

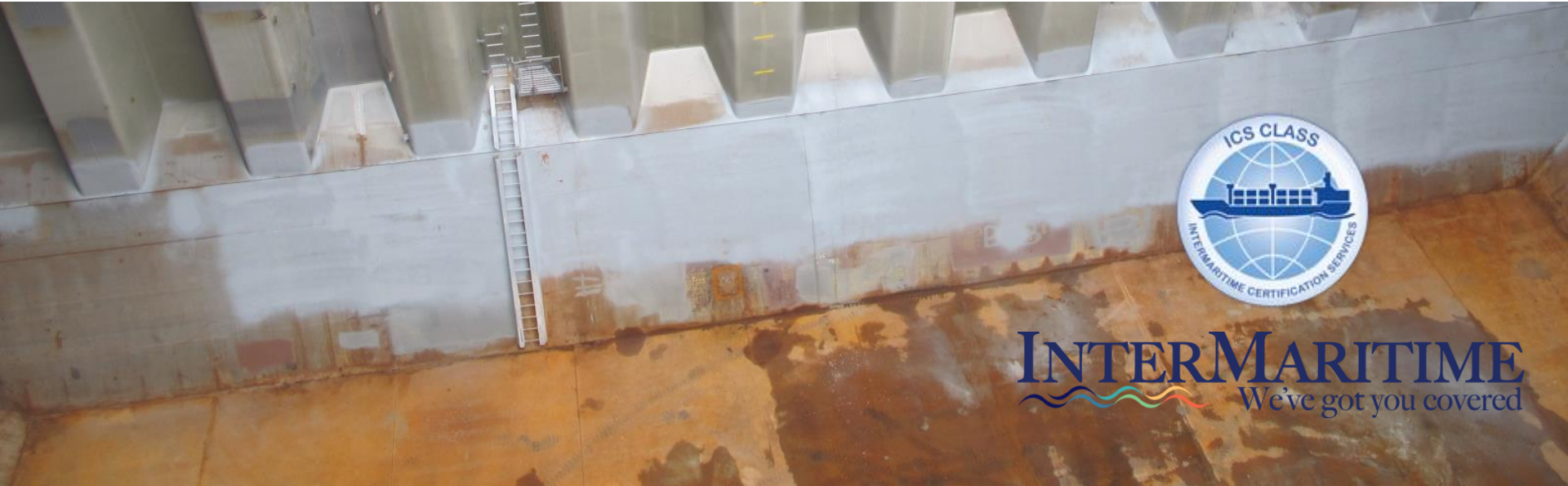


ICS Class

2A: Hull Structure

In compliance with the IMO resolution MSC.349(92) and MEPC.237(65), RO Code, Appendix 2.

Rev.1



INTERMARITIME
We've got you covered

MODULE 2A-Hull Structure (Content)

1. ICS Class Fleet Statistics

2. Actions to be taken when damage is found

- Surveys and Inspections
- How to inspect hull damage
- Damage evaluation
- Mandatory Notification under MARPOL
- Actions to be taken by Master
- Actions to be taken by Manager
- Request for Class/Statutory Surveys
- Service Network
- Evaluation by Surveyor
- Temporary Repairs
- Permanent Repairs

3. Hull Damage

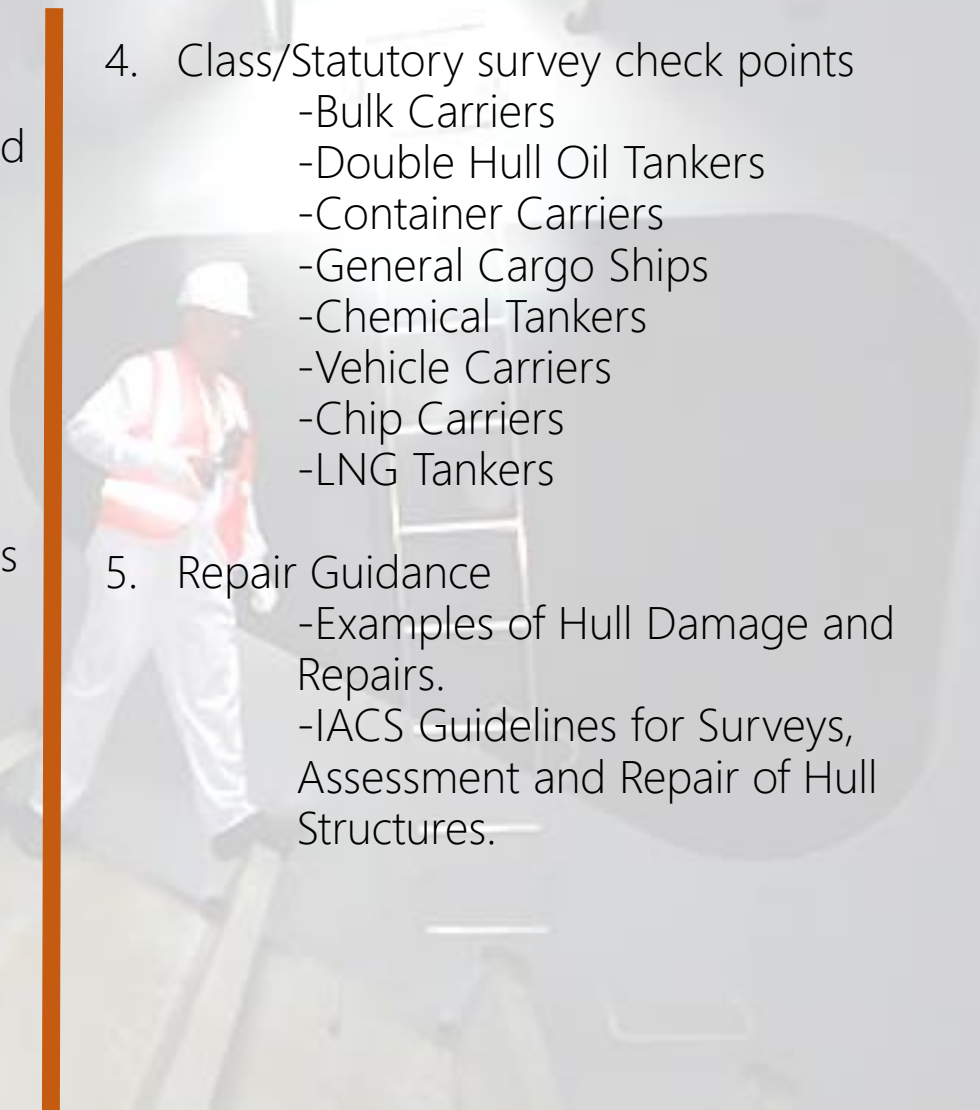
- Causes of damage
- Type of damage
- Example of hull damage

4. Class/Statutory survey check points

- Bulk Carriers
- Double Hull Oil Tankers
- Container Carriers
- General Cargo Ships
- Chemical Tankers
- Vehicle Carriers
- Chip Carriers
- LNG Tankers

5. Repair Guidance

- Examples of Hull Damage and Repairs.
- IACS Guidelines for Surveys, Assessment and Repair of Hull Structures.





2. Actions to be taken when damage is found



-Surveys and Inspections

Class/Statutory Survey



- ➔ Initial Survey (IS)
- ➔ Annual Survey (AS)
- ➔ Intermediate Survey (InS)
- ➔ Docking Survey (DS)
- ➔ Occasional Surveys (OS)

Other Surveys/Inspections

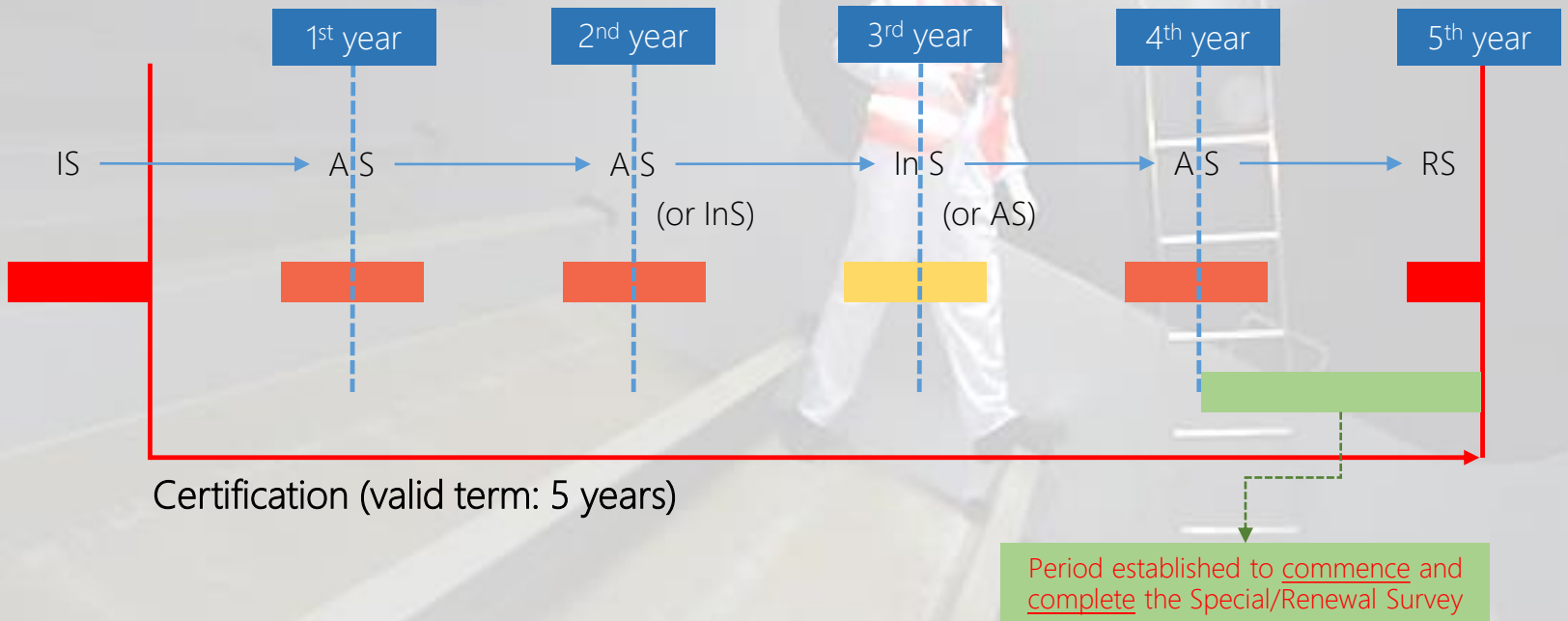


- ➔ Owners
- ➔ Port State Control (PSC)
- ➔ Flag State (ASI)
- ➔ Insurer
- ➔ Charter
- ➔ Ship Vetting
- ➔ Oil Major



-Surveys and Inspections

- Initial Survey (IS) - before the vessel enters into service.
- Annual Surveys (AS) - to be held within 3 months (range dates) before or after each anniversary or due date of the applicable certificate (Hull, SAFCON, ILL).
- Intermediate Survey (InS) – to be held within the 3 months before or after the anniversary date on the 2nd or 3rd year.
- Special/Renewal Survey - to be held every 5 years on or before the expiry date of the applicable certificate (Hull, SAFCON, ILL)



Harmonized System of Survey and Certification (HSSC)

-How to inspect Hull Damages?

Type of Inspection/Test

- General visual inspection
- Close-up inspection
- Thickness Measurement
- Pressure Test
- Non Destructive Test (NDT)
 - Radiographic equipment
 - Ultrasonic equipment
 - Magnetic particle equipment
 - Dye penetrant

Type of Damages

- General Corrosion
- Local Corrosion
- Buckling
- Deformation
- Fracture (Crack)

-How to inspect Hull Damages?

Visual Inspection



-How to inspect Hull Damages?

Visual Inspection



-How to inspect Hull Damages?

Visual Inspection



-How to inspect Hull Damages?

Close Up Survey (Cherry Picker)



-How to inspect Hull Damages?

Close Up Survey (Temporary Stage)



-How to inspect Hull Damages?

Close Up Survey (Raft Survey)



-Damage Evaluation

Management Company and Ship's Master are to assess the damage **taking account of:**

- ➡ Safety of personnel
- ➡ Proximity to shore
- ➡ Weather and sea conditions
- ➡ Availability of repair tools/material
- ➡ Threat of pollution

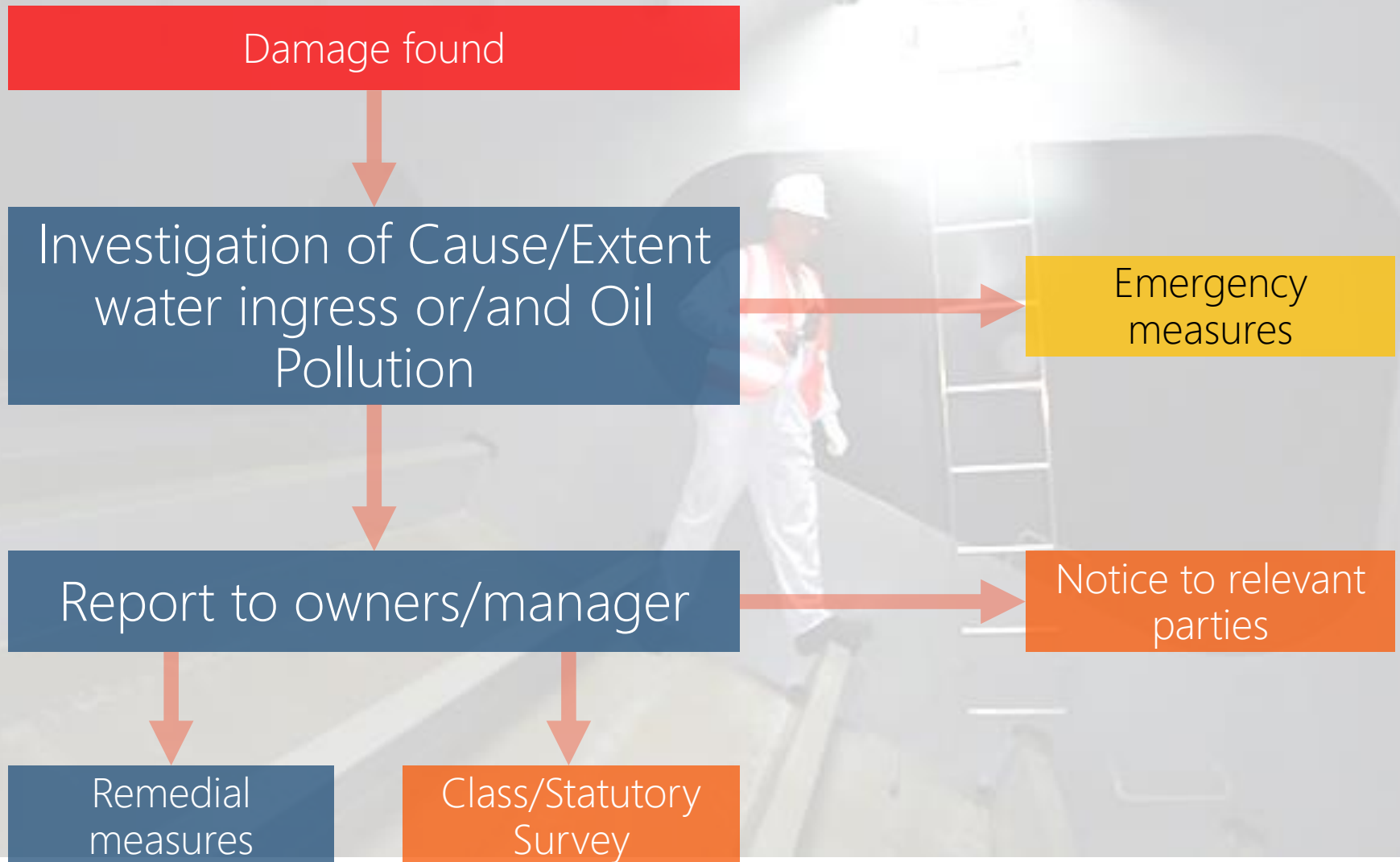
-Mandatory notification under MARPOL

Pollution, or potential for pollution which could affect a coastal area

Inform as per SOPEP/SMPEP

The Government of the coastal area

-Actions to be taken by the Master



-Actions to be taken by the Master

Ships are subject to **Occasional Survey** when main parts of the hull have been damaged or need to be repaired.

