.3.2.(2). In such cases where the design cargo density applied is less than 3.0 t/m^3, the maximum density of the cargo that the vessel is allowed to carry is to be indicated within the annotation, e.g. (maximum cargo density x.y t/m^3, holds a, b,... may be empty).

10.4.4 Ballast conditions (applicable to all notations)

(1) Ballast tank capacity and disposition

All bulk carriers are to have ballast tanks of sufficient capacity and so disposed to at least fulfill the following requirements:

① Normal ballast condition for the purpose of this Section is a ballast (no cargo) condition where:

— all cargo holds adapted for the carriage of water ballast at sea are to be empty;

— the ballast tanks may be full, partially full or empty. Where partially full option is exercised, the conditions in 2.2.2.6 of Section 2, Chapter 2 of PART TWO of the Rules are to be complied with;

— the propeller is to be fully immersed; and

— the trim is to be by the stern and is not to exceed 0.015*L*, where *L* is the length between perpendiculars of the ship. In the assessment of the propeller immersion and trim, the draughts at the forward and after perpendiculars may be used.

② Heavy ballast condition for the purpose of this Section is a ballast (no cargo) condition where:

— at least one cargo hold adapted for carriage of water ballast at sea, where required or provided, is to be full;

— the ballast tanks may be full, partially full or empty. Where partially full option is exercised, the conditions in 2.2.2.6 of Section 2, Chapter 2 of PART TWO of the Rules are to be complied with;

— the propeller immersion I/D is to be at least 0.60 where

I = the distance from propeller centerline to the waterline, in m;

D = propeller diameter, in m; and

— the trim is to be by the stern and is not to exceed 0.015*L*, where *L* is the length, in m, between perpendiculars of the ship;

— the moulded forward draught in the heavy ballast condition is not to be less than the smaller of 0.03*L* or 8 m.

(2) Strength requirements

① Normal ballast condition:

— the structures of bottom forward are to be strengthened in accordance with the relevant requirements of 2.15.3 of Section 15, Chapter 2 of PART TWO of the Rules against slamming for the condition of 10.4.4(1)① at the lightest forward draught;

— the longitudinal strength requirements are to be met for the condition of 10.4.4(1)①; and

— in addition, the longitudinal strength requirements are to be met with all ballast tanks 100% full for the condition of 10.4.4(1)① where the ballast tanks may be partially full or empty.

② Heavy ballast condition

— the longitudinal strength requirements are to be met for the condition of 10.4.4(1)②;

— in addition, the longitudinal strength requirements are to be met with all ballast tanks 100% full for the condition of 10.4.4(1)② where the ballast tanks may be partially full or empty;

and

— where more than one hold is adapted and designated for the carriage of water ballast at sea, it will not be required that two or more holds be assumed 100% full simultaneously in the longitudinal strength assessment, unless such conditions are expected in the heavy ballast condition. Unless each hold is individually investigated, the designated heavy ballast hold and any/all restrictions for the use of other ballast hold(s) are to be indicated in the loading manual.

10.4.5 Unless otherwise specified, each of the design loading conditions defined in 10.4 is to be investigated for the arrival and departure conditions as defined below.

(1) Departure condition: with bunker tanks not less than 95% full and other consumables 100%.

(2) Arrival condition: with 10% of consumables.

10.5 Design loading conditions (for local strength)

10.5.1 The maximum allowable or minimum required cargo mass in a cargo hold, or in two adjacently loaded holds, is related to the net load on the double bottom. The net load on the double bottom is a function of draft, cargo mass in the cargo hold, as well as the mass of fuel oil and ballast water contained in double bottom tanks. For the purpose of the conditions in 10.5.2 to 10.5.6, the following definitions apply:

(1) M_H：the actual cargo mass in a cargo hold corresponding to a homogeneously loaded condition at maximum draught.

(2) M_{Full}： the cargo mass in a cargo hold corresponding to cargo with virtual density (homogeneous mass/hold cubic capacity, minimum 1.0 tonne/m^3) filled to the top of the hatch coaming. M_{Full} is in no case to be less than M_H.

(3) M_{HD}：the maximum cargo mass allowed to be carried in a cargo hold according to design loading condition(s) with specified holds empty at maximum draft.

10.5.2 General conditions applicable for all notations

(1) Any cargo hold is to be capable of carrying M_{Full} with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at maximum draught.

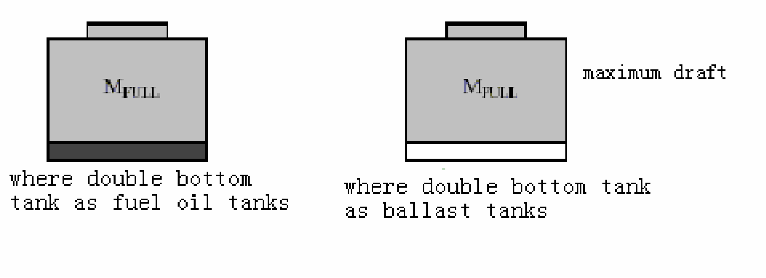


Fig. 10.5.2(1)

(2) Any cargo hold is to be capable of carrying minimum 50% of M_H, with all double bottom tanks in way of the cargo hold being empty, at maximum draught.

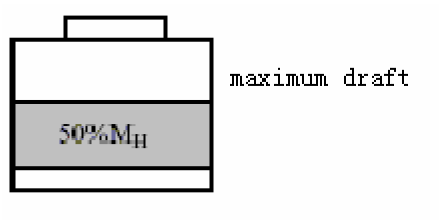


Fig. 10.5.2(2)

(3) Any cargo hold is to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at the deepest ballast draught.

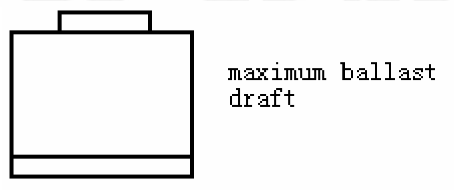


Fig. 10.5.2(3)

10.5.3 Conditions applicable for all notations, except when notation (no MP) is assigned

(1) Any cargo hold is to be capable of carrying M_{Full} with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught.

