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Ships and marine technology — Bulk carriers — Repair quality of hull structure

Navires et technologie maritime — Vraquiers — Qualité de réparation de la structure de la coque

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15402 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 8, *Structures*.

Introduction

The aim of this International Standard is to provide guidelines for good ship-repair conditions.

Details, where appropriate, given in this International Standard were developed with reference to applicable International Association of Classification Societies (IACS) rules and requirements.

Ships and marine technology — Bulk carriers — Repair quality of hull structure

SAFETY PRECAUTIONS — It is the responsibility of the user of this International Standard to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies the quality requirements for the hull structure maintenance and repair of steel bulk carriers. It does not apply to double-skin bulk carriers.

Requirements for the construction of steel bulk carriers are given in ISO 15401.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For a dated reference, subsequent amendments to, or revisions of, the publication do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For an undated reference, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 15401:—[1)], *Ships and marine technology — Bulk carriers — Construction quality of hull structure*.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
bulk carrier
ship which is generally constructed with a single deck, topside tanks and hopper side tanks in cargo spaces, and is intended primarily to carry dry cargo in bulk

3.2
length
L

NOTE The definition is taken from the rules of classification societies.

3.3
coating condition

3.3.1
good coating
condition with only minor spot rusting

1) To be published.

3.3.2
fair coating condition
condition with local breakdown at edges of coating of stiffeners and weld connections and/or light rusting over 20 % or more of areas under consideration, but less than as defined for **poor coating conditions**

3.3.3
poor coating condition
condition with general breakdown of coating over 20 % or more of areas or hard scale on 10 % or more of areas under consideration

4 Inspection and maintenance

4.1 Inspection

4.1.1 Inspection purposes

Inspection of the hull structure shall be carried out earnestly by specially hired inspection crews (referred to as “crew” in the following text). This is in addition to the periodical inspection by the classification society. The purpose of this inspection is to ensure the safety of a bulk carrier while on a voyage and during loading and/or unloading at the port, and to be ready for repairs in dock and/or berth. Corrosion, fracture and deformation of the hull structure and any other circumstance relating to the strength of the hull structure and the safety of the ship shall be discovered by the crews in time. The inspection should be carried out in accordance with a written established procedure valid for the characteristics of the vessel.

The loading/unloading sequence condition should be recorded.

4.1.2 Inspection items and periods

The crews' inspection shall be carried out in accordance with the requirements for the items and periods given in Table 1.

Table 1 — Items and periods of crews' inspection

No.	Area	Kind of deterioration	Main points	Maximum period
1	Shell plate	Corrosion Deformation Weld corrosion Fracture	*Corrosion* and *deformation* of side shell	6 months
2	Upper deck	Corrosion Deformation Fracture Weld corrosion	**a)** *Fracture* at the hatch corner of the deck; **b)** *Corrosion* and *fracture* at the transition from cross-deck plating to the strength-deck plating; **c)** *Corrosion* and *deformation* of cross-deck plating between hatches and the underdeck stiffeners/structure; **d)** *Fracture* at the connections of the hatch-end beams and the top-side tank; **e)** *Corrosion* and *fracture* of the deck plating around the foundations of deck fittings; **f)** *Fracture* of the deck plating at the toes of end/stay brackets of hatchway coamings; **g)** *Fracture* of the deck at the toes of the bulwark stay, especially at the expansion joints; **h)** *Corrosion* at the connections of the upper deck and air pipe, ventilation duct, filling pipe and sounding pipe.	*Fracture*: 3 months *Corrosion*: 6 months
3	Superstructure [a]	Corrosion Deformation Fracture	*Corrosion* at the lower ends of the super-structure and deck-house walls;	6 months
4	Hatch coaming	Corrosion Deformation Fracture	**a)** *Corrosion* and *fracture* in the form of cut-outs and notches of the coamings and their end/stay brackets; **b)** *Fracture* in the fillet-weld connection of the coamings to the deck, particularly at the coaming plate at the corner junction of the longitudinal and transverse hatch coamings; **c)** *Corrosion* and *fracture* at the termination of the hatch-coaming extension brackets.	3 months
5	Hatch cover	Corrosion Deformation Watertight	**a)** *Corrosion* of plating and stiffeners; **b)** *Damaged* sealing; **c)** *Damaged* moving mechanism.	Every voyage

[a] In the accommodation space, steel surfaces cannot be inspected from the inside because walls and decks are covered with linings and ceilings. Inspections can be made from the outside of the space.