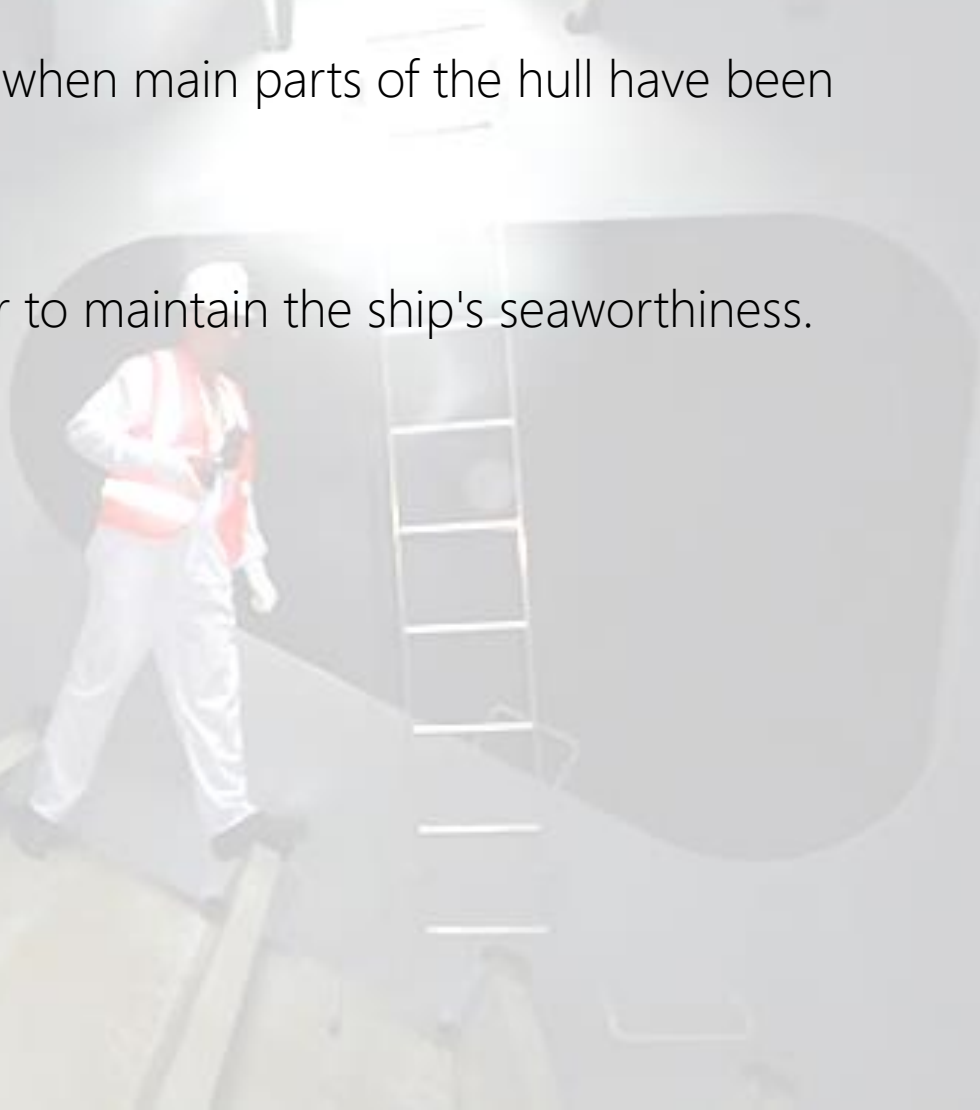
Damage related to Class

Request attendance by an ICS Surveyor to maintain the ship's seaworthiness.

Damage not related to Class

Take actions in accordance with SMS.

SMS: Safety Management Systems



-Request for Class/Statutory Survey

Ship`s Master



Report

Management Company



Request



Request



ICS Class Head Office

-Service Network



ICS Class has more than 70 surveyors/auditors that carry out all the tasks relating to class and statutory surveys.

-Evaluation by Surveyor

- Any damage with wastage over the allowable limits; or
- Extensive areas of wastage over the allowable limits



To be promptly and thoroughly repaired.

-Evaluation by Surveyor

Areas to be considered:

- ➔ bottom structure and bottom plating;
- ➔ side structure and side plating;
- ➔ deck structure and deck plating;
- ➔ watertight or oiltight bulkheads, etc.

-Evaluation by Surveyor

When permanent repairs are impossible due to:

- Possibility of intended voyage
- Treatment of cargoes (unloading/shift)
- Necessary temporary repairs
- Conditions of voyage (towing, escort, etc.)
- Timing of permanent repairs.

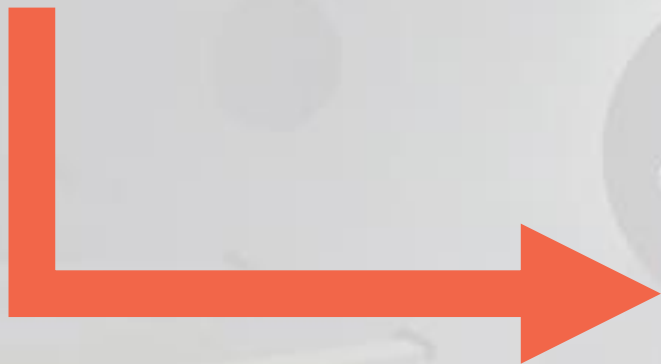
Then

Set out outstanding recommendations.
To be cleared up by the due date.

IMPORTANT: The **ILL** and **SAFCON** may be affected. The Flag State Administration (FSA) shall be informed and the issuance of Conditional Certificates will be applicable **under the Authorization** of the FSA. (refer to Statutory Notice No.106 - Procedures for the Issuance of Conditionals Certificates)

-Temporary Repairs

Temporary Repairs may be carried out in the following cases when:



It is not possible to proceed to shipyard due to:

- Serious damage that impairs seaworthiness
- Threat of harm to the marine environment; or

It is not possible to implement permanent remedial measures at shipyard due to:

- Unavailability of repair yards/facility
- Unavailability of materials/equipment/spare parts

➤ For ensuring water tightness

- Doubling / Patch up (by welding/bolting)
- Cement Box
- Wedge / Caulking



➤ For ensuring strength

- Doubling
- Stiffening
- Stop hole (arresting cracks)
- Welding



-Permanent Repairs

Methods:

- ➔ Renewal
- ➔ Partly renewal
- ➔ Fair in place
- ➔ Re-welding
- ➔ Modification



Conditions:

- ➔ Agreed repair plans
- ➔ Approved material (steel plate & welding)
- ➔ Approved welding procedures
- ➔ Qualified welders
- ➔ NDT/Watertight Test

-Permanent Repairs

Voyage Hull Repairs

➔ Before repair

- Survey planning meeting with a surveyor
- Agreed upon plan kept on board
- Verification of materials and qualified welders

➔ During repair

- Shipboard survey by a surveyor for primary structures

➔ After repair

- Confirmation survey by the surveyor



3. Hull Damage



-Cause of damage



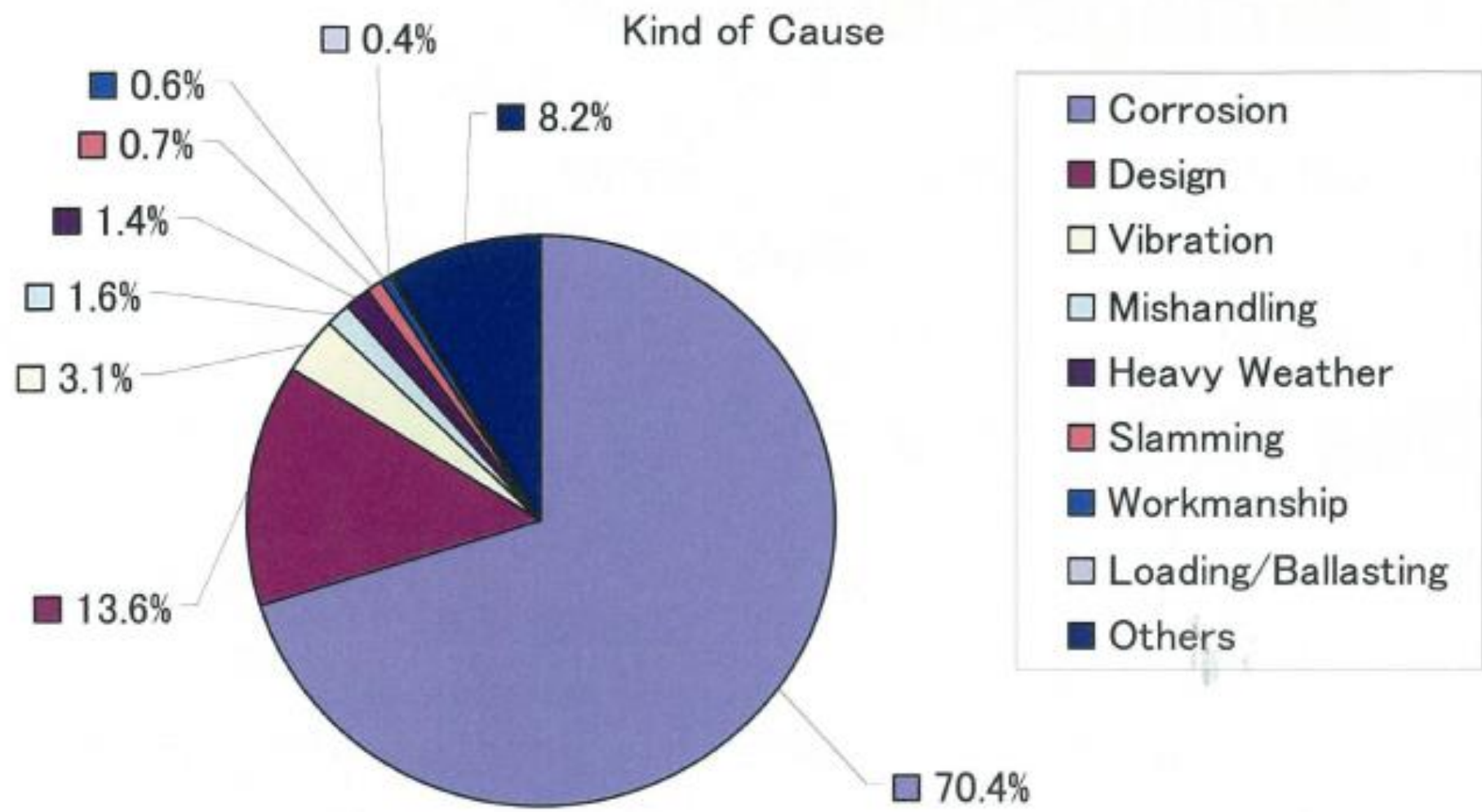
1. Sea Casualty

1. Sink
2. Capsize
3. Flooding
4. Cargo shift
5. Collision
6. Stranding
7. Fire/Explosion

2. General Damage

1. Corrosion
2. Design
3. Vibration
4. Slamming
5. Workmanship
6. Loading/Ballasting
7. Mishandling
8. Heavy Weather
9. Others Unknown