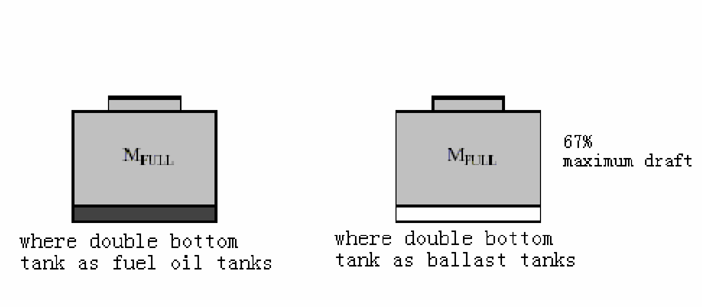


Fig. 10.5.3(1)

(2) Any cargo hold is to be capable of being empty with all double bottom tanks in way of the cargo hold being empty, at 83% of maximum draught.

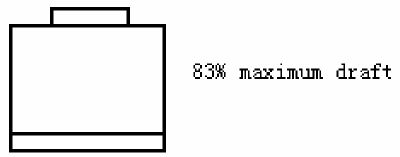
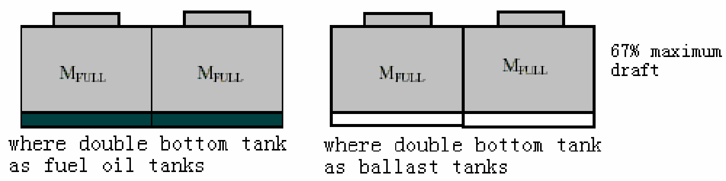


Fig. 10.5.3(2)

(3) Any two adjacent cargo holds are to be capable of carrying M_{Full} with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of the maximum draught. This requirement to the mass of cargo and fuel oil in double bottom tanks in way of the cargo hold applies also to the condition where the adjacent hold is filled with ballast, if applicable.



Where adjacent cargo holds filled with ballast water

Where adjacent cargo holds filled with ballast water

Fig. 10.5.3(3)

(4) Any two adjacent cargo holds are to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at 75% of maximum draught.

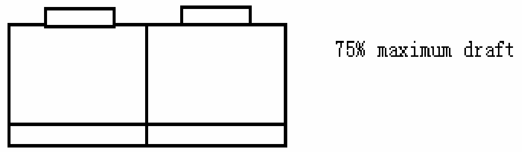


Fig. 10.5.3(4)

10.5.4 Additional conditions applicable for BC-A notation only

(1) Cargo holds, which are intended to be empty at maximum draught, are to be capable of being empty with all double bottom tanks in way of the cargo hold also being empty.

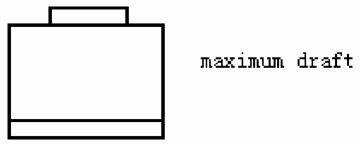


Fig. 10.5.4(1)

(2) Cargo holds, which are intended to be loaded with high density cargo, are to be capable of carrying M_{HD} plus 10% of M_H, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom being empty in way of the cargo hold, at maximum draught. In operation the maximum allowable cargo mass are to be limited to M_{HD}.

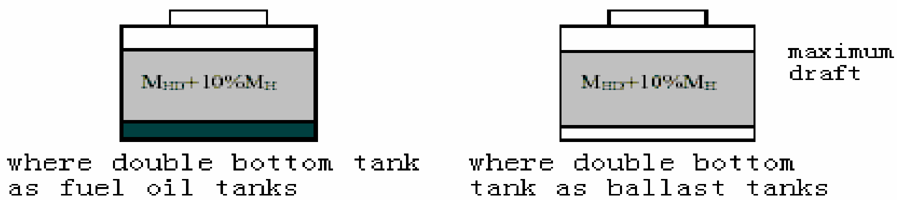


Fig. 10.5.4(2)

(3) Any two adjacent cargo holds which according to a design loading condition may be loaded with the next holds being empty, are to be capable of carrying 10% of M_H in each hold in addition to the maximum cargo load according to that design loading condition, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double

bottom in way of the cargo hold being empty, at maximum draught. In operation the maximum allowable mass are to be limited to the maximum cargo load according to the design loading conditions.

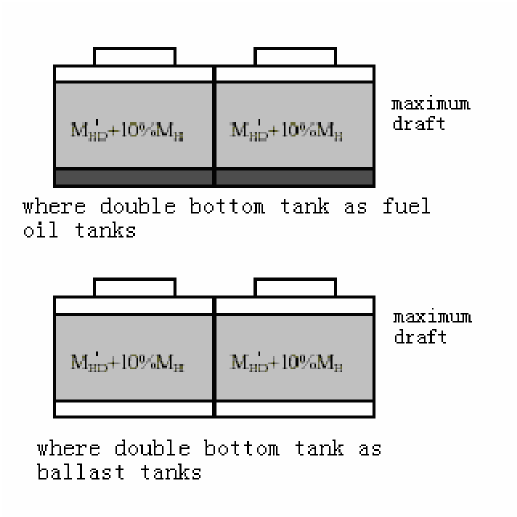


Fig. 10.5.4(3)

10.5.5 Additional conditions applicable for ballast hold(s) only

(1) Cargo holds, which are designed as ballast water holds, are to be capable of being 100% full of ballast water including hatchways, with all double bottom tanks in way of the cargo hold being 100% full, at any heavy ballast draught. For ballast holds adjacent to topside wing, hopper and double bottom tanks, it is to be strengthwise acceptable that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty.