Table 1 — *(continued)*

No.	Area	Kind of deterioration	Main points	Maximum period
6	Cargo hold	Corrosion Deformation Fracture Weld corrosion Detachment of frames	**a)** *Corrosion, fracture* and *detachment* of side-shell frames on their webs; **b)** *Corrosion, fracture* and *detachment* at the toes of the upper and lower brackets of the side frames; **c)** *Fracture* at the weld connections of the corrugated bulkhead to the stool; **d)** *Fracture* at the weld connections of transverse bulkheads or stool structure to boundary-deck plate, side-shell plate, sloping plate of topside tanks and hopper tanks, inner-bottom plate, etc.; **e)** *Corrosion* at the midheight and bottom of the transverse bulkheads; **f)** *Fracture* at the transition regions with fore bulkhead of engine room and collision bulkhead due to discontinuities of the longitudinal structures.	Side-shell frames of vessel above 15 years: 6 months Any other case: 12 months
7	Inner bottom Low part of bulkhead Side-shell structure	Deformation Fracture	*Damage* of inner bottom, lower part of bulkheads and side-shell structure due to loading/unloading operations.	Every voyage
8	Topside tank, hopper tank and other ballast tanks	Corrosion Deformation Fracture	**a)** *Corrosion* of the internal structure of the topside tank and inlet/outlet seawater valves due to the heat of upper deck and the moisture in the tank; **b)** *Fracture* at the corners of transverse webs in topside tank, hopper tank, and at the transverse brackets where there is no transverse web; **c)** *Fracture* at the connections of longitudinals to transverse webs, i.e., at the cut-out of transverse web in the topside tank and hopper tank; **d)** *Fracture* due to the knuckle between the inner bottom and hopper tank sloping plating; **e)** *Fracture* in the double bottom at the connections of longitudinals to floors, i.e., at the cut-out of floors and at the discontinuities of the longitudinals; **f)** *Fracture* at the edges of the unreinforced openings and manholes; **g)** *Fracture* at the connections of the deck longitudinals to the bulkheads. **h)** *Corrosion / fracture* of plating and internal stiffening of transverse tanks on top of bulkheads (if any).	Coating in ***good*** condition: 30 months Coating in ***fair / poor*** condition, or vessel above 15 years: 12 months

Table 1 — *(continued)*

No.	Area	Kind of deterioration	Main points	Maximum period
9	Engine room	Corrosion Deformation Fracture	**a)** *Corrosion* of the inner-bottom plating in the engine room; **b)** *Corrosion* and *fracture* at the weld connections of the top/bottom end of side-shell plating to the fore/aft bulkheads of the engine room.	Coating in ***good*** condition: 30 months Coating in ***fair / poor*** condition, or vessel above 15 years: 12 months
10	Forecastle spaces Bo'sun store	Corrosion Deformation Fracture	**a)** *Corrosion* at the bottom of forecastle spaces and Bo'sun store; **b)** *Corrosion* at the joint of the top of fore peak and the aft wall of forecastle; **c)** *Corrosion* and *deformation* at side-shell platings of the forecastle due to rough seas or contact with other objects such as quay, buoy or other vessels.	Coating in ***good*** condition: 30 months Coating in ***fair / poor*** condition, or vessel above 15 years: 12 months
11	Fore/aft peak	Corrosion Deformation Fracture Weld corrosion Detachment of frames	**a)** *Corrosion* at the top of fore/aft peak; **b)** *Fracture* of the side shell and damage of the internal structure in the fore peak due to collision/or sloshing; **c)** *Fracture* of the internal structure of the aft peak due to propeller vibration; **d)** Inspection of the anti-corrosion zinc plates in the fore and aft peak shall be carried out.	Coating in ***good*** condition: 30 months Coating in ***fair / poor*** condition, or vessel above 15 years: 12 months

4.1.3 Inspection reports

The inspection reports shall be written after the crews' inspection of the hull structure, and be filed on board. Personnel name, date, location, contents, result of the inspection and suggested follow-on actions shall be included in the reports. Reports with proposals for remedial actions shall be forwarded to the operator of the vessel. Follow-up procedures shall be established.

4.2 Maintenance of coating system

4.2.1 Maintenance purposes

Maintenance of the areas which affect the safety of the ship shall be carried out in time by the crew after the inspection of the hull structure. The maintenance shall be carried out within the limits of the crew's ability and the crew's safety shall be insured.

4.2.2 Maintenance items and periods

The crews' maintenance of the hull-structure coating shall be carried out in accordance with the requirements for the items and periods given in Table 2.