-Cause of damage



Statics taken from ClassNK

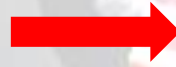
-Types of damage

Corrosion



- Uniform corrosion
- Pitting

Crack



- Brittle fracture
- Ductile fracture
- Fatigue

Buckling/Deformation

Vibration

Statics taken from ClassNK



-Examples of Hull Damage

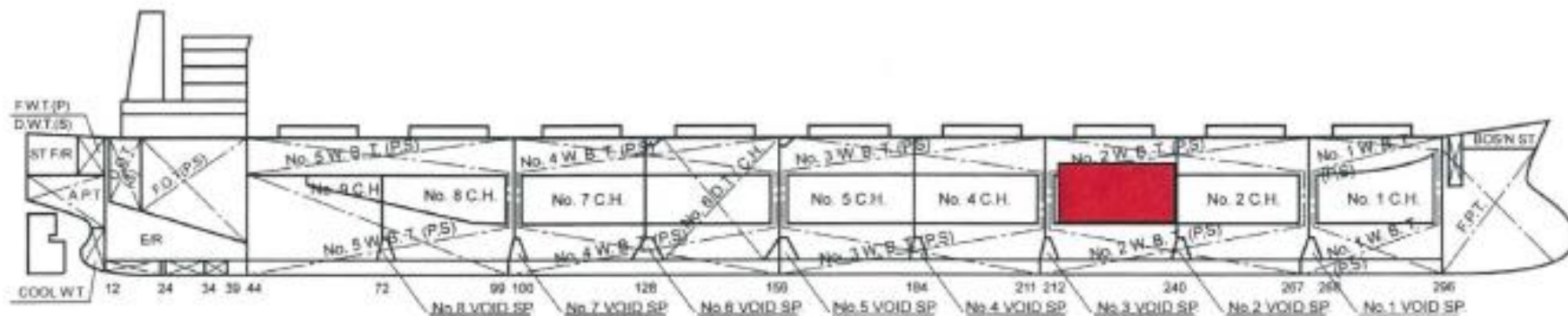


CORROSION

DAMAGE EXAMPLE 1

CORROSION IN THE HOLD FRAME OF BULK CARRIERS

Cape Size Bulk Carrier with Single Skin



Hold Frame Fracture due to Corrosion



Side Shell Plate Indented

Collapse of Hold Frame



Collapse of Hold Frame



← Aft Side



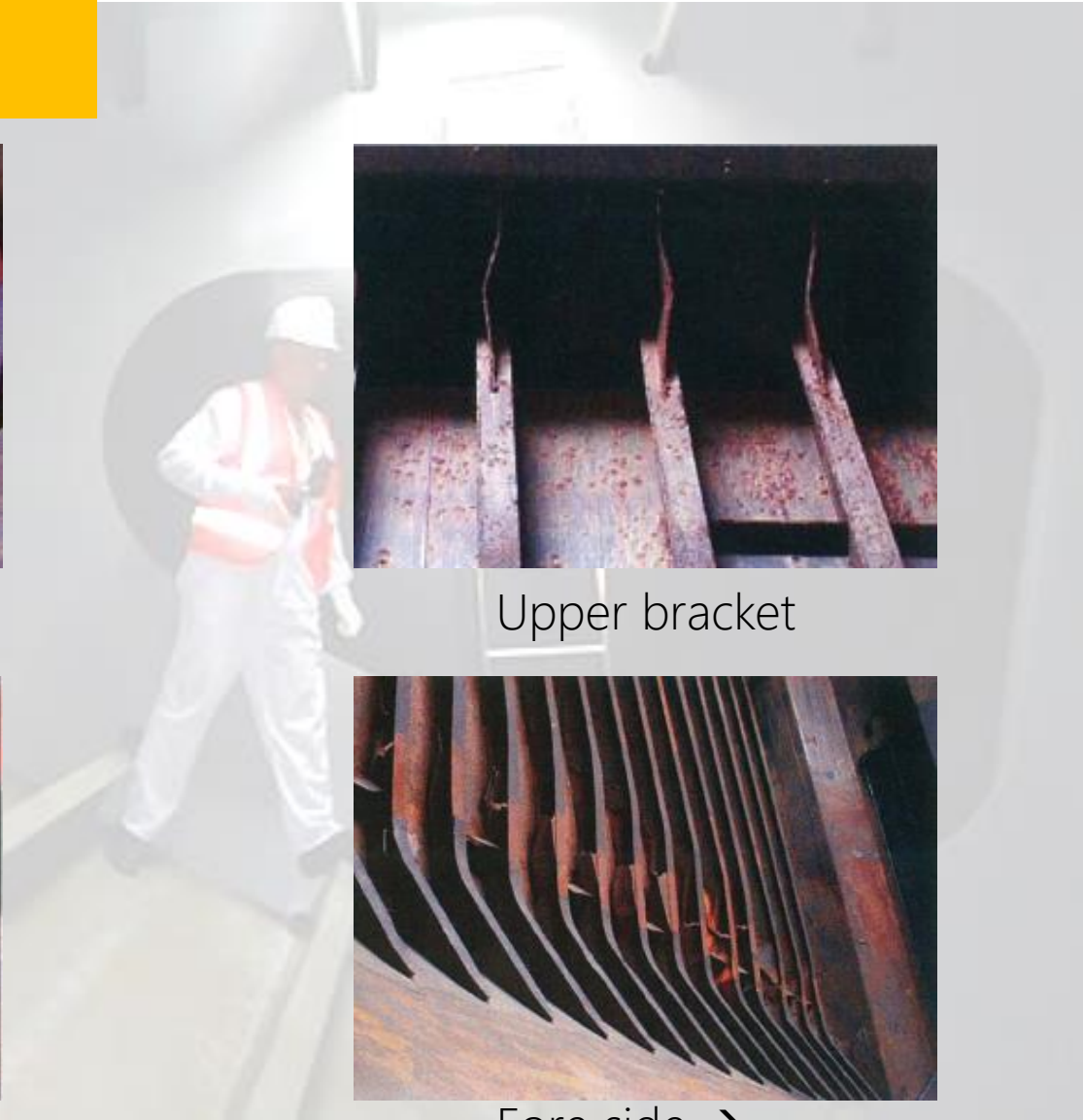
Lower bracket



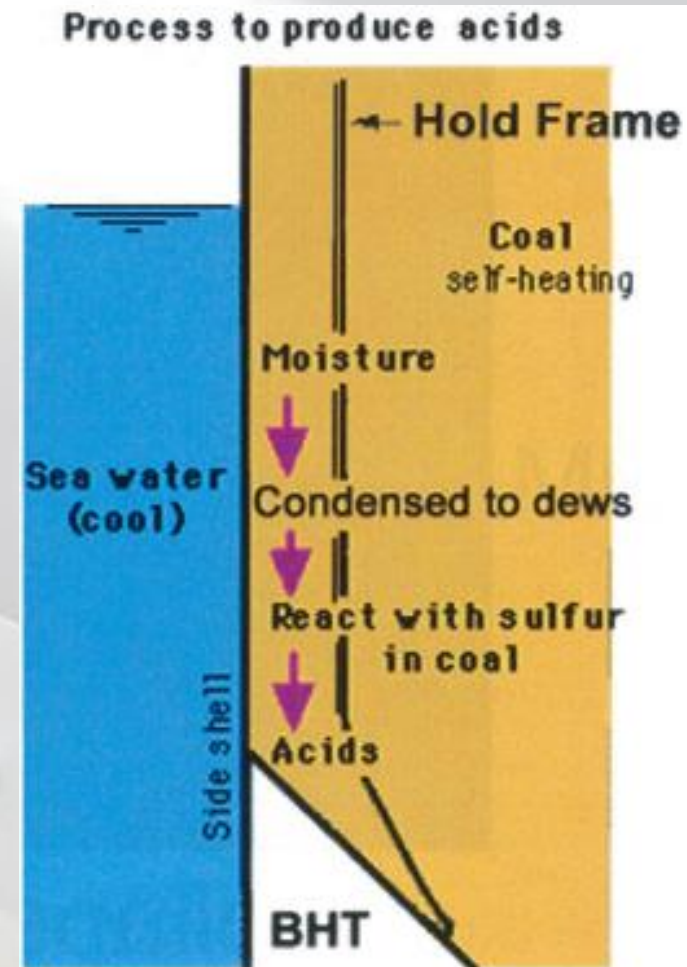
Upper bracket



Fore side →



Hold frame corrosion process

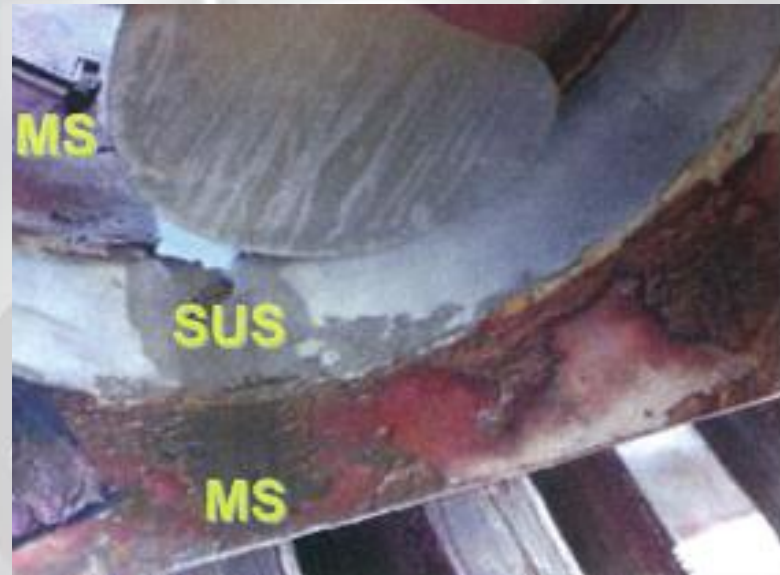
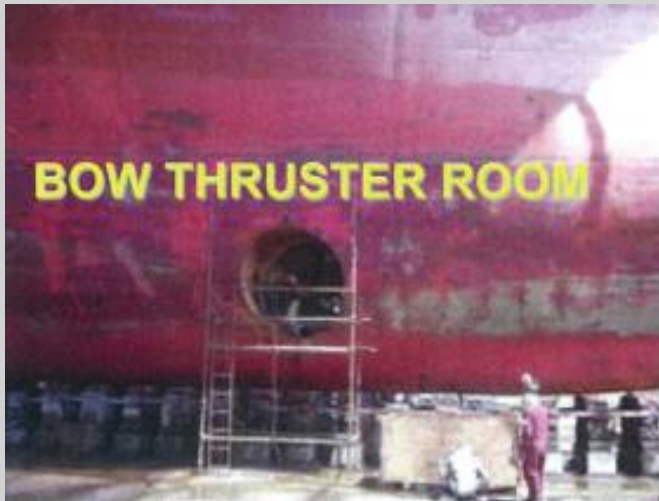


CORROSION

DAMAGE EXAMPLE 2

GALVANIC CORROSION IN BOW THRUSTER DUCT

-Examples of Hull Damage (Corrosion Example 2)

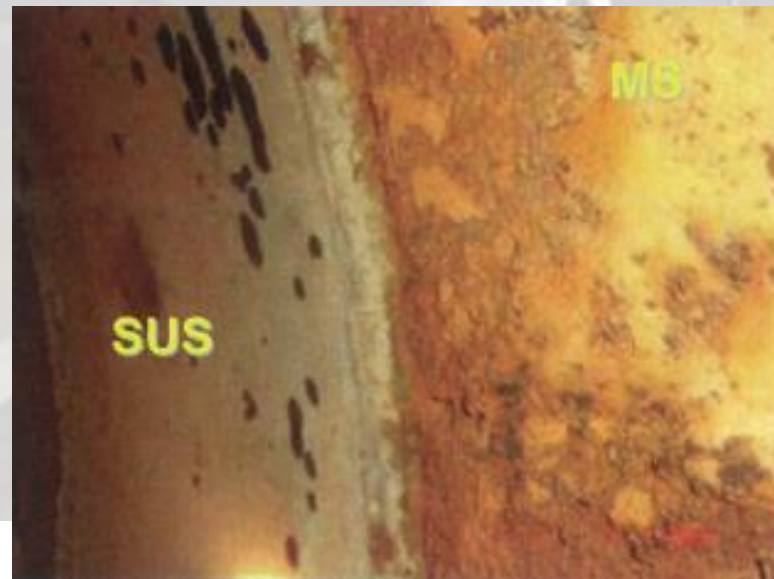


MS: Mild Steel

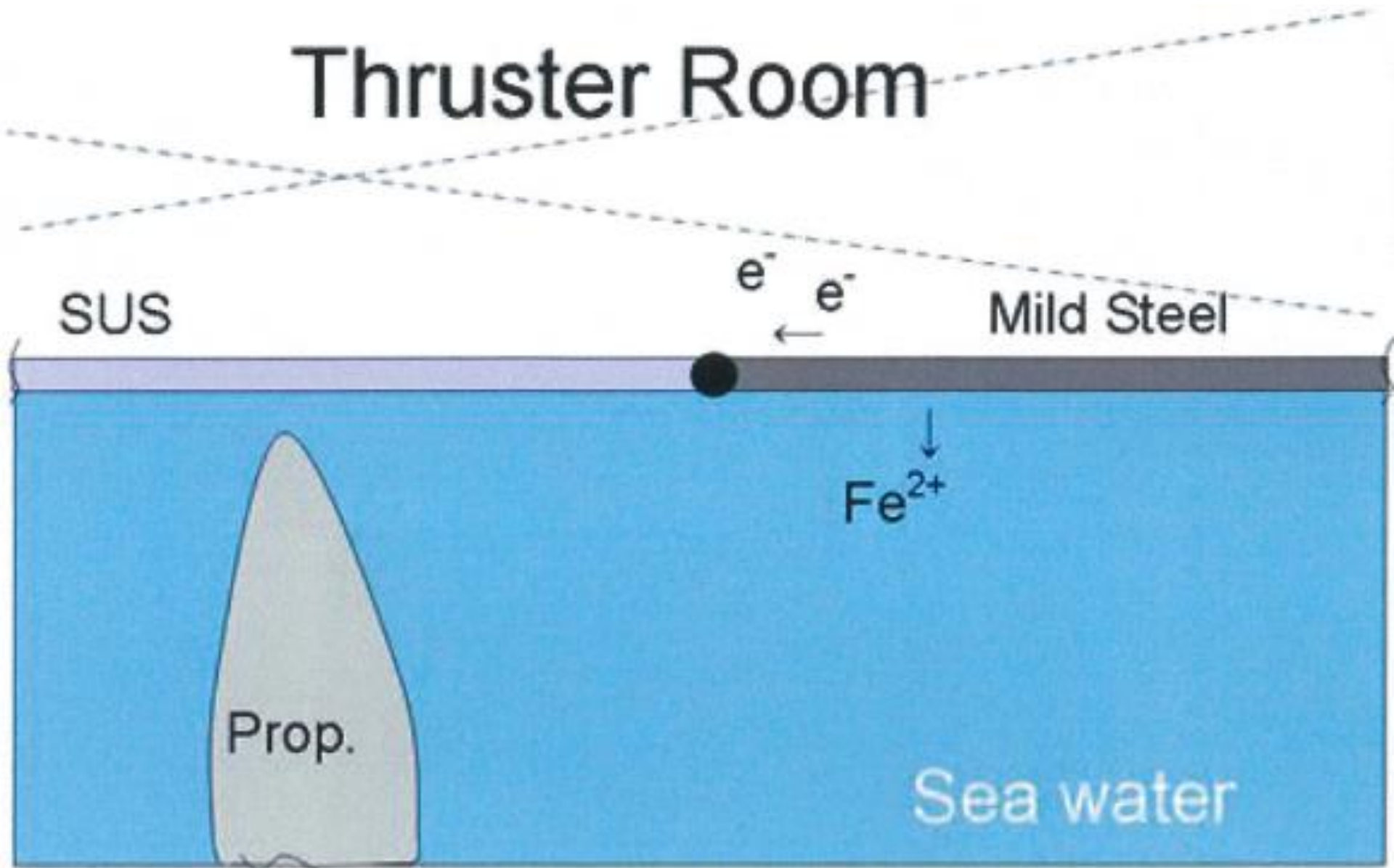
SUS: SUS stands for Steel Use Stainless (stainless steel Material)



-Examples of Hull Damage (Corrosion Example 2)



Thruster Room



Examples of Repair

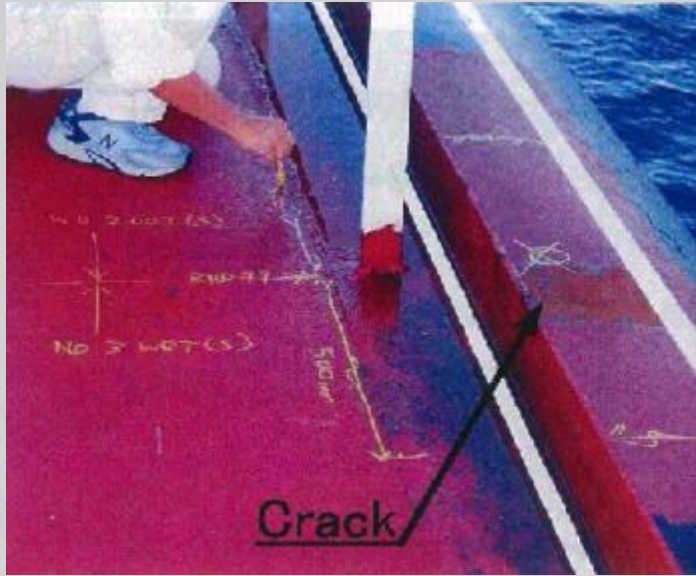
- Both metals are insulated from electrolytes by not only an anodic metal coating but also a cathodic metal coating.
- Different kind metals are made electrically nonconductive via insulation etc.
- If it is not necessary to use several kind materials, it is possible to modify with only a single type of metal.

CORROSION

DAMAGE EXAMPLE 3

LOCAL CORROSION AROUND UPPER
DECK OF AN OIL TANKER

-Examples of Hull Damage (Corrosion Example 3)



Selectively and Heavily
Corrosion in Water
Ballast Tank



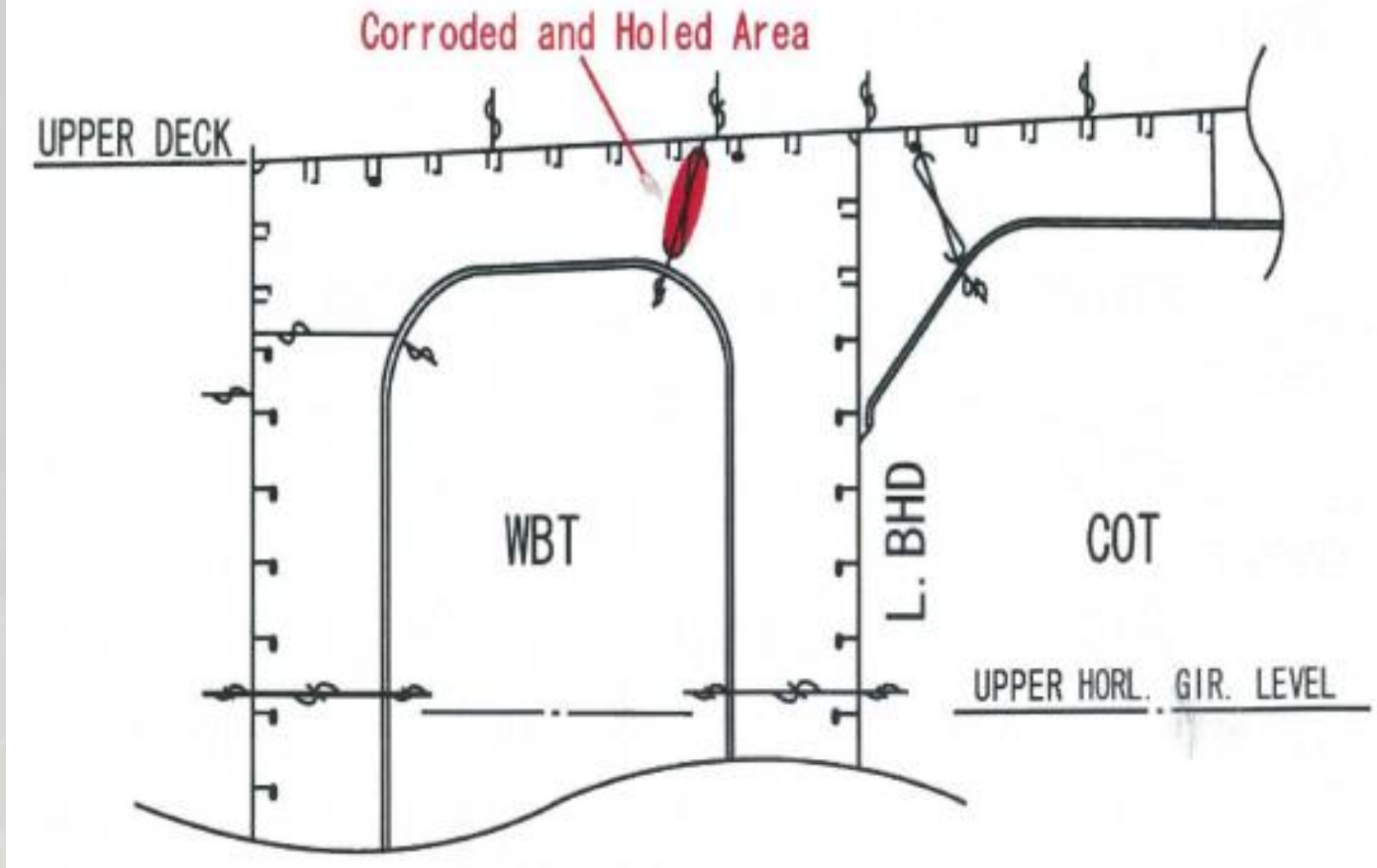
Possibility of
SERIOUS INCIDENT

-Examples of Hull Damage (Corrosion Example 3)



Heavy localized corrosion of the ballast water tank

-Examples of Hull Damage (Corrosion Example 3)