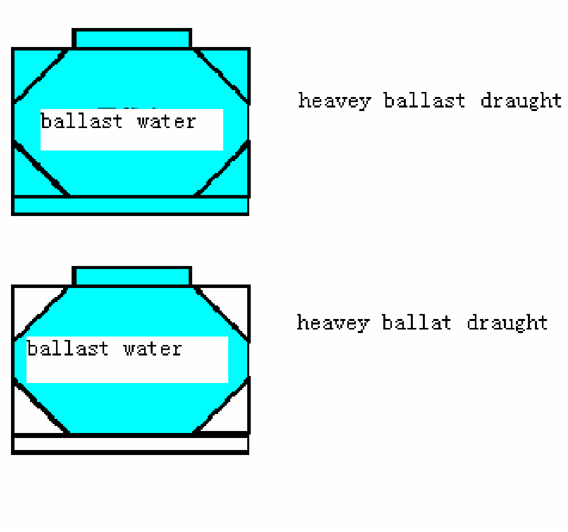


Fig. 10.5.5(1)

10.5.6 Additional conditions applicable during loading and unloading in harbour only

(1) Any single cargo hold is to be capable of holding the maximum allowable seagoing mass at 67% of maximum draught, in harbour condition.

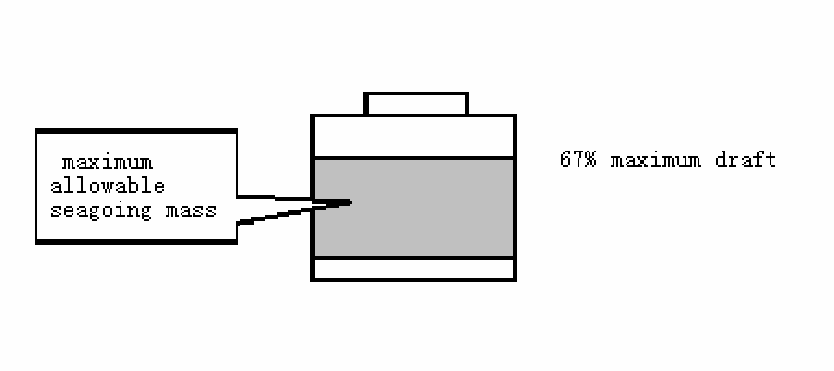


Fig. 10.5.6(1)

(2) Any two adjacent cargo holds are to be capable of carrying M_{Full}, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught, in harbour condition.

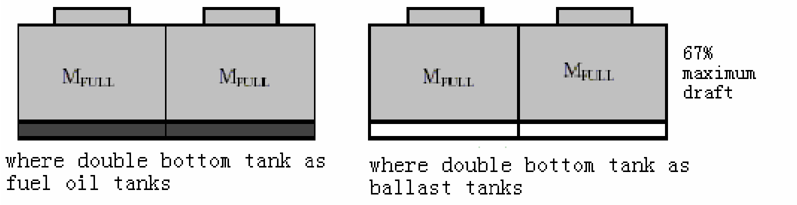


Fig. 10.5.6(2)

(3) At reduced draught during loading and unloading in harbour, the maximum allowable mass in a cargo hold may be increased by 15% of the maximum mass allowed at the maximum draught in sea-going condition, but are not to exceed the mass allowed at maximum draught in the sea-going condition. The minimum required mass may be reduced by the same amount.

10.5.7 Hold mass curves

(1) Based on the design loading criteria for local strength, as given in 10.5.2 to 10.5.6 above, hold mass curves are to be included in the loading manual and the loading instrument, showing maximum allowable and minimum required mass as a function of draught, in sea-going condition as well as during loading and unloading in harbour (See Chapter 3 of the Guidelines).

(2) At other draughts than those specified in the design loading conditions above, the maximum allowable and minimum required mass is to be adjusted for the change in buoyancy acting on the bottom. Change in buoyancy is to be calculated using water plane area at each draught.

Chapter 11 Requirements for the Fitting of a Forecastle on Weather Deck

11.1 General requirements

11.1.1 This Chapter applies to all bulk carriers, ore carriers and combination carriers engaged on international voyages, which are contracted for construction on or after 1 January 2004.

11.1.2 Structural arrangements and scantlings of the forecastle are to comply with the applicable requirements in Section 17, Chapter 2 of PART TWO of the Rules.

11.2 Arrangement

11.2.1 The forecastle is to be located on the freeboard deck with its aft bulkhead fitted in way or aft of the forward bulkhead of the foremost hold, as shown in Figure 11.1.

11.2.2 The forecastle height H_F above the main deck is to be not less than:

$$H_{F1} = H_{sh} \quad \text{m}$$

$$H_{F2} = H_C + 0.5 \quad \text{m}$$

where:

H_{sh} — the standard height of a superstructure as specified in the International Convention on Load Line 1966 and its Protocol of 1988;

H_C — the height, in m, of the forward transverse hatch coaming of cargo hold No.1,

whichever is the greater.

11.2.3 All points of the aft edge of the forecastle deck are to be located at a distance l_f from the hatch coaming plate in order to apply the reduced loading to the No.1 forward transverse hatch coaming:

$$l_f \leq 5\sqrt{H_F - H_C} \quad \text{m}$$

11.2.4 A breakwater is not to be fitted on the forecastle deck with the purpose of protecting the hatch coaming or hatch covers. If fitted for other purposes, it is to be located such that its upper edge at centre line is not less than $H_B / \tan 20^{\circ}$ forward of the aft edge of the forecastle deck, where H_B is the height of the breakwater above the forecastle (see Figure 11.1).