Table 2 — Items and periods of crews' maintenance

No.	Area	Item	Period
1	Shell plate above light waterlines	Remove corrosion Patch up coating	6 months
2	Upper deck, forecastle and poop deck, superstructure	Remove corrosion Patch up coating	6 months
3	Bulwark	Remove corrosion Patch up coating	6 months
4	Hatch coaming	Remove corrosion Patch up coating	6 months
5	Hatch cover, pressure pipes of hydraulic hatch cover	Remove corrosion Patch up coating	6 months
6	Cargo hold	Remove corrosion Patch up coating	30 months or 12 ± 3 months [a]
7	Topside tank	Remove corrosion Patch up coating	30 months or 12 ± 3 months [a]
8	Hopper tank, ballast tank in double bottom	Remove corrosion Patch up coating	30 months or 12 ± 3 months [a]
9	Fore and aft peak	Remove corrosion Patch up coating	30 months or 12 ± 3 months [a]

[a] For those bulk carriers having ages of 15 years or more, the maintenance period of 12 ± 3 months is required.

4.2.3 Maintenance records

The maintenance records shall be written after the crews' maintenance of the hull structure. Personnel name, date, location and contents of the maintenance shall be included in the records.

5 Repair of the hull structure

5.1 Assessment of the hull structure

5.1.1 Thickness measurement of the hull structure

5.1.1.1 General

In order to determine the extent to which the longitudinal strength and local strength of a bulk carrier are weakened due to the structural wastage/corrosion and to adopt necessary repair measures to reinforce the hull structure, it is required to measure the thickness of the hull structural members during the related survey.

5.1.1.2 Measurement method

5.1.1.2.1 The thickness-measuring equipment shall be calibrated before use.

5.1.1.2.2 Coating and rust at the measuring position shall be cleaned away.

5.1.1.2.3 The thickness measurement shall be carried out by a qualified, certified company or an organization recognized by the administration or by a qualified technician employed by operator of the vessel. The measurement report shall be prepared in accordance with the approval format. The surveyor shall verify and countersign the thickness-measurement reports.

5.1.1.3 Location and amount of thickness measurements

5.1.1.3.1 The location of the thickness-measurement points shall be determined by the classification society according to a random method. Upon request, thickness measurement can be done at other locations as a function of the close-up survey.

5.1.1.3.2 The number of thickness measurements shall be increased with the rise in the ship's age as well as the deteriorated technical conditions.

5.1.1.3.3 The thickness measurements and close-up survey shall be in compliance with the requirements given in Tables 3 and 4, respectively.

5.1.1.3.4 The thickness measurements may be dispensed, provided the surveyor is satisfied by the close-up survey, that there is no structural corrosion-wastage and that the coating applied remains effective.

Table 3 — Thickness-measurement requirements

Ages in years

Age $\leqslant$ 5	**5 < Age $\leqslant$ 10**	**10 < Age $\leqslant$ 15**	**Age > 15**
1	**2**	**3**	**4**
1. Suspect areas	1. Suspect areas 2. Within the cargo length area: a) Two transverse sections of deck plating outside the line of cargo-hatch openings. 3. Measurement, for general assessment and recording of corrosion pattern, of those structural members subject to a close-up survey in accordance with Table 4. 4. All cargo-hold hatch covers and coamings (plating and stiffeners). 5. Selected areas of deck plating inside the line of openings between cargo-hold hatches. 6. All wind and water strakes within the cargo length area.	1. Suspect areas 2. Within the cargo length area: a) Each deck plate outside the line of cargo-hatch openings. b) Two transverse sections, one of which should be in the amidship area, outside the line of cargo-hatch openings. 3. Measurement, for general assessment and recording of corrosion pattern, of those structural members subject to a close-up survey in accordance with Table 4. 4. All cargo-hold hatch covers and coamings (plating and stiffeners) 5. All deck plating inside the line of openings between cargo-hold hatches. 6. All wind and water strakes within the cargo length area. 7. Selected wind and water strakes outside the cargo length area.	1. Suspect areas 2. Within the cargo length area: a) Each deck plate outside the line of cargo-hatch openings. b) Three transverse sections, one of which should be in the amidship area, outside the line of cargo-hatch openings. c) Each bottom plate. 3. Points 3 to 7 referred to in column 3.
NOTE The requirements of the classification societies should also be considered.			