The coating breaks down more easily at the block joint than other areas

This is especially true for the upper parts of the ballast water tank



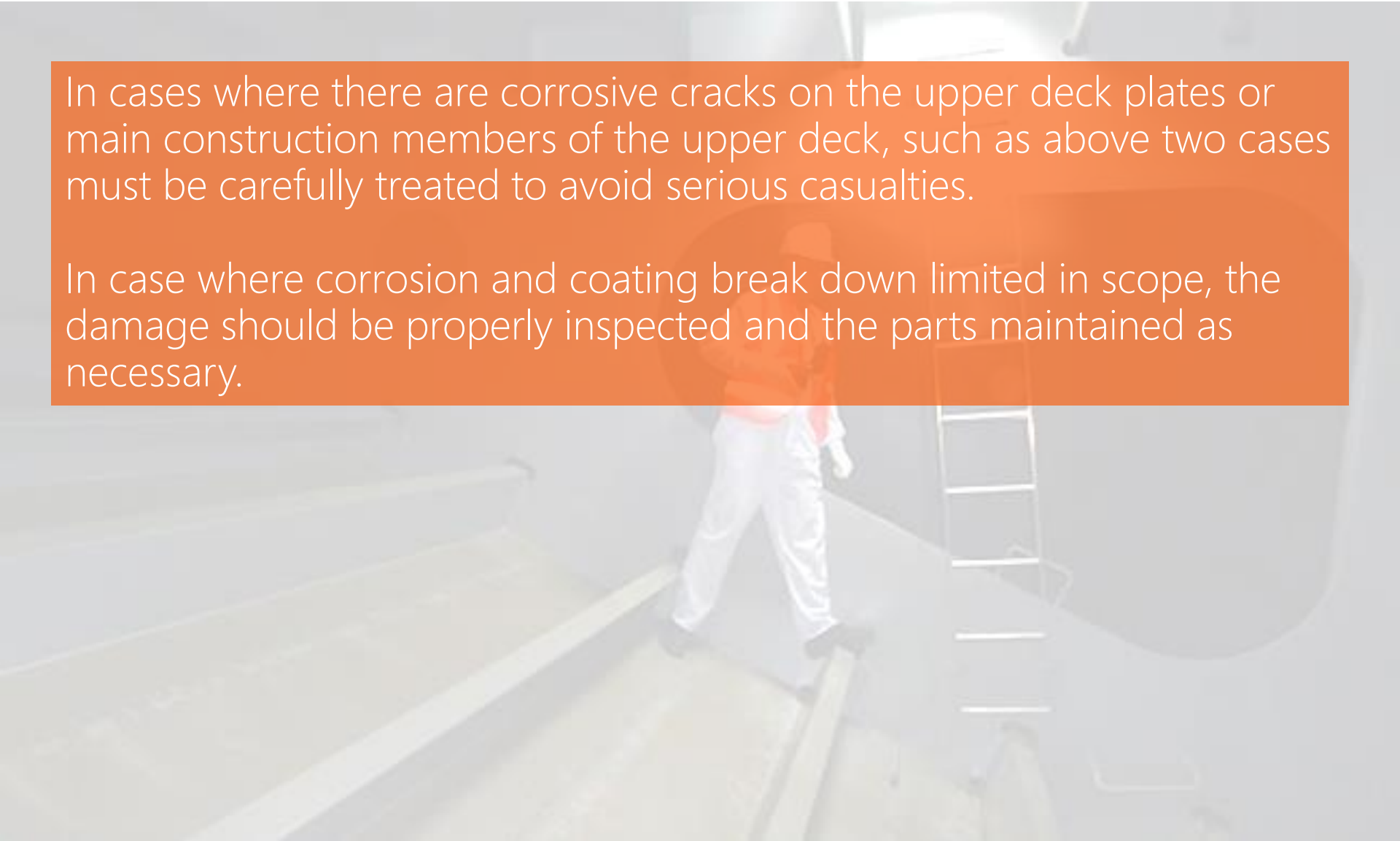
Heavy localized corrosion of ballast water tank

Air pockets under ballast condition accelerates the corrosion on the upper parts of the ballast tank

-Examples of Hull Damage (Corrosion Example 3)

In cases where there are corrosive cracks on the upper deck plates or main construction members of the upper deck, such as above two cases must be carefully treated to avoid serious casualties.

In case where corrosion and coating break down limited in scope, the damage should be properly inspected and the parts maintained as necessary.





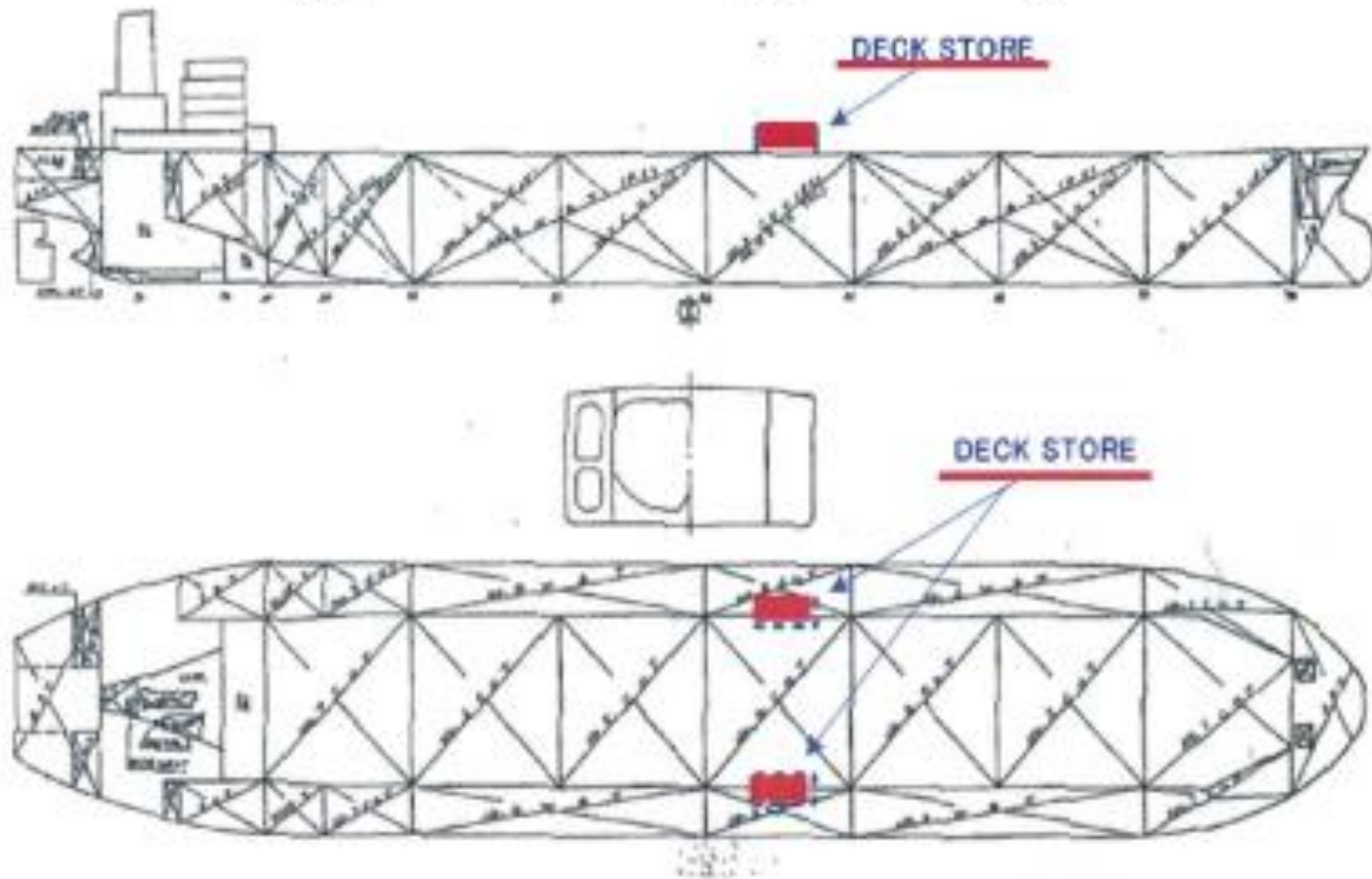
CRACK

DAMAGE EXAMPLE 1

CRACK IN OIL TANKER DECK STORE

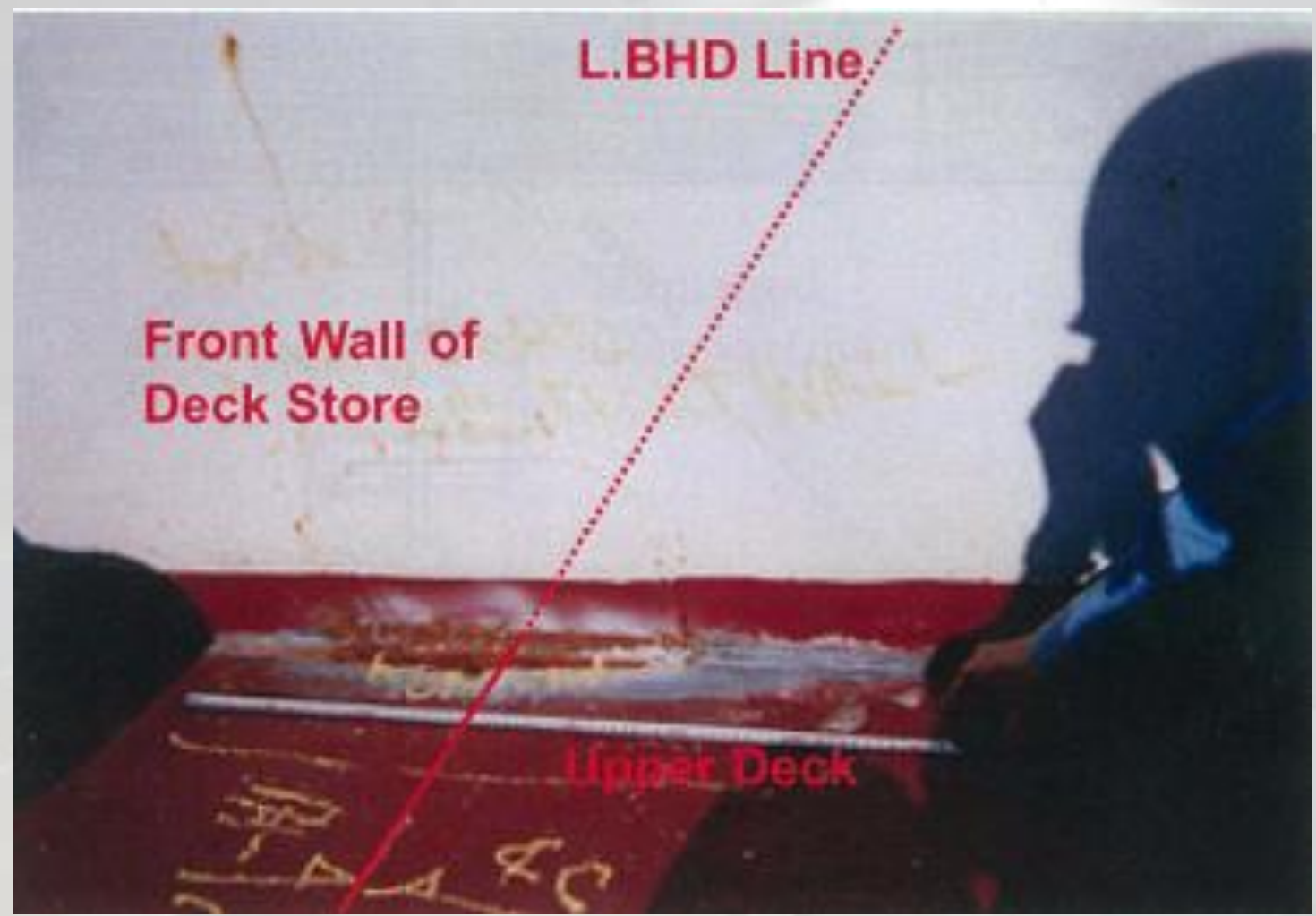
Aframax Oil Tanker

Length: 200m Age: 15+ years

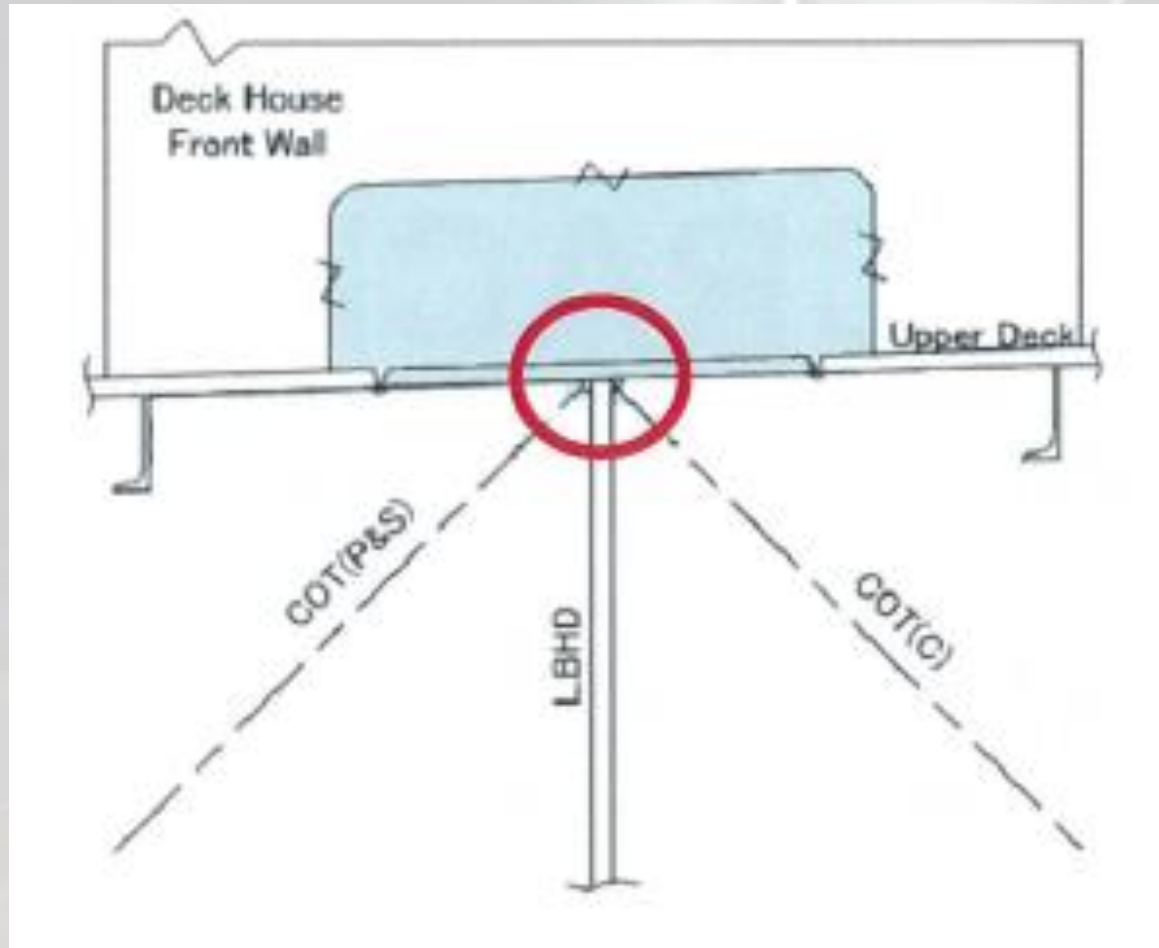


-Examples of Hull Damage (Crack Example 1)

Picture from damaged part

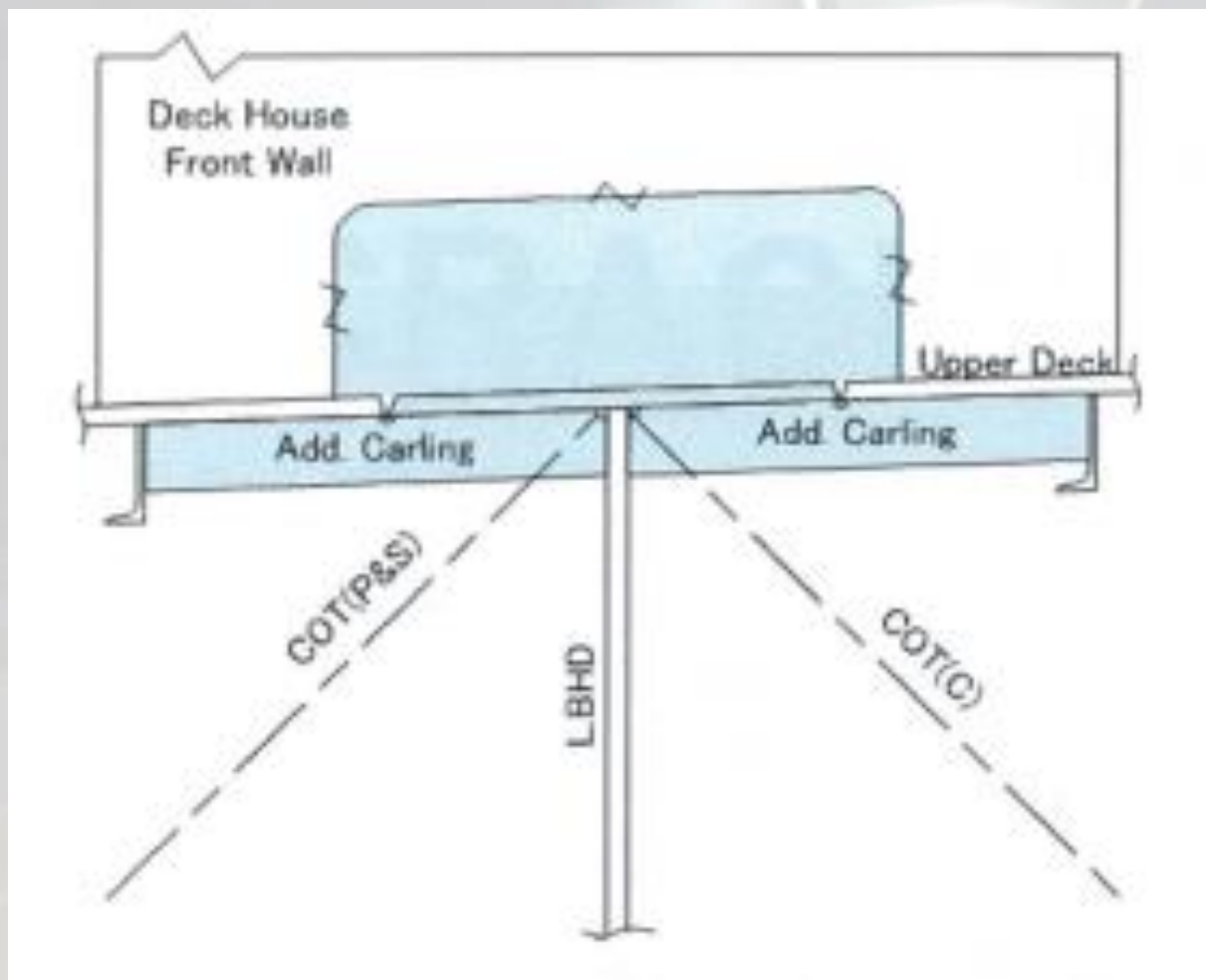


-Examples of Hull Damage (Crack Example 1)