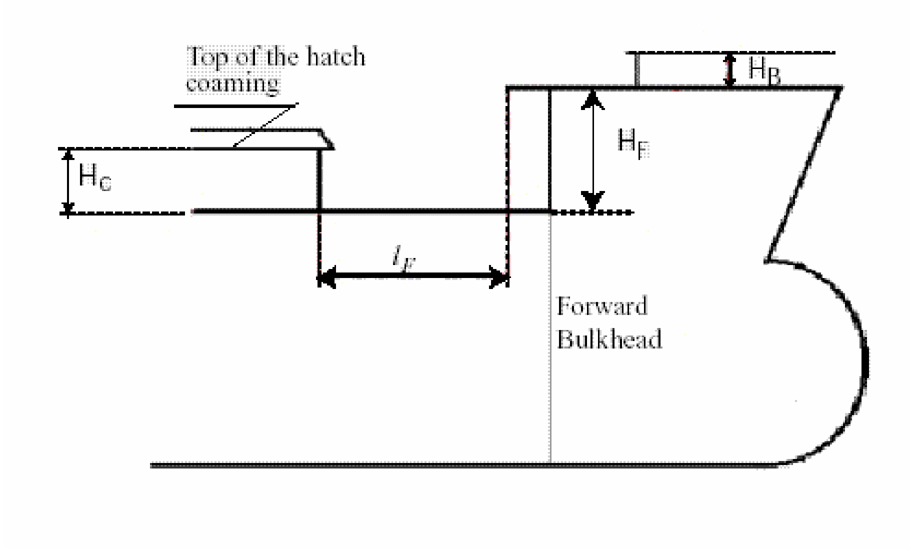


Fig. 11.1

Appendix

Examples of Typical Structural Details of Double Side Skin Bulk Carriers

Table 1.7.3

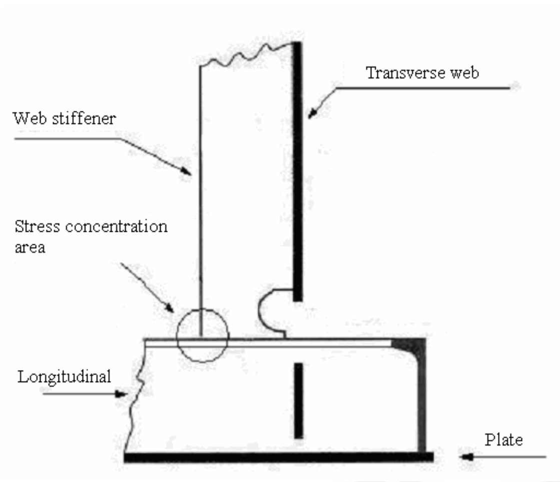
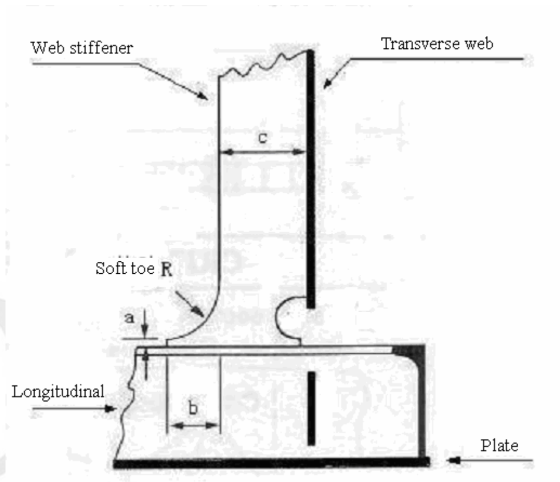
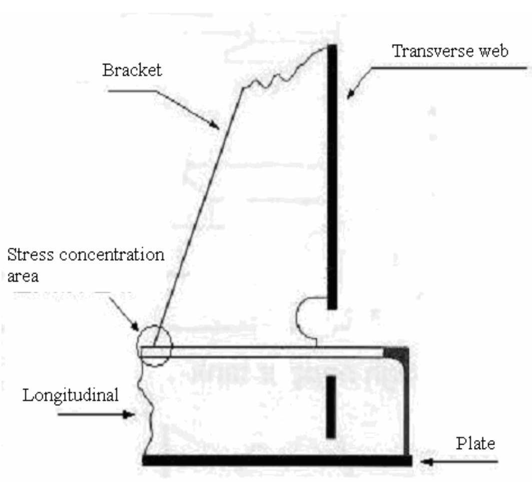
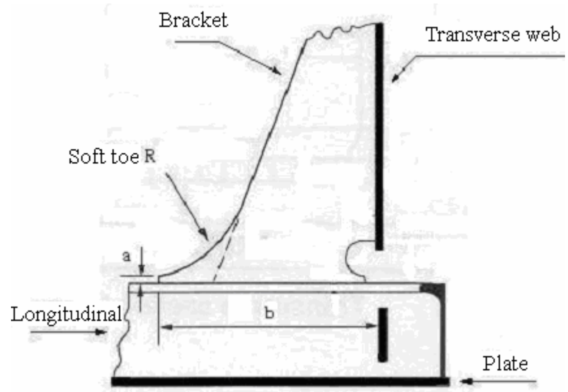
<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of longitudinals to transverse webs (with flat bar stiffeners)</td><td>Example 1</td></tr>
<tr><td>Areas</td><td colspan="3">Double bottom, double side, deck, hopper tank and topside tank</td></tr>
<tr><td colspan="2">Diagram of detail

</td><td colspan="2">Diagram of detail improvement

</td></tr>
<tr><td colspan="2">Description:
① Transverse webs support longitudinals under local load and under axial hull girder global loading.
② Due to abrupt change of structural geometry in way of connection of web stiffeners to face plates of longitudinals, stress concentration occurs at base of the web stiffeners, and this will easily result in fatigue cracks, thus damaging joints of structural connection.</td><td colspan="2">Description:
① Use soft toe of the web stiffeners to reduce stress concentration factor, soft toe sized as follows:
$R \geq 0.75$ c; $b \geq 0.5$ c; $a \leq 15$ mm
② Ensure good alignment of the web stiffeners and the web of the longitudinal.
③ Connection of web stiffeners to face plates of longitudinals by double continuous fillet welding and wraparound welding at both ends.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of longitudinals to transverse webs (with tripping brackets as stiffeners)</td><td>Example 2</td></tr>
<tr><td>Areas</td><td colspan="3">Double bottom, double side, deck, hopper tank and topside tank</td></tr>
<tr><td colspan="2">Diagram of detail