Table 4 — Close-up survey requirements

Ages in years

Age $\leqslant$ 5	**5 < Age $\leqslant$ 10**	**10 < Age $\leqslant$ 15**	**Age > 15**
1	**2**	**3**	**4**
(A) 25 % of shell frames in the forward cargo hold at representative positions. Selected frames in remaining cargo holds. (B) One transverse web with associated plating and longitudinals in two representative water ballast tanks of each type (i.e., topside, hopper side or side tank). (C) Two selected cargo hold transverse bulkheads, including internal structure of upper and lower stools, where fitted. (D) All cargo-hold hatch covers and coamings	(A) 25 % of shell frames in all cargo holds including upper and lower end attachments and adjacent shell plating. (B) One transverse web with associated plating and longitudinals in each water ballast tank (i.e., topside, hopper side or side tank). (B) Forward and aft transverse bulkhead in one side ballast tank, including stiffening system. (C) One transverse bulkhead in each cargo hold, including internal structure of upper and lower stools, where fitted. (D) All cargo-hold hatch covers and coamings. (E) Selected areas of deck plating inside the line of hatch openings between cargo-hold hatches.	(A) All shell frames in the forward cargo hold and 25 % of frames in remaining cargo holds, including upper and lower end attachments and adjacent shell plating. (B) All transverse webs with associated plating and longitudinals in each water ballast tank (i.e., topside, hopper side or side tank). (B) All transverse bulk-heads in ballast tanks, including stiffening system. (C) All cargo-hold transverse bulkheads including internal structure of upper and lower stools, where fitted D) All cargo-hold hatch covers and coamings. (E) All deck plating inside the line of hatch openings between cargo-hold hatches.	(A) All shell frames in all cargo holds including upper and lower end attachments and adjacent shell plating. (B) Areas (B) to (E) as for column 3.
(A) Cargo hold transverse frame. (B) Transverse web frame or watertight transverse bulkhead in water ballast tanks. (C) Cargo hold transverse bulkheads plating, stiffeners and girders. (D) Cargo hold hatch covers and coamings. (E) Deck plating inside line of hatch openings between cargo hold hatches. The close-up survey of transverse bulkheads shall include the following: — the upper construction: immediately below the upper deck plating, wing tanks or topside tanks, upper stool shelf plates; — the mid-height of the bulkhead; — the lower construction: immediately above the bottom, above the lower stool shelf plate, respectively the line of gussets and shedder. NOTE The requirements of the classification societies should also be considered.			

5.1.2 Criterion of longitudinal strength assessment

According to the requirements of the classification society, the minimum midship section modulus after wastage/corrosion shall not be less than 90 % of that required by the classification society for the original ship.

5.1.3 Criterion of local strength assessment

Unless otherwise required by the classification society:

a) The acceptable corrosion allowance of the strength deck, side-shell plates and bottom plates is 25 % of thickness, as required by the classification society rules.

b) The acceptable corrosion allowance of continuous longitudinal strength members and side transverses is 25 % of thickness, as required by the classification society rules.

c) The acceptable corrosion allowance of watertight corrugated bulkhead plates is 25 % of thickness, as required by the classification society rules.

d) The acceptable corrosion allowance of side-frame web and bracket is 30 % of thickness, as required by the classification society rules.

e) The acceptable corrosion allowance of other structural members is 30 % of thickness, as required by the classification society rules.

5.1.4 Acceptable limits for corrosion of welds

5.1.4.1 The surveyor shall examine all the butt welds of shell plates. The welds of which the surface is lower than the adjacent base material shall be rectified, repaired and recorded on related drawings and technical documents. Other butt welds of which the surface is lower than the adjacent base material shall also be rectified and repaired.

5.1.4.2 The fillet welds whose dimensions are less than 80 % of that required by the classification society shall be rectified and repaired.

5.1.5 Acceptable limits for structural deformation of the hull

5.1.5.1 Buckling caused by structural stresses

For cross decks between hatch openings and side-shell plates framed transversely within 0,4 L amidships, the allowable maximum deflection measured between adjacent stiffeners shall be determined by formula (1):

$$f_{max} \leqslant 15 + 1{,}5\,t \quad (1)$$

where

f_{max} is the allowable maximum deflection measured between adjacent stiffeners, in millimetres;

t is the thickness of plates where deflection occurred, in millimetres.

For upper decks, bottom-shell plates and cross decks between hatch openings framed longitudinally within 0,4 L amidships, the allowable maximum deflection measured between adjacent stiffeners shall be determined by formula (2)

$$f_{max} \leqslant 20 + 2{,}0\,t \quad (2)$$

where

f_{max} is the allowable maximum deflection measured between adjacent stiffeners, in millimetres;

t is the thickness of plates where deflection occurred, in millimetres.

5.1.5.2 Deformation caused by external forces such as impact, etc.

For cross decks between hatch openings and side-shell plates framed transversely within 0,4 L amidships, the allowable maximum deflection shall be determined by formula (3) or (4):

$$f_{max} \leqslant 2{,}6\,t \quad \text{as } s/t \leqslant 50 \quad (3)$$

$$f_{max} \leqslant 0{,}06\,s \quad \text{as } s/t > 50 \quad (4)$$

where

f_{max} is the allowable maximum deflection, in millimetres;

s is the frame space, in millimetres;

t is the thickness of plates where deflection occurred, in millimetres.