Spot contact of front wall of Deck Store & L.BHD

-Examples of Hull Damage (Crack Example 1)



Provide additional carlings

Spot support



Line support

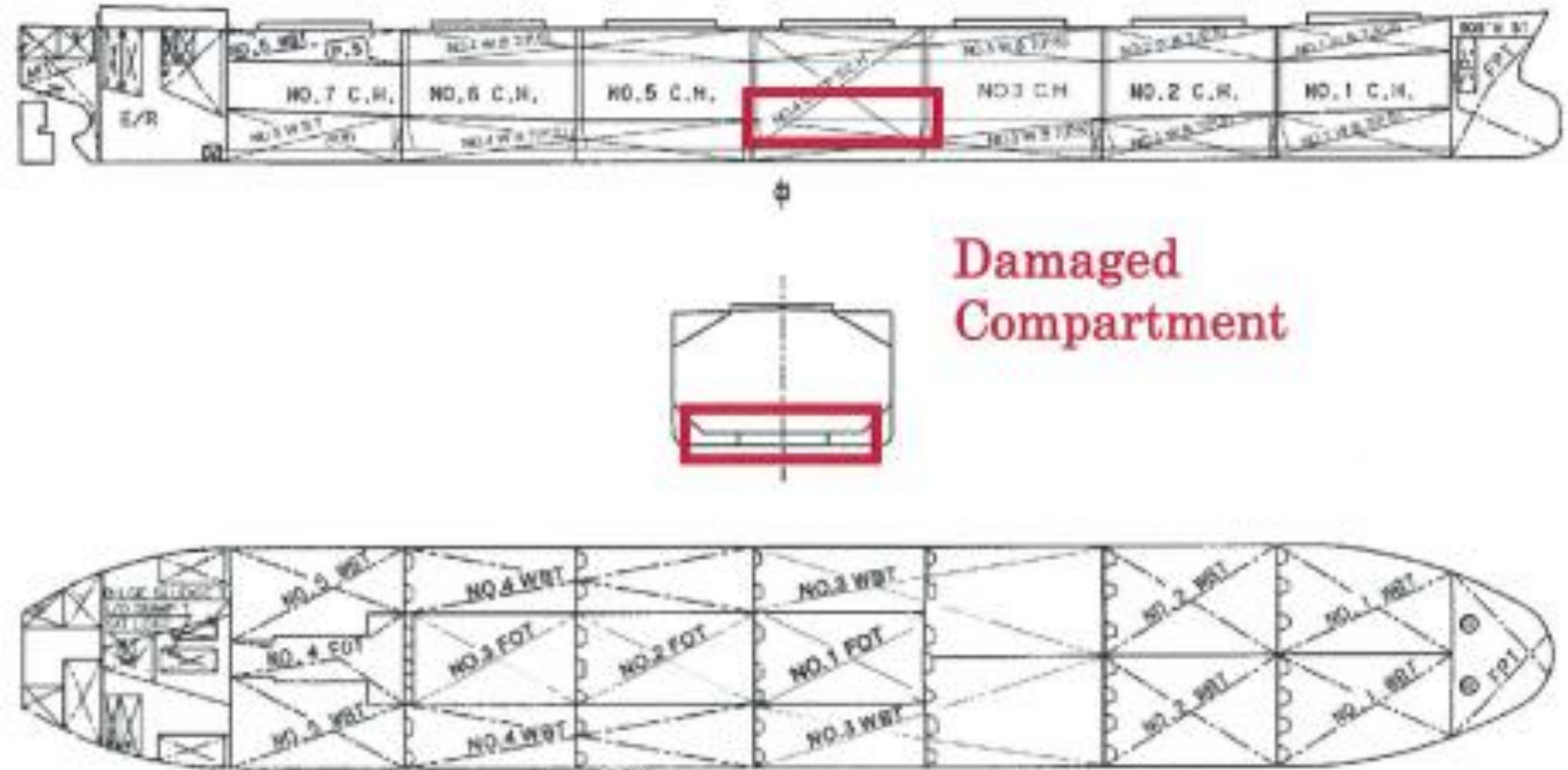


CRACK

DAMAGE EXAMPLE 2

CRACK IN A BULK CARRIER INNER BOTTOM PLATE

Panamax size Bulk Carrier Age:10 Years



-Examples of Hull Damage (Crack Example 2)



Crack in inner bottom plate at intersection of lower stool, DB floor and DB girder

-Examples of Hull Damage (Crack Example 2)



Leakage from Double Bottom Tank

No.4 Cargo/Ballast Hold

Repeated high stress at the connection between lower stool and tank top plate in heavy ballast condition

Fatigue Crack

-Examples of Hull Damage (Crack Example 2)



Inner bottom plate should be renewed with thicker plate



CRACK

DAMAGE EXAMPLE 3

CRACK IN DOUBLE BOTTOM TANK OF CAR CARRIER

-Examples of Hull Damage (Crack Example 3)



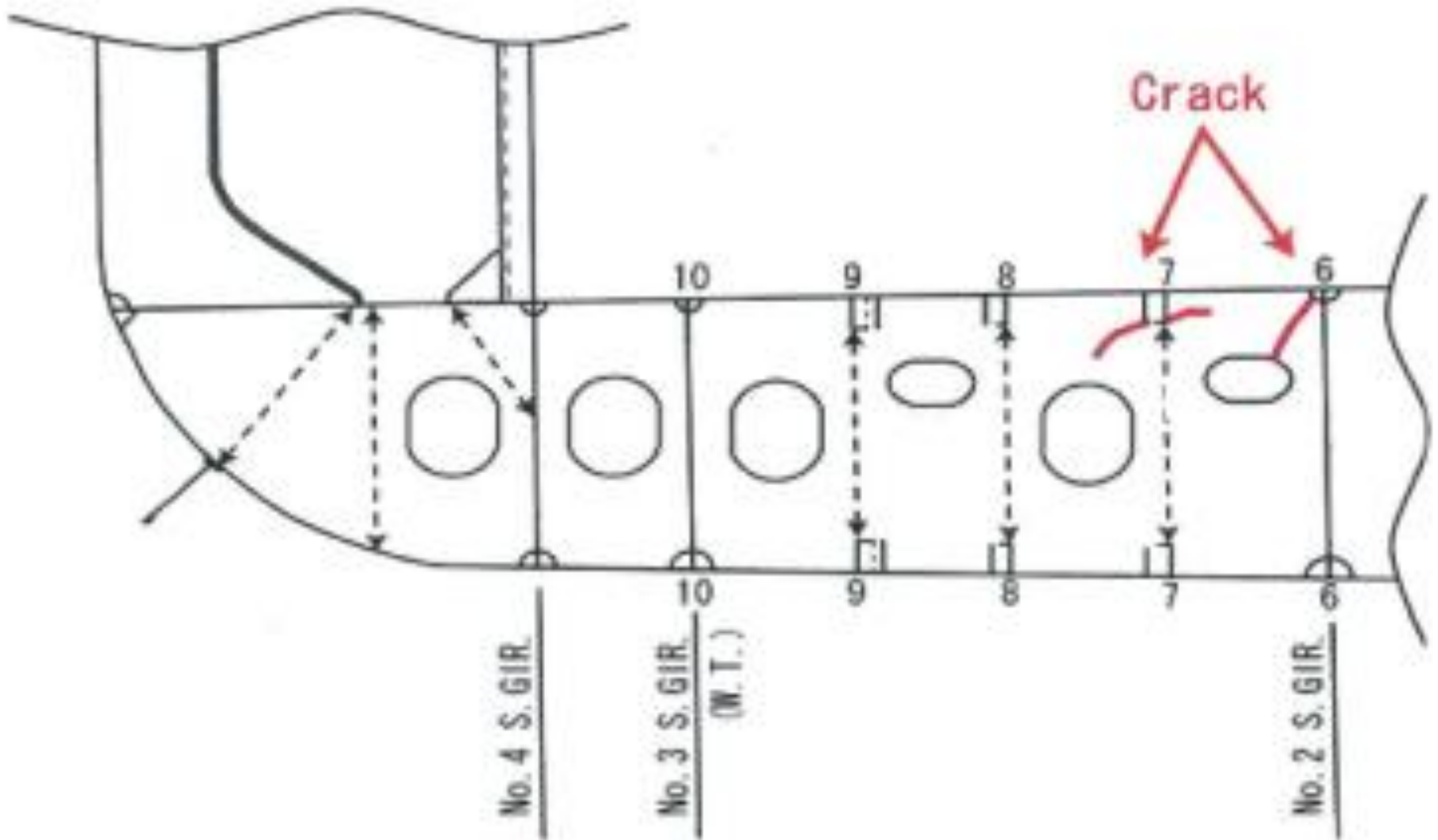
Inner bottom plate should be renewed with thicker plate

-Examples of Hull Damage (Crack Example 3)

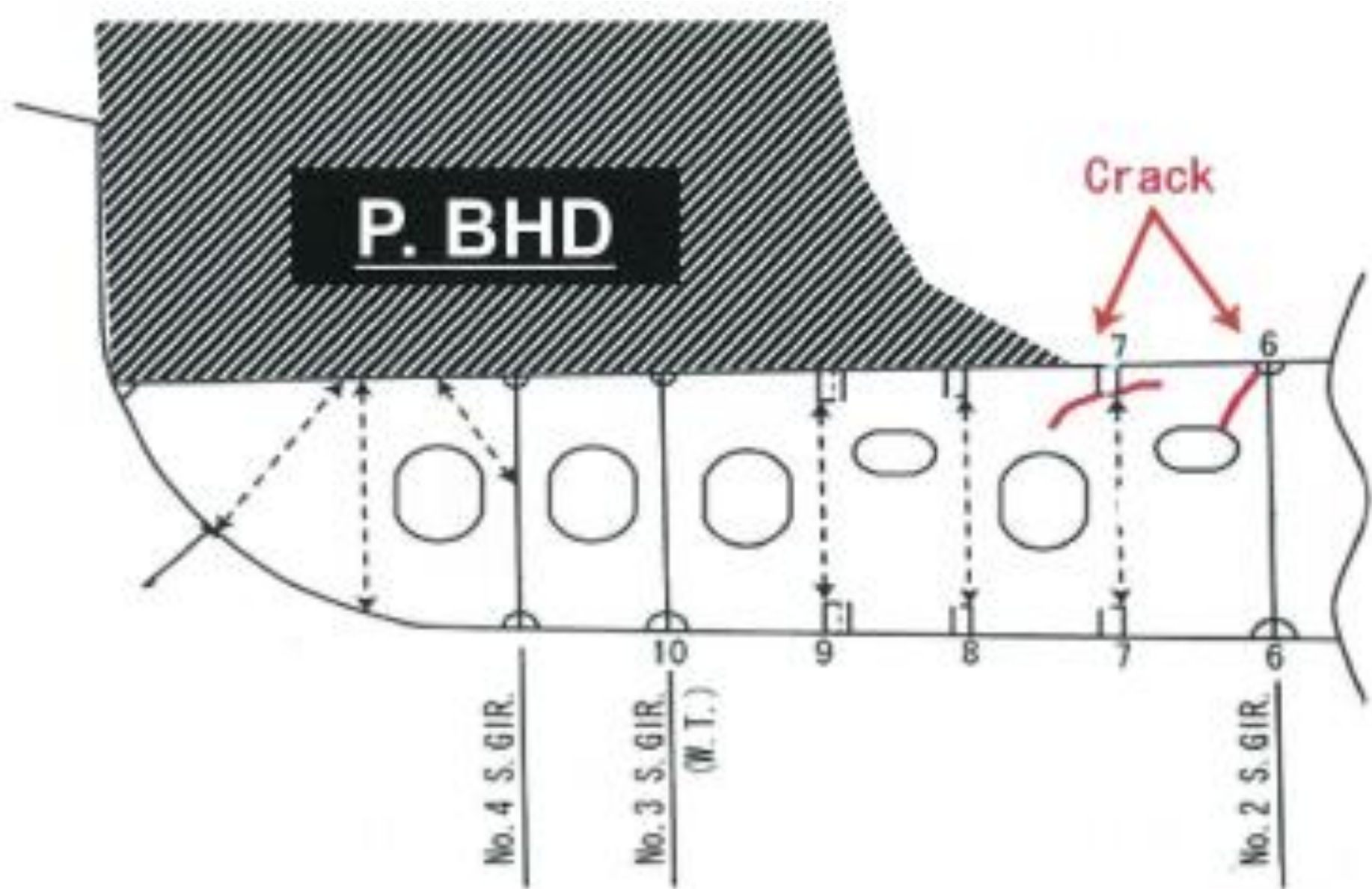


Crack in pipe penetration

-Examples of Hull Damage (Crack Example 3)



-Examples of Hull Damage (Crack Example 3)



CRACK

DAMAGE EXAMPLE 4

CRACK IN DOUBLE BOTTOM TANK OF CONTAINER CARRIER



-Examples of Hull Damage (Crack Example 4)