</td><td colspan="2">Diagram of detail improvement



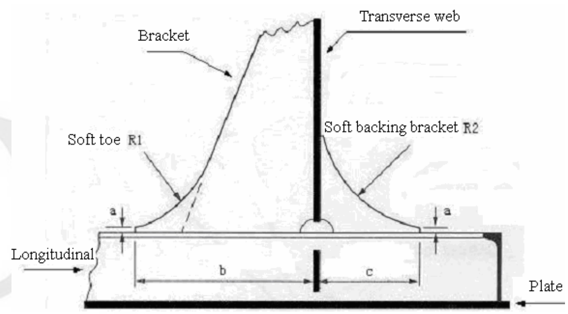
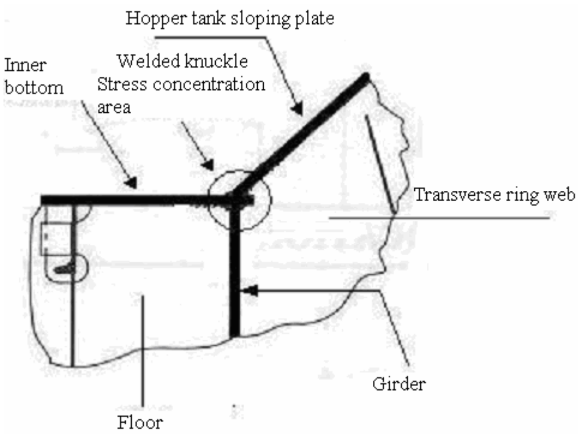
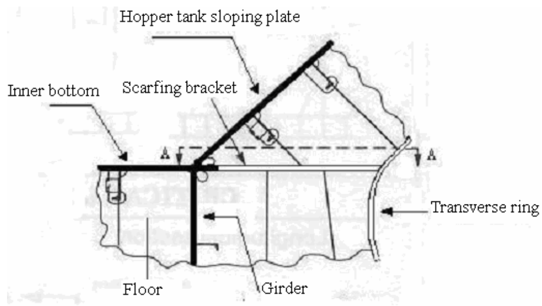
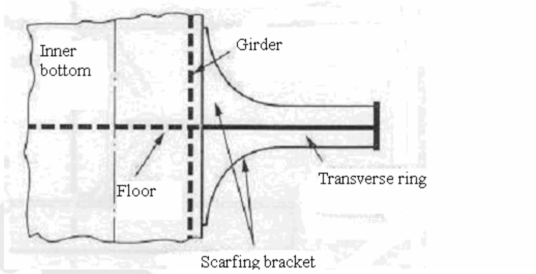

</td></tr>
<tr><td colspan="2">Description:
① Transverse webs support longitudinals under local load and under axial hull girder global loading.
② Due to abrupt change of structural geometry in way of connection of tripping brackets to face plates of longitudinals, stress concentration occurs at base of the tripping brackets, and this will easily result in fatigue cracks, thus damaging joints of structural connection.</td><td colspan="2">Description:
① Use soft toe of the tripping brackets to reduce stress concentration factor, soft toe sized as follows:
R ≥ 300 mm; a ≤ 15 mm
② Use soft toe of the tripping brackets and soft backing bracket on other side of the transverse web to further reduce stress concentration factor of other toe end of the tripping bracket, soft toe and soft backing bracket sized as follows:
R 1 ≥ 300 mm; R2 ≥ MAX (400 mm, 0.67b)
a ≤ 15 mm; c ≥ MAX (300 mm, 0.5 b)
③ Ensure good alignment of the tripping bracket, soft backing bracket and the web of the longitudinal.
④ Connection of tripping brackets and soft backing brackets to face plates of longitudinals by double continuous fillet welding and wraparound welding at both ends.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of inner bottom plating to hopper tank sloping plating</td><td>Example 3</td></tr>
<tr><td>Areas</td><td colspan="3">Double bottom and hopper tank (in way of floors and hopper transverse ring)</td></tr>
<tr><td colspan="2">Diagram of detail

</td><td colspan="2">Diagram of detail improvement


A-A section


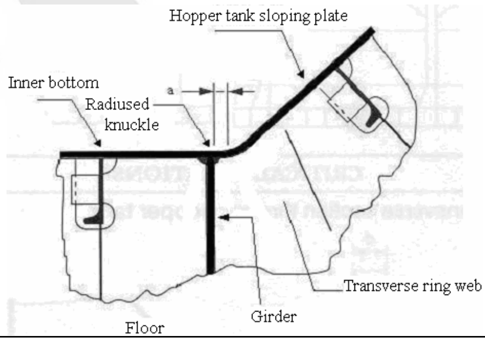
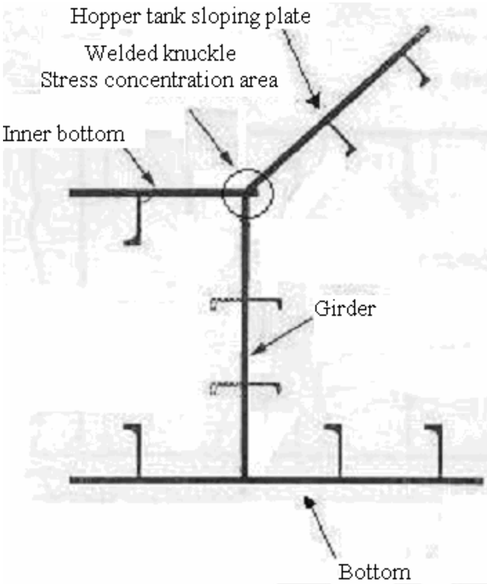
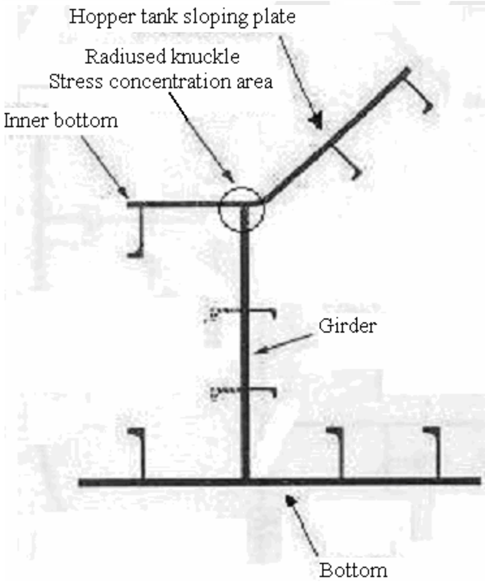
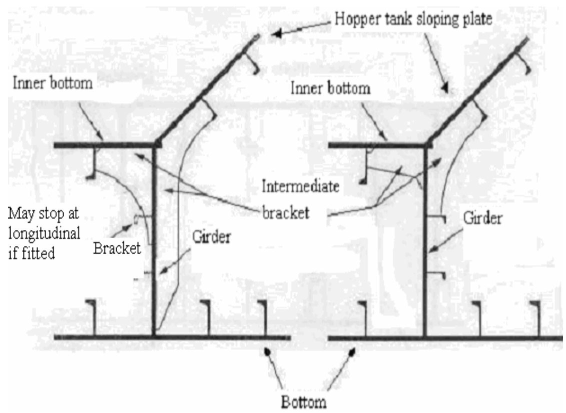