For upper decks, bottom-shell plates and cross decks between hatch openings framed longitudinally within 0,4 L amidships, the allowable maximum deflection shall be determined by formula (5) or (6):

$$f_{max} \leqslant 3{,}0\ t \quad \text{as } s/t \leqslant 50 \tag{5}$$

$$f_{max} \leqslant 0{,}07\ s \quad \text{as } s/t > 50 \tag{6}$$

where

f_{max} is the allowable maximum deflection, in millimetres;

s is the space between longitudinals, in millimetres;

t is the thickness of plates where deflection occurred, in millimetres.

5.1.5.3 Web plate

The allowable maximum deflection of web plate of longitudinal strength structural members, floors, deck transverses and side transverses is required less than the 4 % of the web height.

5.1.5.4 Caved-in or stuck-out deformation

For upper deck, bottom plate and shell plate, the allowable deflection of caved-in or stuck-out deformation shall be determined by formula (7)

$$f_{max} < 0{,}006\ l + 10 \tag{7}$$

where

f_{max} is the allowable maximum deflection, in millimetres;

l is the span of stiffeners, in millimetres.

5.1.6 Fracture of structural members

No fracture in the hull structure, especially in strength structural members and the location where the concentration of stress occurred, is allowed.

5.1.7 Assessment for the coating condition of structural members

5.1.7.1 The coating condition of shell plates including bottom plates, bilge plates, side-shell plates and keel plates shall be examined. If the coating loses its effectiveness, the rust condition shall be examined. Where obvious corrosion is found or the thickness of plate is suspected to be reduced, the thickness measurement shall be carried out.

5.1.7.2 The coating condition of ballast tanks shall be examined. Where a coating is found in poor condition as defined in 5.1.7.1, and is not renewed, or where a coating has not been applied, the thickness in question shall be examined annually. When extensive corrosion is found, thickness measurements shall be carried out.

5.1.7.3 For bulk carriers of 15 year age or more, the close-up survey shall be carried out on all side frames and their upper and lower brackets in all cargo holds. The thickness measurements for these structural members shall be carried out according to the surveyor's request.

5.2 Requirements for hull structure repair

5.2.1 General

During repair, the grade of substitute is required to be the same as that of the original materials or, at least, not lower than that of the original materials.

The substitute plate thickness is in conformity with that of the original one or shall be increased by 1 mm to 2 mm.

In general, cut-renewing repair is adopted during repair.

During repair, structural stress concentration shall be avoided. Joints shall be treated carefully, refer to ISO 15401:—[2)], subclause 5.5.

During repair, low-hydrogen welding in accordance with a welding procedure that is approved by classification societies shall be used to ensure the welding quality.

Welding of hull structures shall be performed by qualified welders.

5.2.2 Repair for hull structural members with corrosions exceeding the limits

5.2.2.1 Hull structural members shall be renewed, or replaced partly when their corrosion exceed the limits stipulated by 5.1.2 and 5.1.3. If their corrosion is within the limits, only rust removal and coating are needed during repair.

5.2.2.2 The width of insert plate of strength deck, side-shell plate, bottom plate and web plate of built-up longitudinal continuous-strength members is required to be more than 300 mm. The distance between the seam and fillet welding shall be more than 50 mm, and the distance between the seam and butt welding shall be more than 100 mm.

5.2.2.3 For face plate of built-up strength members, the renewal width is required to be the whole width of face plate, and the renewal length shall be more than 500 mm.

5.2.3 Overlaying repair for pitting

Overlaying repairs are normally adopted when diameters of pitting are between 15 mm and 50 mm and depths are more than 50 % of plate thickness. The usual procedure is grit blasting and the use of primed steel.

5.2.4 Repair for welds with corrosions exceeding limits

Repair welding shall be carried out when weld corrosions exceed the limits stipulated in 5.1.4. Rust, water and grease on welds and base metals near welds shall be cleaned out before repair welding.

After repair welding, the weld appearance is required to be smooth and even. Transitions between weld passes or from weld pass to base metal shall be smooth. Abrupt sectional changes are not allowed. The leg size of fillet welds shall be in accordance with stipulations of drawings and the related classification society rules. Quality inspection of weld seams is necessary. X-ray detection, ultrasonic detection or other methods approved by the classification society may be adopted. All welds which do not satisfy the quality requirements shall be repaired and inspected again.

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2) To be published.