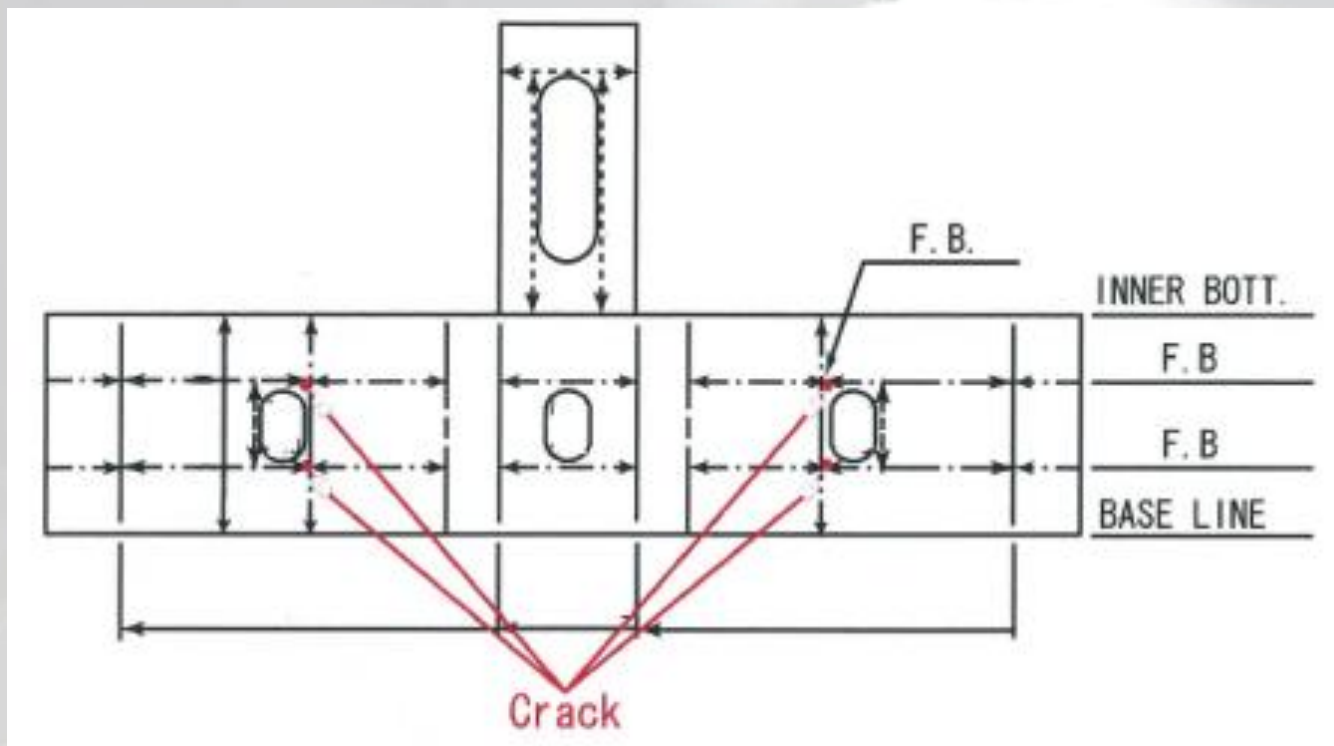


Crack on midship only



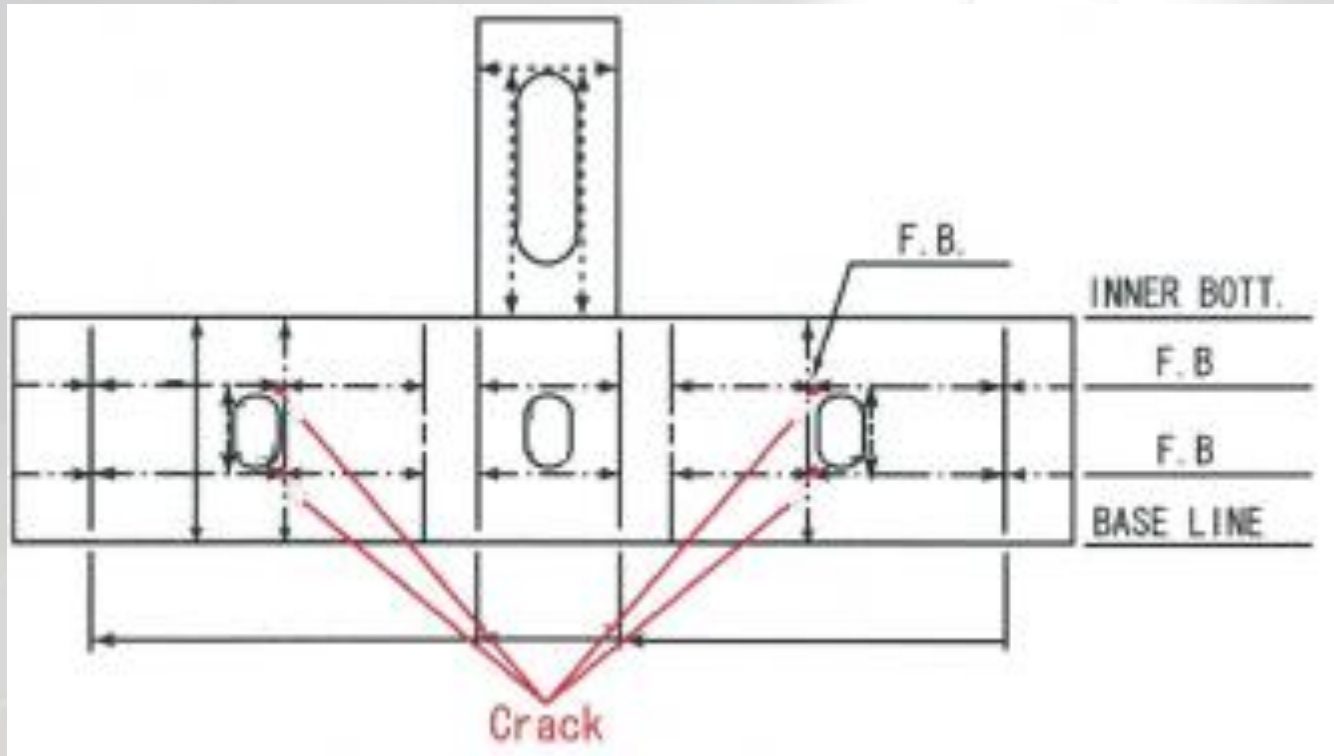
- ➡ Due to hull girder stress
- ➡ Due to local shearing stress

-Examples of Hull Damage (Crack Example 4)



The snip end of L.Stiffener near manhole might cause high stress & cracks and their propagations

Countermeasure



- ➔ The doubling plates fitted around the manholes
- ➔ The end shape of L.Stiffener changed to clipped end and connected to V.Stiffener

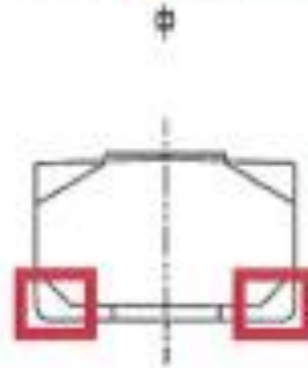


CRACK

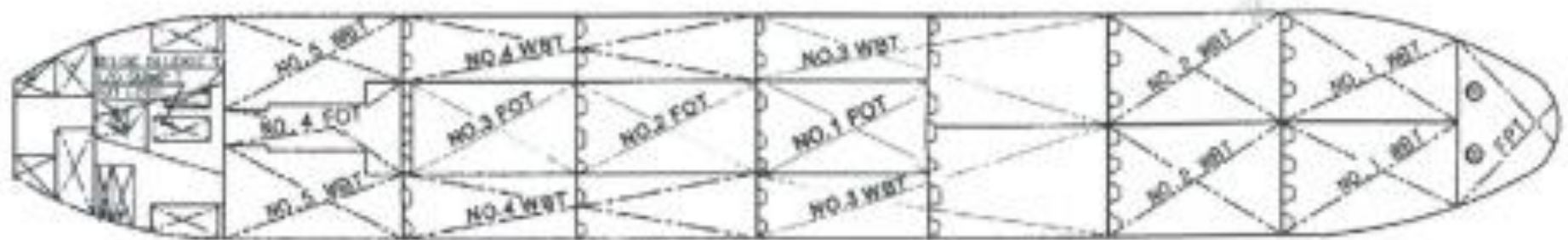
DAMAGE EXAMPLE 5

CRACK IN A BULK CARRIER BILGE HOPPER TANK

Panamax Size Bulk Carrier Age: 10 years



**Damaged
Compartment**

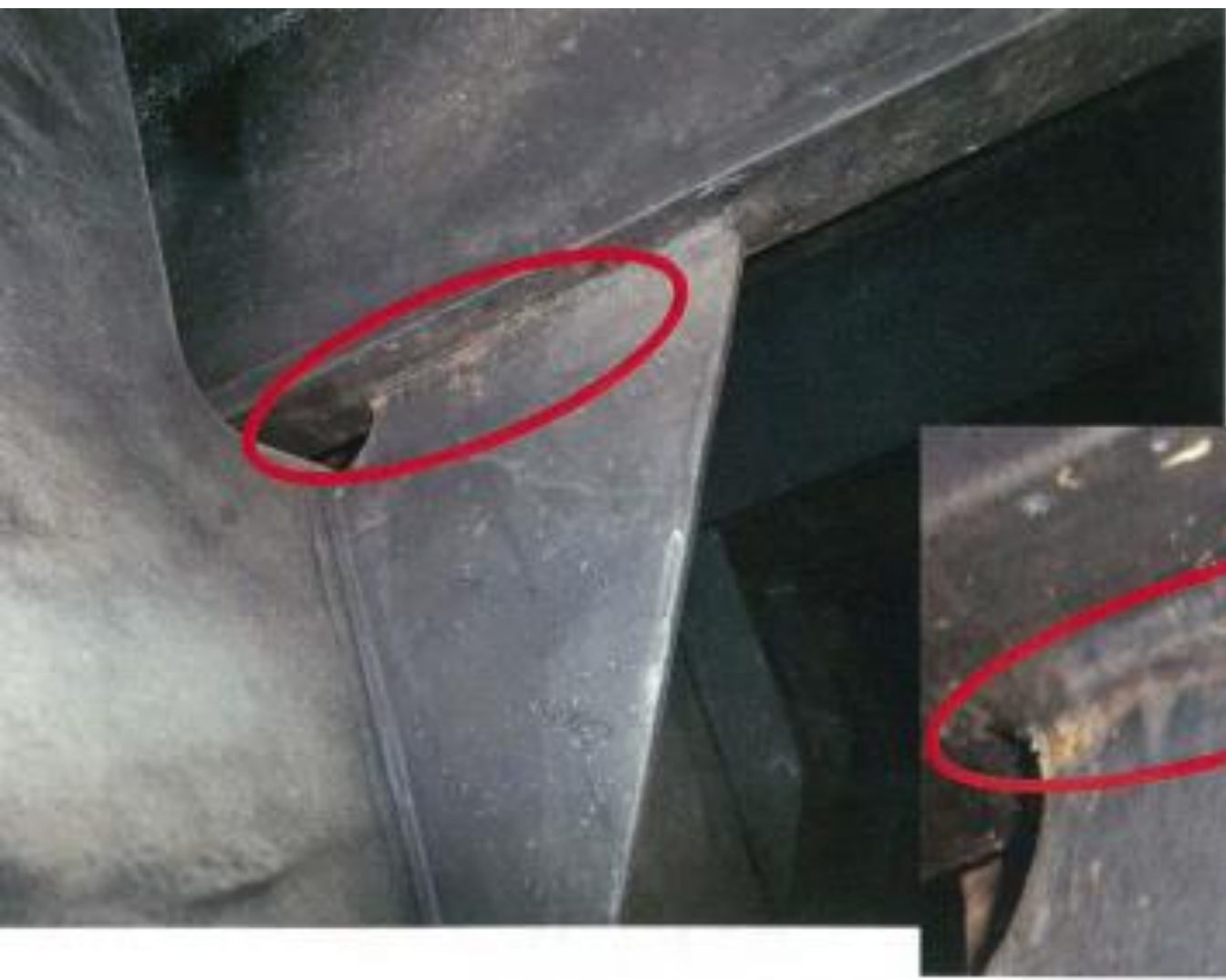


-Examples of Hull Damage (Crack Example 5)



Crack in stiffener on transverse web at slot for bilge hopper longitudinal

-Examples of Hull Damage (Crack Example 5)



Crack in bracket on trance web at slot for bilge hopper longitudinal

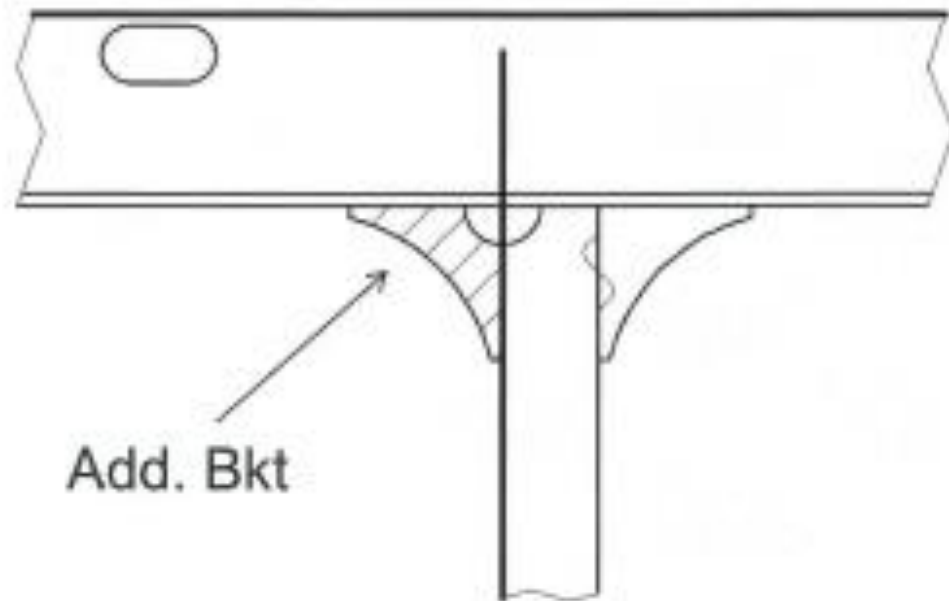
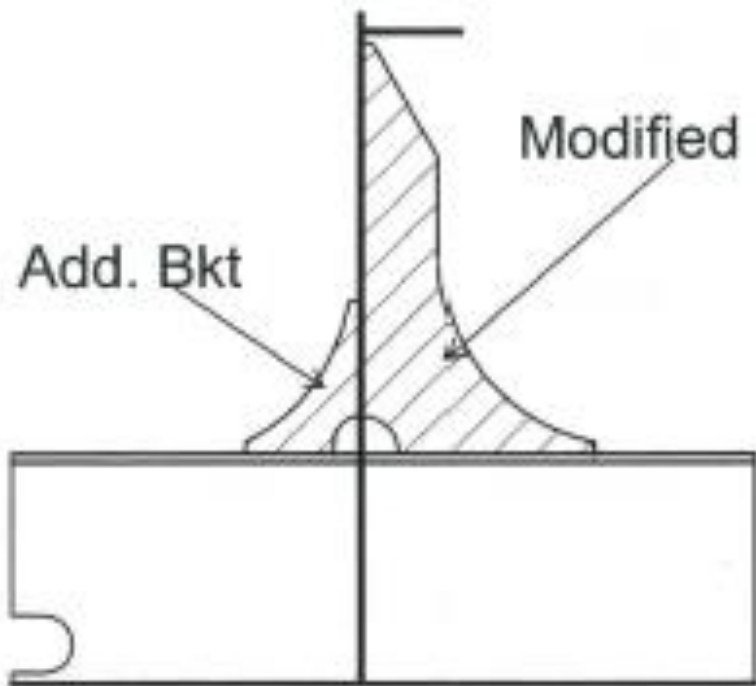
-Examples of Hull Damage (Crack Example 5)

No.3 Bilge Hopper Tank is located under the No.4 Cargo/Ballast Hold

High stress in heavy ballast condition

Fatigue Crack

Effective reinforcement to increase fatigue life



CRACK

DAMAGE EXAMPLE 6

CRACK IN THE UPPER DECK OF AN OIL
TANKER

-Examples of Hull Damage (Crack Example 6)



Hose Rail Stanchion

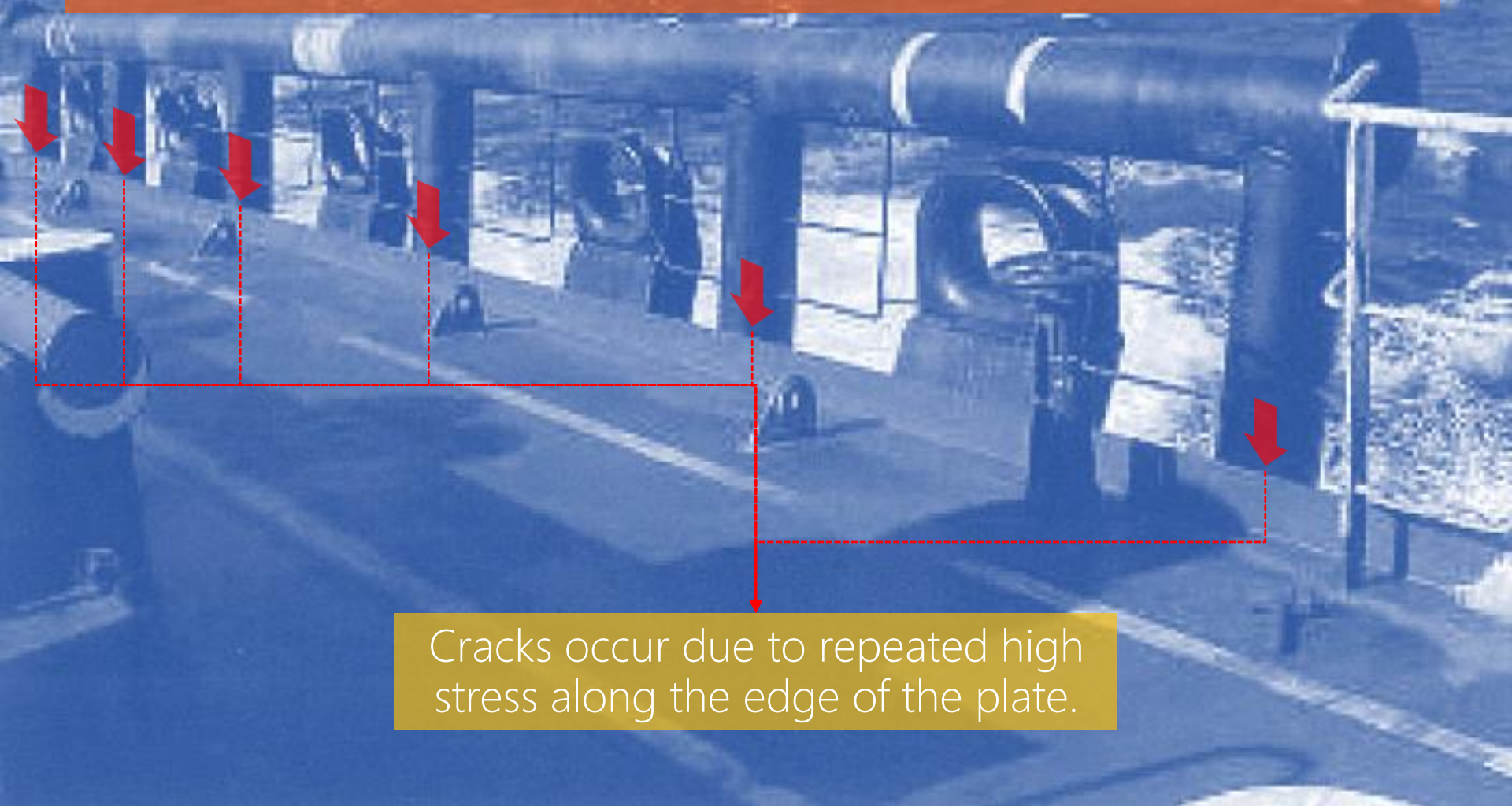
-Examples of Hull Damage (Crack Example 6)



Cracks along fillet weld of pad plates beneath the steel pipe stanchions located at the transverse bulkhead section between the wing ballast and cargo tanks on both sides.