</td></tr>
<tr><td colspan="2">Description:
① Details of connection of inner bottom and hopper plate to floor and hopper web are under inertia pressure of cargo and hopper tank ballast water as well as under external hydrodynamic pressure.
② Due to noncontinuous abrupt change of structural geometry from inner bottom to hoper tank in way of hopper transverse ring, local stress concentration occurs at this detail and will easily result in damage.</td><td colspan="2">Description:
① For welded knuckle connection of inner bottom plating to hopper tank sloping plating, soft scarfing bracket is fitted at same level of hopper tank inner bottom plating to reduce stress concentration factor.
② For non-welded radiused knuckle connection of inner bottom plating to hopper tank sloping plating, the distance a from side girder to centre of knuckle: 50 mm $\leq a \leq$ 70 mm.
③ Ensure good alignment between floor and hopper transverse ring web. The nominal distance between the centres of thickness of the two abutting members is not to exceed 1/3 of the table member thickness.
④ For welded knuckle connection of inner bottom plating to hopper tank sloping plating, centerlines of thickness of inner bottom plating, hopper tank sloping plating and girder are to intersect at the same point as practicable.
⑤ Full penetration welding to be applied to stress concentration areas.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td>Connection of inner bottom plating to hopper tank sloping plating</td><td>Example 4</td></tr>
<tr><td>Areas</td><td colspan="2">Double bottom and hopper tank (between hopper transverse rings)</td></tr>
<tr><td colspan="2">Diagram of detail



</td><td>Diagram of detail improvement


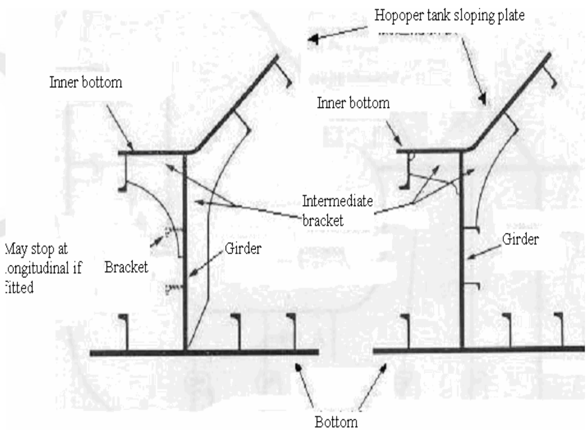
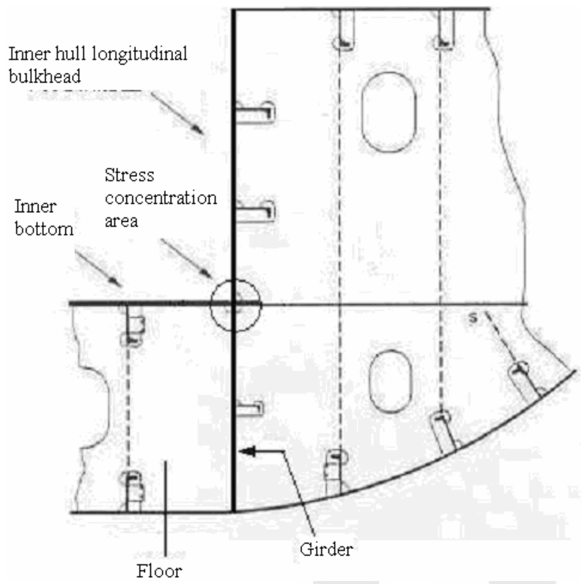

</td></tr>
<tr><td colspan="2">Description:
① Details of connection of inner bottom to hopper sloping plating in way of centre of floor spacing or hopper web spacing are under inertia pressure of cargo and hopper tank ballast water.
② Local high stress occurs at details between floor spans or hopper web spans and will easily result in damage.</td><td>Description:
① If floor spacing or hopper web spacing is greater than 2.5 m, two intermediate brackets are to be fitted at uniform space from floor or hopper web to reduce stress.
② Ensure good alignment between intermediate brackets in hopper tank and double bottom.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of inner bottom plating to inner hull longitudinal bulkhead</td><td>Example 5</td></tr>
<tr><td>Areas</td><td colspan="3">Double bottom and side tank</td></tr>
<tr><td colspan="2">Diagram of detail