5.2.5 Repair for hull structural members with deformation exceeding the acceptable limits

Rectification of deformation by flame heating and water cooling or by flame is adopted when deformation of hull structural members exceed the acceptable limits. Plates and sections which cannot be repaired by the above-mentioned methods shall be replaced in accordance with the principles stipulated in 5.2.2.

5.2.6 Repair of fractures

5.2.6.1 Fractures shall be cleaned by gouging out before patching up. If the fracture is penetrated, it is required to drill stopping holes at both ends of the fracture, and then, one side of the fracture shall be grooved. After repair welding, the other side of the fracture shall be cleaned and back welding shall be carried out.

5.2.6.2 For fractures on strength members and positions of stress concentration, it is necessary to find out the reasons for the fracture occurring. After strengthening and repair welding, the tightness test and non-destructive detection shall be carried out according to the fracture positions.

5.2.7 Repair in cargo holds

5.2.7.1 For frames and end brackets with fractures, perforated corrosions, serious deformations, thinner thickness due to widespread corrosion which exceeds the allowed limits, as well as detachment, it is necessary to cut and renew the damaged elements.

5.2.7.2 Subject to special approval by the classification society, consideration may be given to renewing all other frames if most frames in a cargo hold need repairing. The remaining frames will be renewed during the next repair.

5.2.7.3 If only a few frames in a cargo hold need repairing, different repair methods are adopted in view of the specific technical conditions of different frames, such as complete renewing, partial renewing or making use of a doubler to strengthen frame webs.

5.2.7.4 For the repair of frames in cargo holds of large bulk carriers over 15 years of age, consideration is given to add one or two (depending on the frame span) longitudinal continuous girders or to fix longitudinal inclined brackets at interval frames.

5.2.7.5 Damaged parts with fracture or perforated corrosion on transverse bulkheads and inner bottoms shall be replaced. A few defective parts may be repaired by doublers while parts with massive defects shall be cut and renewed.

5.2.7.6 Care shall be taken to examine corrosion conditions around bilge wells. Perforated corrosion parts and parts with fractures shall be renewed. An effectiveness test for the bilge system shall be carried out.

5.2.8 Repair in topside tanks and hopper tanks

5.2.8.1 For transverse webs which are seriously corroded, and/or with perforated corrosion on a large scale, the whole transverse web shall be renewed. Locally damaged parts may be partly renewed.

5.2.8.2 Sloping plates with widespread corrosion and thinner thickness which exceeds the limits or with perforated corrosion in many places shall be cut and renewed. A few perforated corrosion parts may be repaired by doublers subject to agreement by the surveyor of a classification society. For topside tanks, the tightness test shall be carried out to ensure no water leakage to cargo holds.

5.2.8.3 Watertight bulkhead with massive defects shall be cut and renewed. Local perforated corrosion parts may be repaired by doublers subject to agreement by the surveyor of a classification society.

5.2.9 Repair in forepeak and afterpeak

Corroded and/or ruptured frames and (wash) plates are required to be renewed. Care shall be given to the repair of joints and other seriously damaged structures to ensure the structural completeness of frames.

The ruptured parts on every platform shall be cut and renewed. Collision bulkheads with perforated corrosion shall be cut and renewed.

5.2.10 Repair for double-bottom ballast tanks

Structural members with diminished thickness due to serious corrosion as well as with ruptures shall be cut and renewed.

Inner bottoms with perforated corrosion shall be cut and renewed.

5.2.11 Repair for cargo hatches

5.2.11.1 During rectification of the deformation of hatch coamings, at the deformed positions the connection of face plate and coaming shall be dissected and then rectified. Cuts shall be welded after rectification.

5.2.11.2 For hatch coamings with serious local deformation or corrosion which have unfavorable influence on use and hull strength, the damaged parts shall be cut and renewed.

5.2.11.3 After damaged parts of hatch coaming have been cut and removed, grease, scale and coating left around cuts on hatch coamings shall be cleaned carefully. Groove welding shall be carried out.

5.2.11.4 After repairing, the appearance inspection shall be carried out. For all welds, defects such as miss-out welding, fractures, air bubbles and serious undercuts are not allowed. For hatch coamings with the plates replaced, the water-jet test shall be carried out, and no leakage is allowed.

5.2.12 Repair for hatch cover

5.2.12.1 When the top plates of hatch covers are used, the parts with wastage, perforated corrosion, or serious deformations are required to be partly repaired.

5.2.12.2 Side plates, end plates of hatch covers with wastage or perforated corrosion shall be partly replaced. Double continuous welding shall be carried out for all fillet welds.

5.2.12.3 The seal shall be renewed where the wear of the sealing surface is in excess of 4 mm or the seal is torn, buckled or partly hardened and the sealing effect cannot be ensured.