-Examples of Hull Damage (Crack Example 6)

Long hose rails are not capable of responding to hull deformations which occur over time.



Cracks occur due to repeated high stress along the edge of the plate.

-Examples of Hull Damage (Crack Example 6)



Round Gunwales are an important part of the hull structure, and proper attention needs to be paid to them during welding.

A smoother welding bead is an effective countermeasure

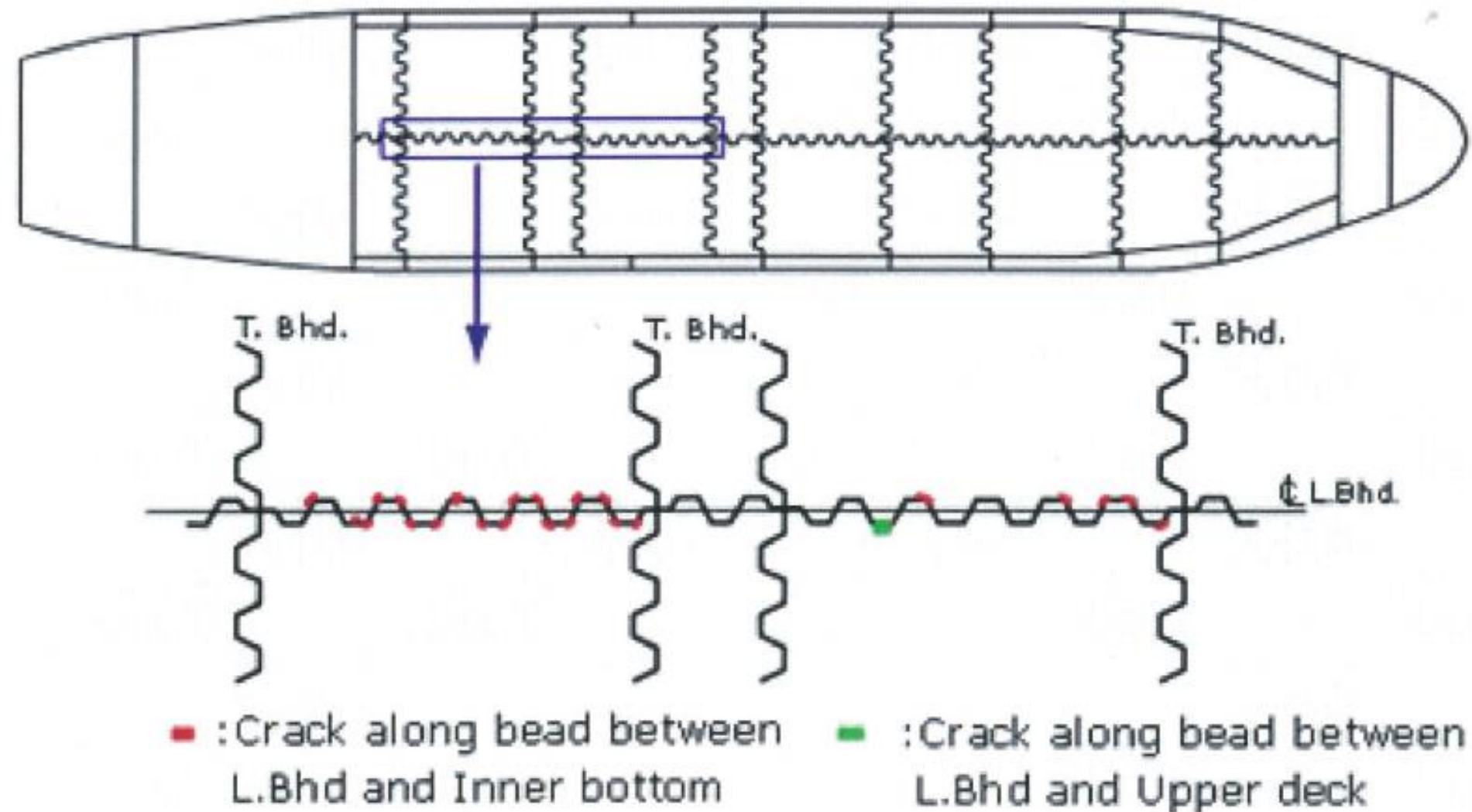
CRACK

DAMAGE EXAMPLE 7

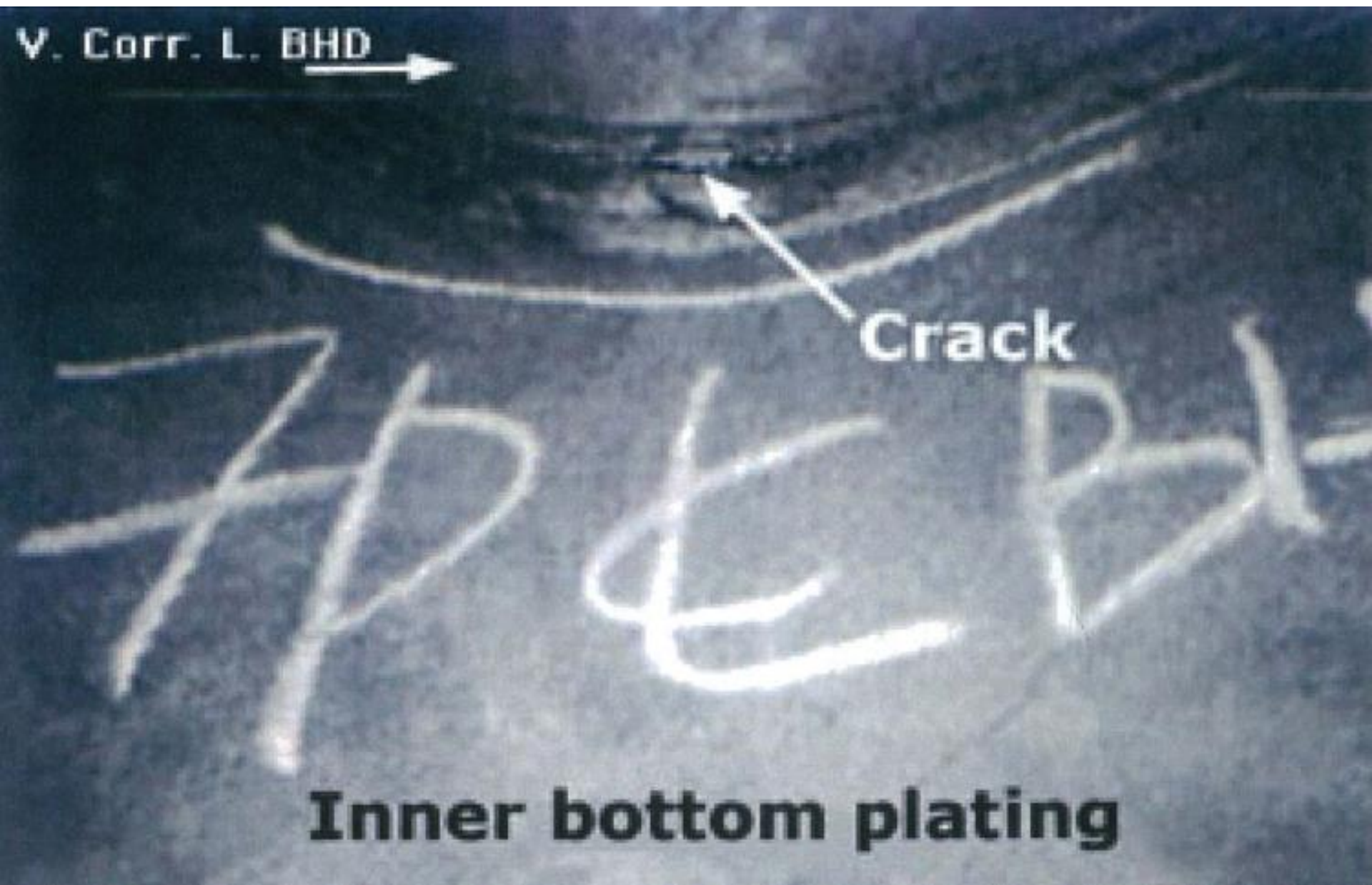
CRACK ALONG CORRUGATED BULKHEAD
OF A CHEMICAL TANKER



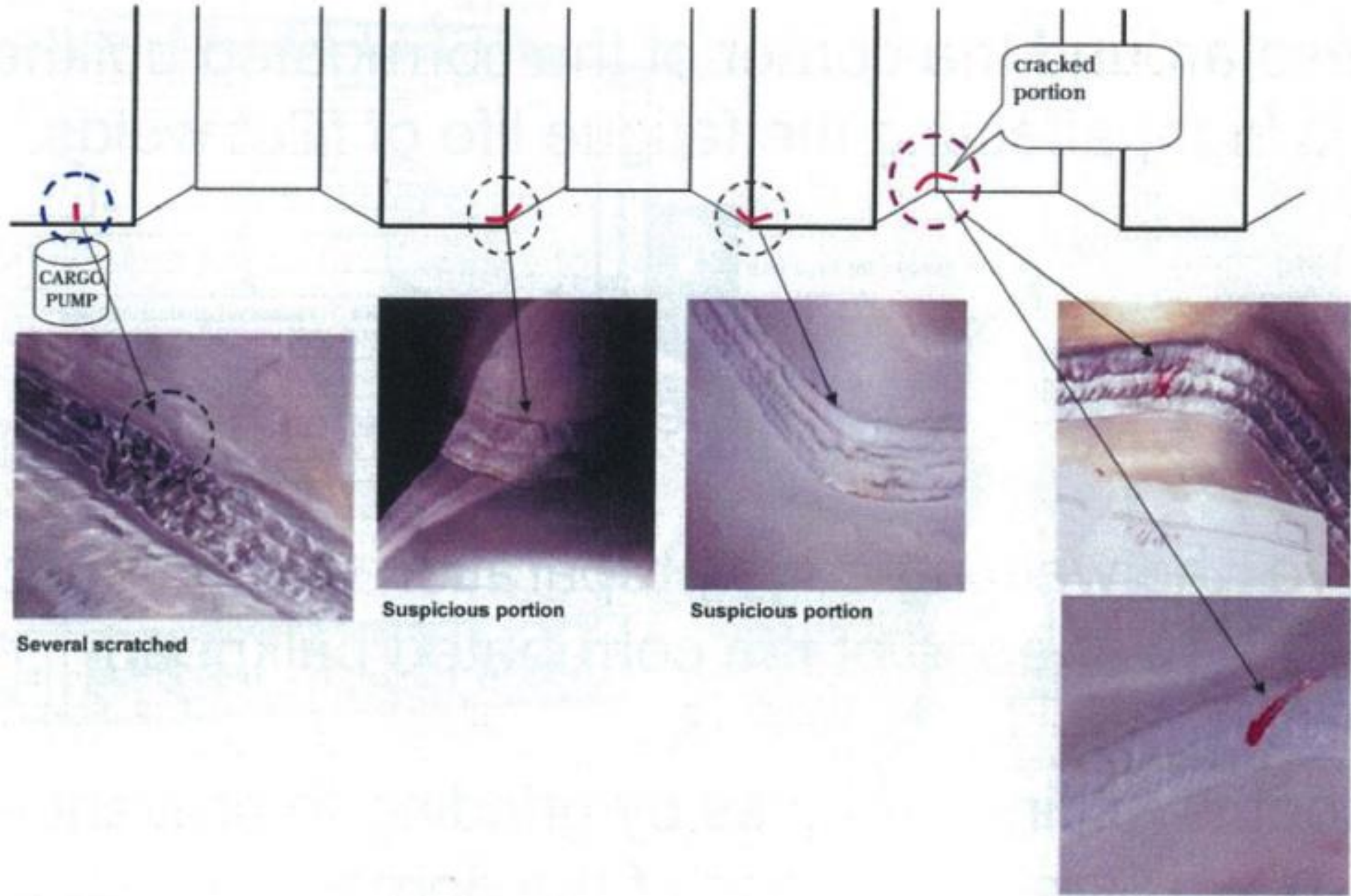
Example of cracked location



-Examples of Hull Damage (Crack Example 7)



-Examples of Hull Damage (Crack Example 7)



-Examples of Hull Damage (Crack Example 7)



Stress around the corner of the corrugated bulkhead is high, affecting the fatigue life of fillet welds.

Recommendation

- ➡ Improve the welding edge preparation of the upper and lower edge of the corrugated bulkhead; and
- ➡ Smooth welding surfaces by grinding to prevent any reoccurrence of the damage.