</td><td colspan="2">Diagram of detail improvement

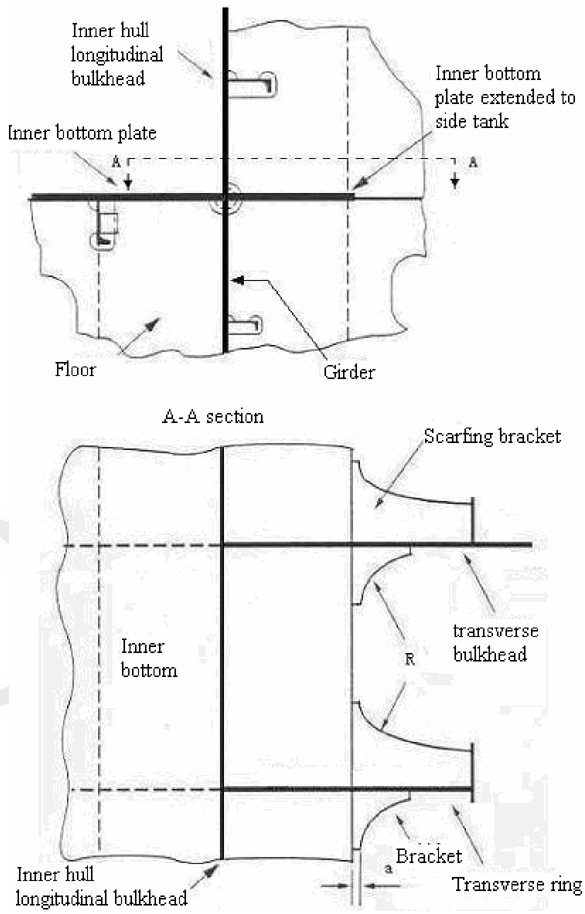

</td></tr>
<tr><td colspan="2">Description:
① Details of connection of inner bottom to inner hull longitudinal bulkhead, floors and transverse ring web or transverse bulkhead are under inertia pressure of cargo and side tank ballast water as well as under external hydrodynamic pressure.
② Due to noncontinuous abrupt change of structural geometry from inner bottom to hopper tank in way of hopper transverse ring and transverse bulkhead, local stress concentration occurs at this detail and will easily result in damage.</td><td colspan="2">Description:
① Inner bottom plating is extended into side tank and scarfing bracket is fitted in way of transverse ring or transverse bulkhead to reduce stress concentration factor, scarfing bracket sized as follows:
R ≥ 400mm; 15 mm ≤ a ≤ 25 mm
② Ensure good alignment between floor and transverse ring web/inner bottom/inner hull longitudinal bulkhead/girder. The nominal distance between the centres of thickness of the two abutting members is not to exceed 1/3 of the table member thickness.
③ Full penetration welding to be applied to stress concentration areas.</td></tr>
</table>

Table 1.7.3 (continued)

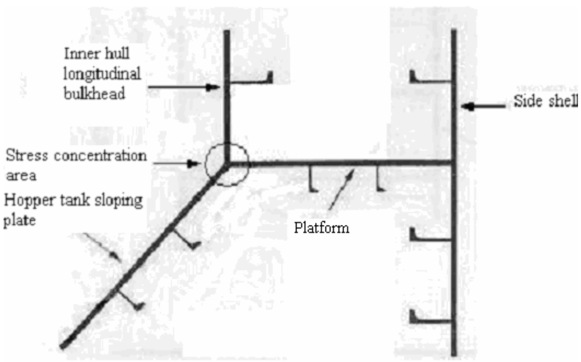
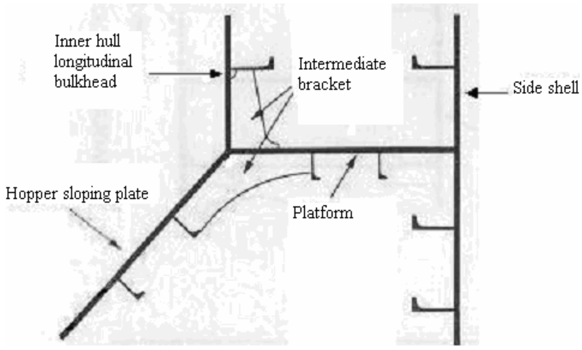
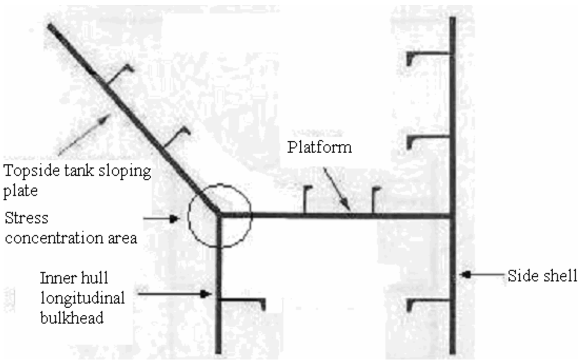
<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of hopper tank sloping plating to inner hull longitudinal bulkhead</td><td>Example 6</td></tr>
<tr><td>Areas</td><td colspan="3">Hopper tank and side tank (between side tank transverse rings)</td></tr>
<tr><td colspan="2">Diagram of detail

</td><td colspan="2">Diagram of detail improvement

</td></tr>
<tr><td colspan="2">Description:
① Details of connection of inner hull longitudinal bulkhead to hopper sloping plating in way of centre of side tank transverse ring spacing are under inertia pressure of cargo and side tank ballast water.
② Local high stress occurs at details between side tank transverse ring spans and will easily result in damage.</td><td colspan="2">Description:
① If side tank transverse ring spacing is greater than 2.5 m, two intermediate brackets are to be fitted at uniform space from them to reduce stress.
② Ensure good alignment between intermediate brackets in hopper tank and side tank.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of topside tank sloping plating to inner hull longitudinal bulkhead</td><td>Example 7</td></tr>
<tr><td>Areas</td><td colspan="3">Topside tank and side tank (between side tank transverse rings)</td></tr>
<tr><td colspan="2">Diagram of detail