5.2.12.4 The test and approval of repairing are described in 5.2.12.4.1 to 5.2.12.4.3.

5.2.12.4.1 Function test of hatch-cover handling

a) The hatch cover shall be easily handled during the test.

b) In the process of hatch-cover handling, it is necessary that each moving device, actuating device and control device work normally. The actions of starting, interlocking and emergency stopping are required to be normally operated.

c) A different securing device (wedge) shall be easily compressed and removed.

5.2.12.4.2 Water-jet test

a) Before the water-jet test, the hatch cover shall be closed and the securing device shall be compressed.

b) The test shall be carried out under water pressure of more then 0,1 MPa (10 m water-head height). The distance between the nozzle and object tested shall not be more than 3 m. The diameter of nozzle shall not be less than 16 mm.

c) During the test, the surroundings of the hatch cover, transverse connections, and different welds shall be checked and no leakage is allowed.

5.2.12.4.3 Alternative test

For testing the tightness of hatch covers, an alternative means approved by a classification society can also be used.

5.3 Protection of the hull structure from corrosion

The main measures for protection of the hull from corrosion are coating and electrochemical protection. The hull shall be coated on the internal and external surfaces and the electrochemical protection for the whole ship or local area shall be adopted. In general, the coating may reduce average hull wastage/corrosion.

5.3.1 Principle for changing sacrificial anode

5.3.1.1 The sacrificial anode material is zinc-based or aluminum-based. The sacrificial anode is a cast whose surface is free of oxide slag and burr. The positive surface shall not have any fractures and longitudinal fractures on other surfaces are not allowed. One fine transverse fracture with length less than 50 mm and depth less than 5 mm is allowed. The maximum depth of the concave part of the surface shall not exceed 10 % of the sacrificial anode thickness. The surface of the sacrificial anode shall be kept clean and without any paint and grease.

5.3.1.2 During repair, the sacrificial anode shall be changed according to its designed life expectancy.

5.3.1.3 During repair, the sacrificial anode shall be changed when its thickness is less than one-third of the original thickness even if it does not exceed its designed life expectancy. The sacrificial anode is allowed to be used until its life designed expectancy is reached, when the remaining thickness of the sacrificial anode exceeds one-third of its original thickness.

5.3.1.4 During repair, the sacrificial anode shall be changed in time when the surface of the anode is not dissolved by corrosion or it forms a hard shell which has no protection effect.

5.3.1.5 The sacrificial anode shall be changed and reinstalled according to the original design drawing provided by the ship owner or the trace of the original anode with the same material, size and type.

5.3.2 Arrangement principle of sacrificial anode

5.3.2.1 The sacrificial anode of the hull is distributed evenly on bilge keels and their extension lines on both sides of the hull.

5.3.2.2 The sacrificial anodes needed for the propeller and rudder shall be evenly distributed on the afterbody and rudder. However, the sacrificial anodes shall not be arranged on shell plates within 300 mm of the blade tip of the propeller and the non-sacrificial anode area of a ship with a single propeller which is shown in Figure 1.

5.3.2.3 The sacrificial anodes needed for the Kingston and sonar transducer well shall be arranged on the internal surface of the valve box and well.

5.3.3 Technical requirements of installing a sacrificial anode

5.3.3.1 The length direction of the sacrificial anode shall be along a stream line and the back of the anode shall be closely installed on the hull.

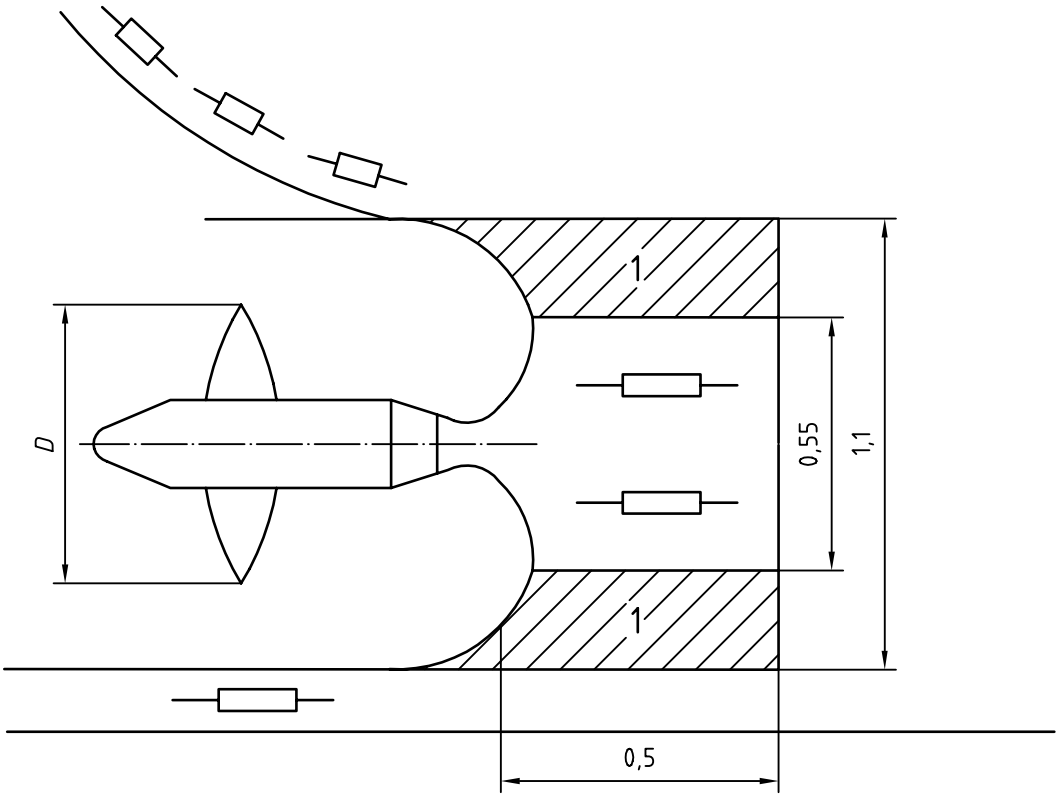
5.3.3.2 The leg of the sacrificial anode shall be cleaned out when the remaining anode is cut and it is not allowed to damage the shell plate. If the shell plate is cut off and becomes caved in, it shall be rectified and repaired before installing the new anode.

5.3.3.3 The sacrificial anode shall be firmly welded onto the ship hull and welding slag shall be cleaned out. Another way to install the sacrificial anode is to fix it firmly on the ship hull using screws. The anode shall be kept in good electric contact with the ship hull.

5.3.3.4 The surface of the sacrificial anode is not allowed to be painted or greased. Before the whole ship hull is coated, the sacrificial anode shall be covered with pressure-sensitive adhesive tape and shall be taken off before the ship is launched.

5.3.3.5 When repair is not carried out in the dockyard, the sacrificial anode may be changed using under water welding.

Dimensions in metres



Key

1 Area without anode

Figure 1 — Sketch of area without anode

5.3.4 Coating protection of the hull and structural members

5.3.4.1 Surface treatment

Before coating, mud, marine fouling, salt and grease, etc., on the steel surface shall be cleaned out using a method such as a high-pressure water jet or scraping.

The rust, bubbles, crackles and peels on previous coatings of structural members shall be examined and treated by using abrasive blasting or a power tool, etc., according to the defect condition.

5.3.4.2 Coating recoatability

The coating used for repair shall be of the same type as the previous coating. The coating selected shall be suitable for recoating the previous one according to the information about previous coating provided by the owner.

5.3.4.3 Requirement of the hull coating

5.3.4.3.1 Before coating the hull, all the surfaces shall be dried and cleaned of rust and grease, etc.

5.3.4.3.2 The sacrificial anode including the impressed current anode and propeller, etc., shall be well covered before the hull is ready for coating, to avoid any contamination by paints.

5.3.4.4 Coating of repaired structural members

After repairing or renewing, it is recommended that structural members be coated.

5.4 Approval and documentation after repair of the hull structure

5.4.1 The owner's detailed thickness-measurement report shall be filed on board after the thickness measurement for hull structural members.

5.4.2 Approval shall be carried out in accordance with the requirements given in 5.2 after repair of the hull structure.

5.4.3 The tightness test shall be carried out in accordance with the following requirements after repair of tight structural members and any leakage is not permitted.

a) A pressure test of all ballast tanks, deep tanks and the boundaries of cargo holds which are used for ballast within the cargo-hold area shall be carried out.

b) The test pressure is usually the same as the water height measured at the top of the ballast tank or cargo hold, or at the top of the air pipe in the ballast tank.

5.4.4 Non-destructive examination of butt welds of strength members shall be carried out, and the signed owner's examination report shall be filed on board.

5.4.5 It is required to submit the material property certificate of the renewal material for strength members.

5.4.6 Documents such as final drawings and calculation reports shall be submitted to the ship owner after a major repair project.

The requirements of the classification societies should also be considered.

Bibliography

[1] IMO A.744 (18), *Guidelines on the enhanced programme of inspections during surveys of bulk carriers and oil tankers*.