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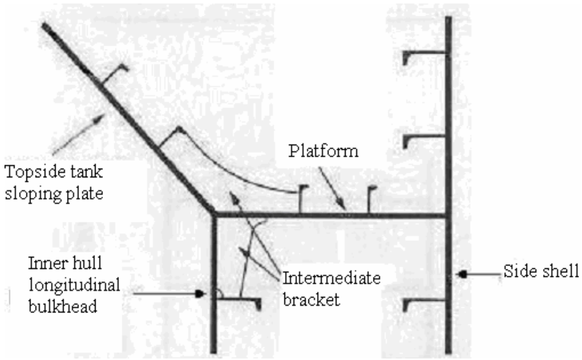
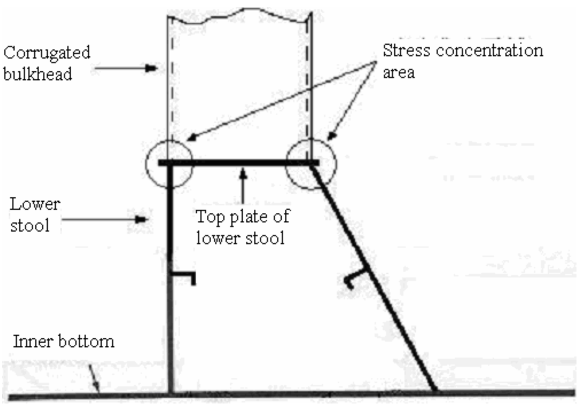

</td></tr>
<tr><td colspan="2">Description:
① Details of connection of inner hull longitudinal bulkhead to topside tank sloping plating in way of centre of side tank transverse ring spacing are under inertia pressure of cargo and side tank ballast water.
② Local high stress occurs at details between side tank transverse ring spans and will easily result in damage.</td><td colspan="2">Description:
① If side tank transverse ring spacing is greater than 2.5 m, two intermediate brackets are to be fitted at uniform space from them to reduce stress.
② Ensure good alignment between intermediate brackets in topside tank and side tank.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td colspan="2">Connection of corrugated bulkhead to top plate of lower stool</td><td>Example 8</td></tr>
<tr><td>Areas</td><td colspan="3">Transverse bulkhead in hold</td></tr>
<tr><td colspan="2">Diagram of detail

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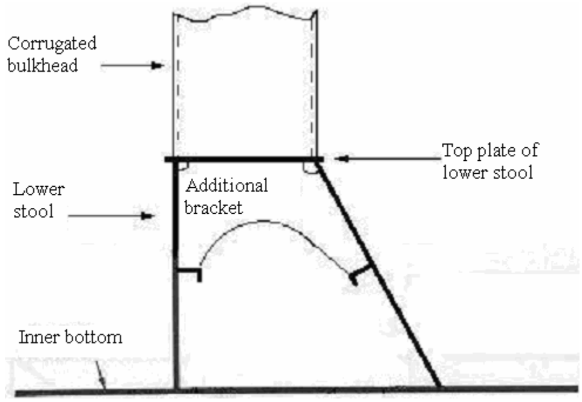
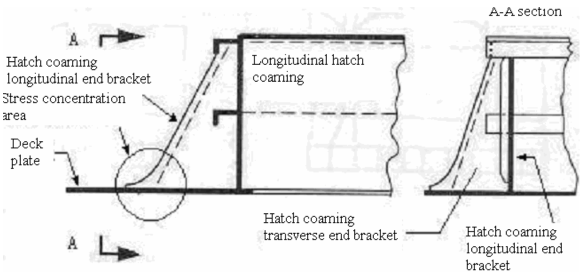

</td></tr>
<tr><td colspan="2">Description:
① Pressure and inertia pressure of cargo.
② Due to noncontinuous vertical abrupt change of structural geometry in way of connection of corrugated bulkhead plate to top plate of lower stool, local high stress concentration occurs here and will easily result in damage.</td><td colspan="2">Description:
① An additional bracket is fitted within lower stool at same level of corrugated bulkhead shedder plate to reduce stress concentration factor.
② Ensure good alignment between additional bracket and corrugated bulkhead shedder plate.</td></tr>
</table>

Table 1.7.3 (continued)

<table>
<tr><td>Typical structural details</td><td colspan="2">Toe of hatch coaming longitudinal end bracket</td><td>Example 9</td></tr>
<tr><td>Areas</td><td colspan="3">Hatch coaming</td></tr>
<tr><td colspan="2">Diagram of detail

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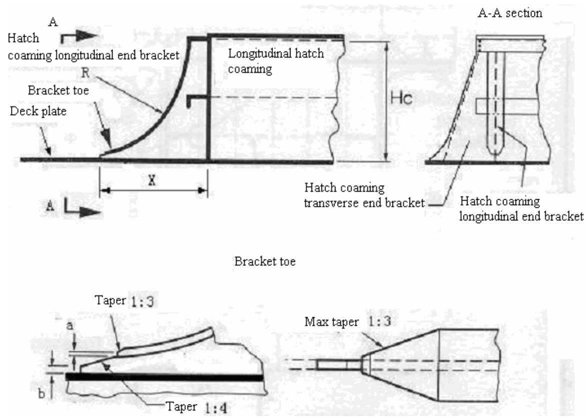
</td></tr>
<tr><td colspan="2">Description:
① Under hull girder global vertical bending moment.
② Due to noncontinuous abrupt change of structural geometry in way of connection of longitudinal hatch coaming and longitudinal bracket to main deck in longitudinal direction of the hull, local high stress concentration occurs at longitudinal bracket toe end and will easily result in damage.</td><td colspan="2">Description:
① The shape of bracket is changed into a flexible circular arc, and a symmetrical face flange sized as follows, is used:
R = 500 mm, X = 0.7 Hc
② The bracket is fitted with a soft toe sized as follows:
a = 7 mm; 15 mm ≤ b ≤ 25 mm
③ Use full penetration welding for a distance of 0.15 Hc from the bracket toe end and a wraparound weld around the toe connection of the bracket to the deck plating.</td></tr>
</table>