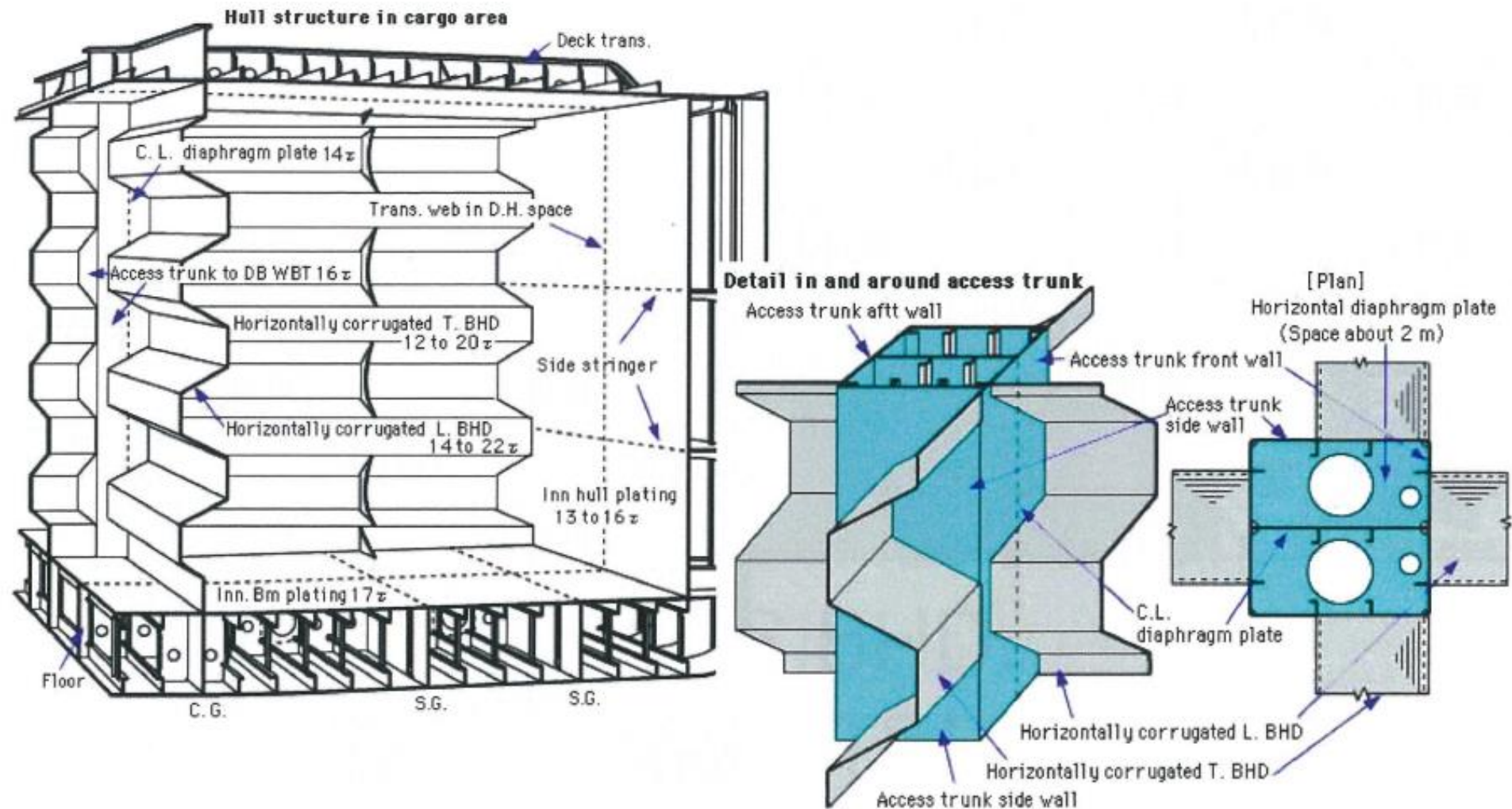


CRACK

DAMAGE EXAMPLE 8

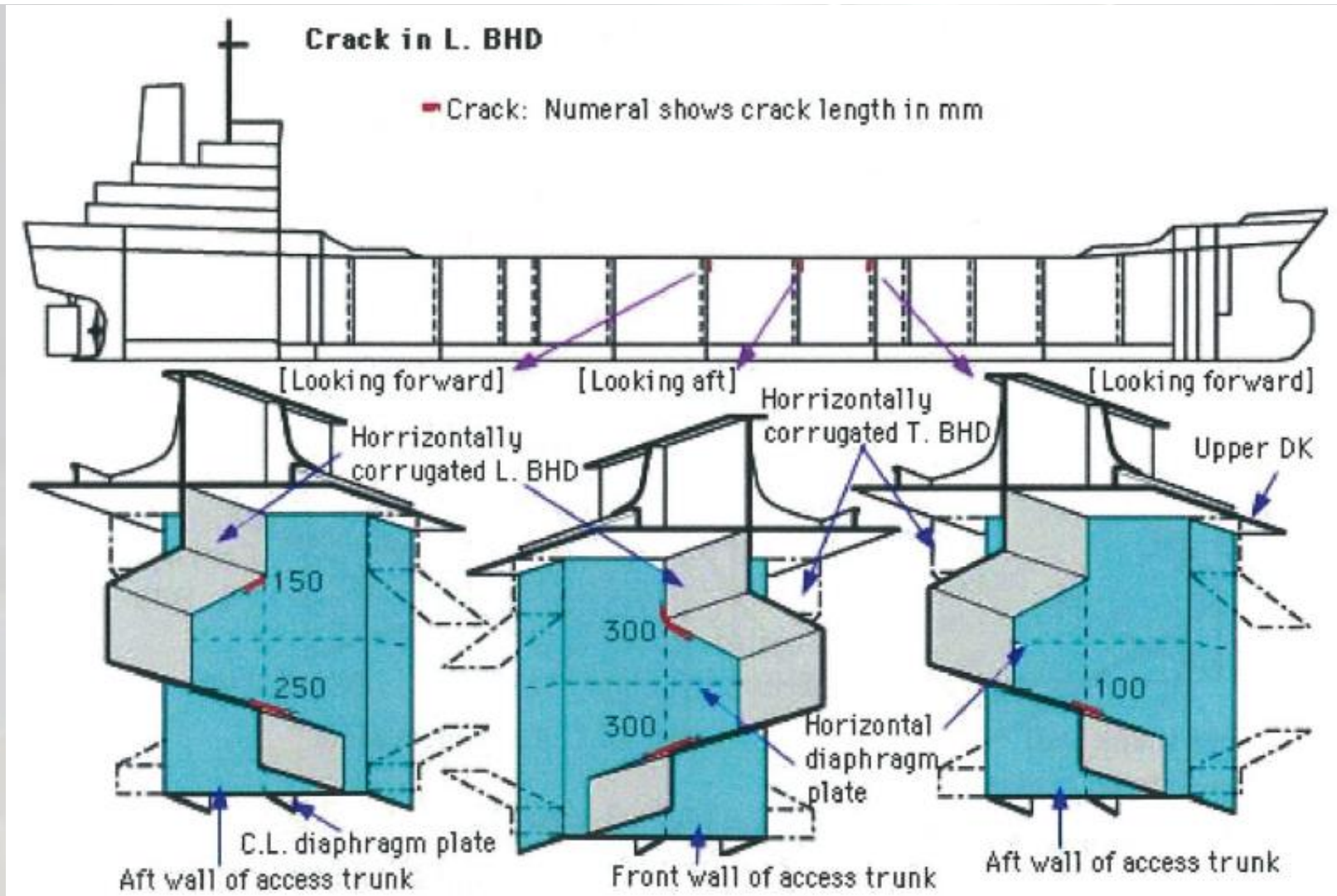
CRACK AT CENTER LINE CORRUGATED
BULKHEAD ON CHEMICAL TANKER

-Examples of Hull Damage (Crack Example 8)



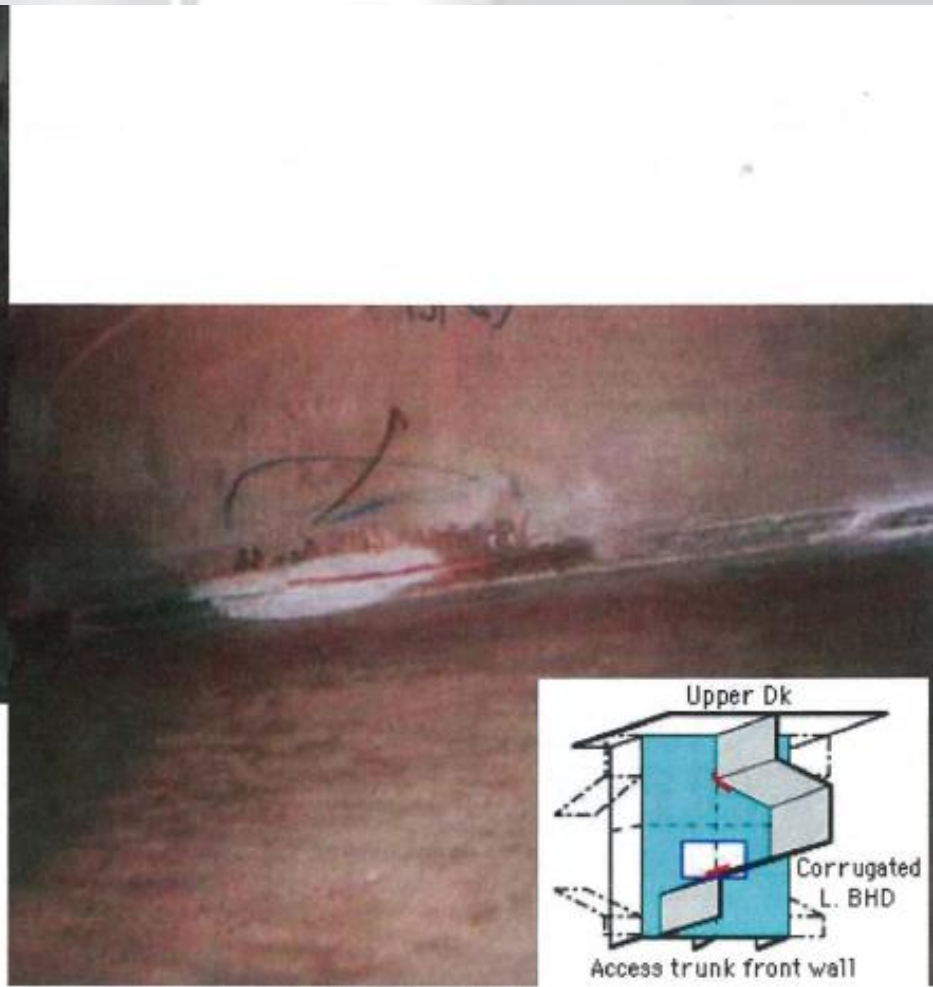
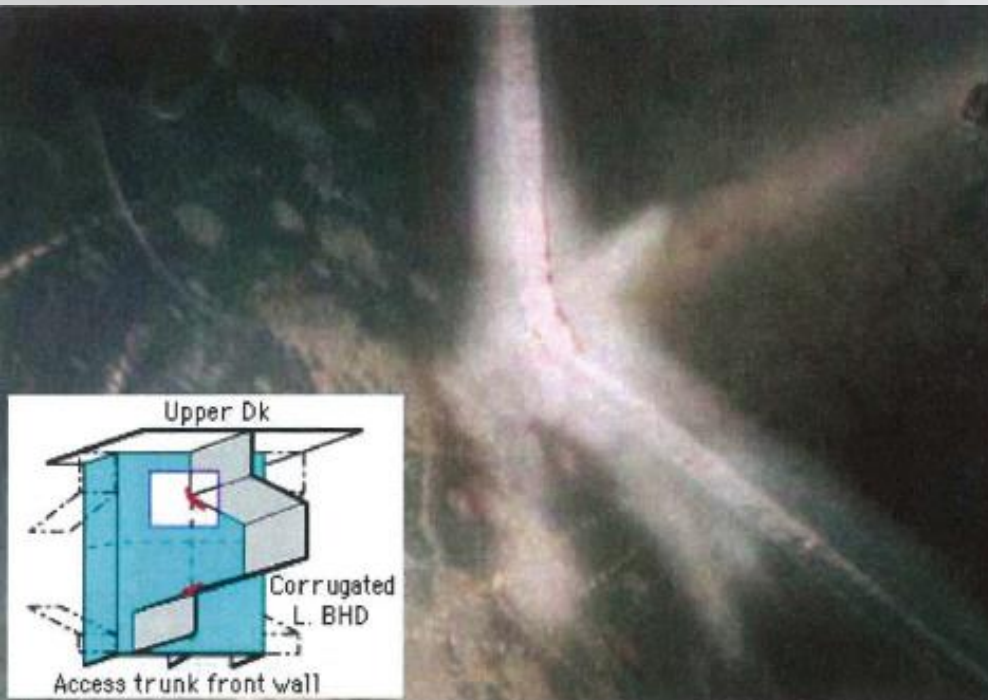
Access Trunk at the connection between T.BHD and L.BHD

-Examples of Hull Damage (Crack Example 8)



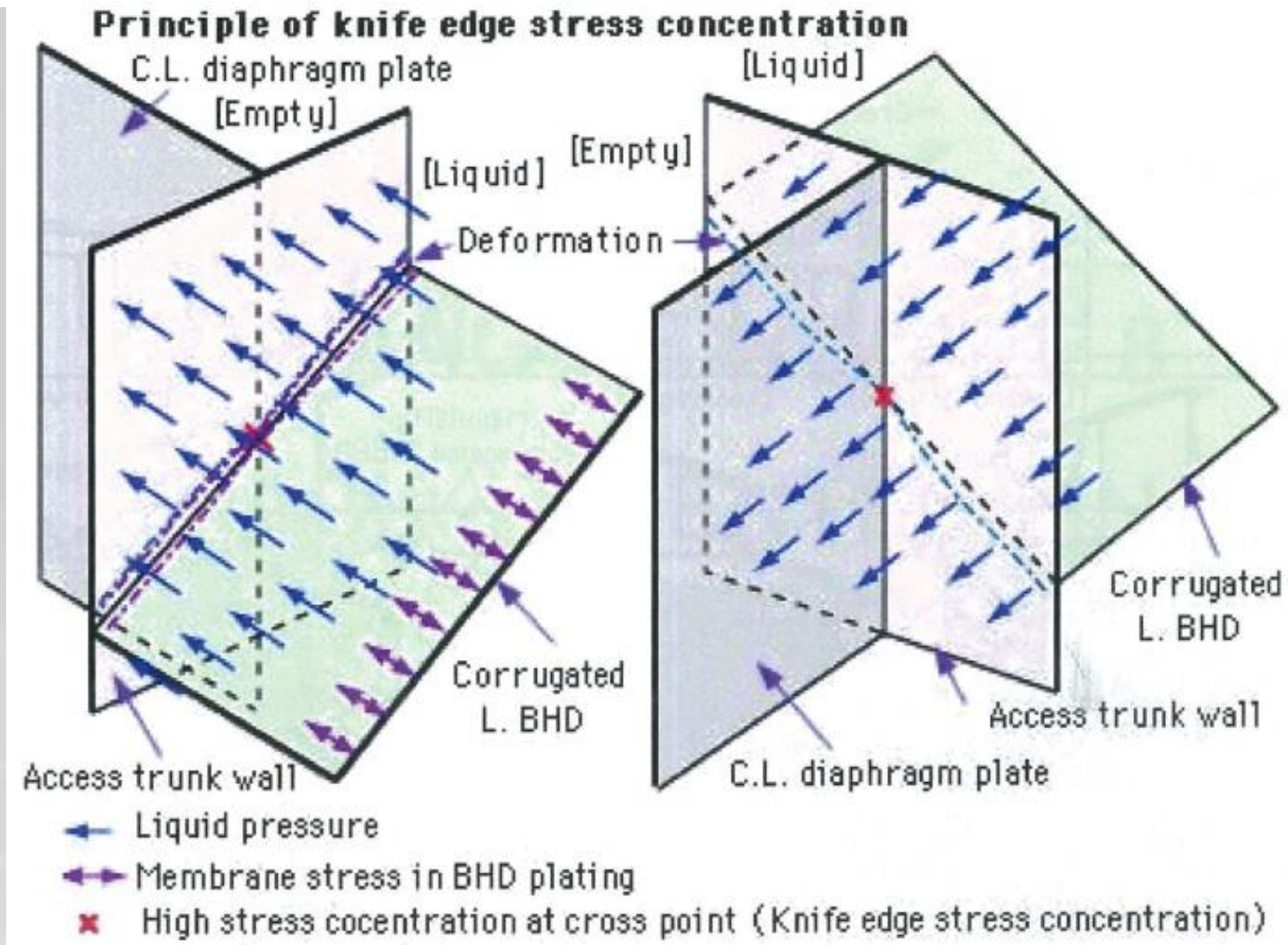
Crack in the vertical web connected to the access trunk

-Examples of Hull Damage (Crack Example 8)



Crack in the vertical web connected to the access trunk

-Examples of Hull Damage (Crack Example 8)



Stress Concentration at cross point



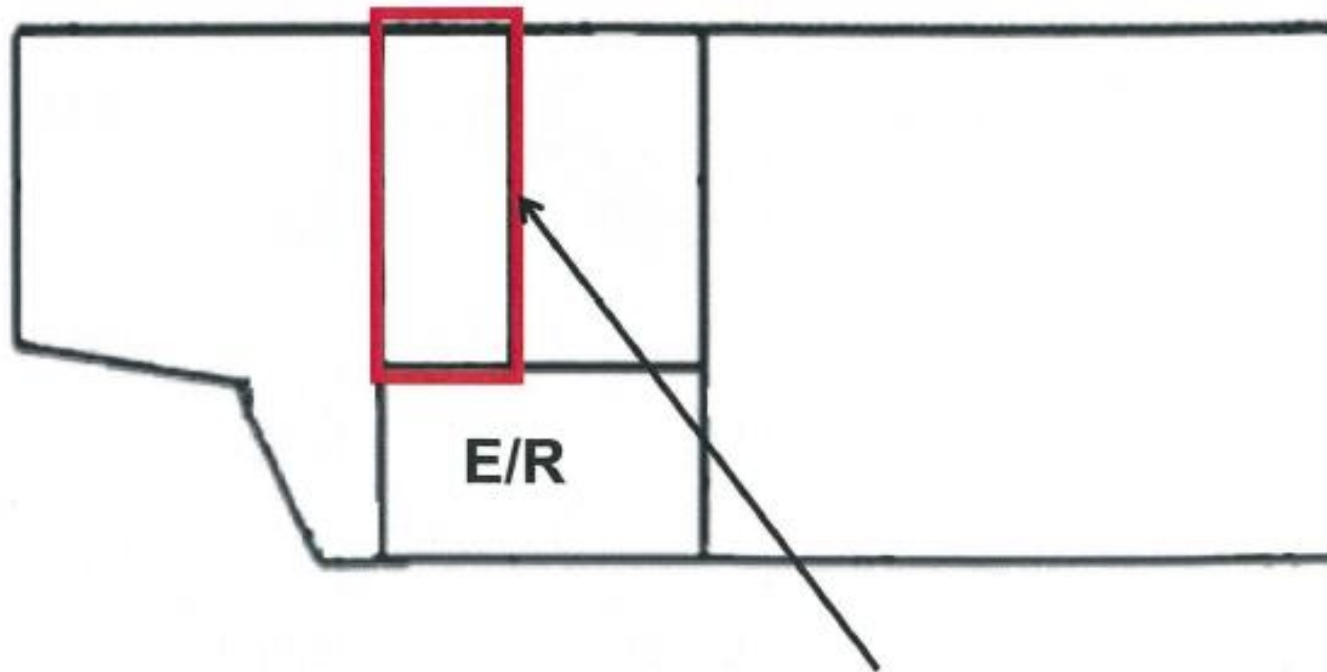
CRACK

DAMAGE EXAMPLE 9

CRACK DUE TO VIBRATION IN
TRANSVERSE BULKHEAD IN FRESH
WATER TANK

General Cargo Age: 5 Years

**Damaged
Compartment**



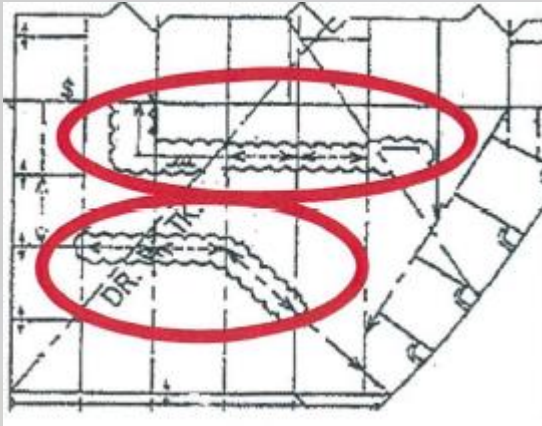
**Fresh Water Tank (S)
Fore T. BHD**

-Examples of Hull Damage (Crack Example 9)



Crack in transverse bulkhead plate of Fresh Water Tank along V.Stiffener on transverse bulkhead.

-Examples of Hull Damage (Crack Example 9)



Reinforcement with a carling or stiffener is highly effective.

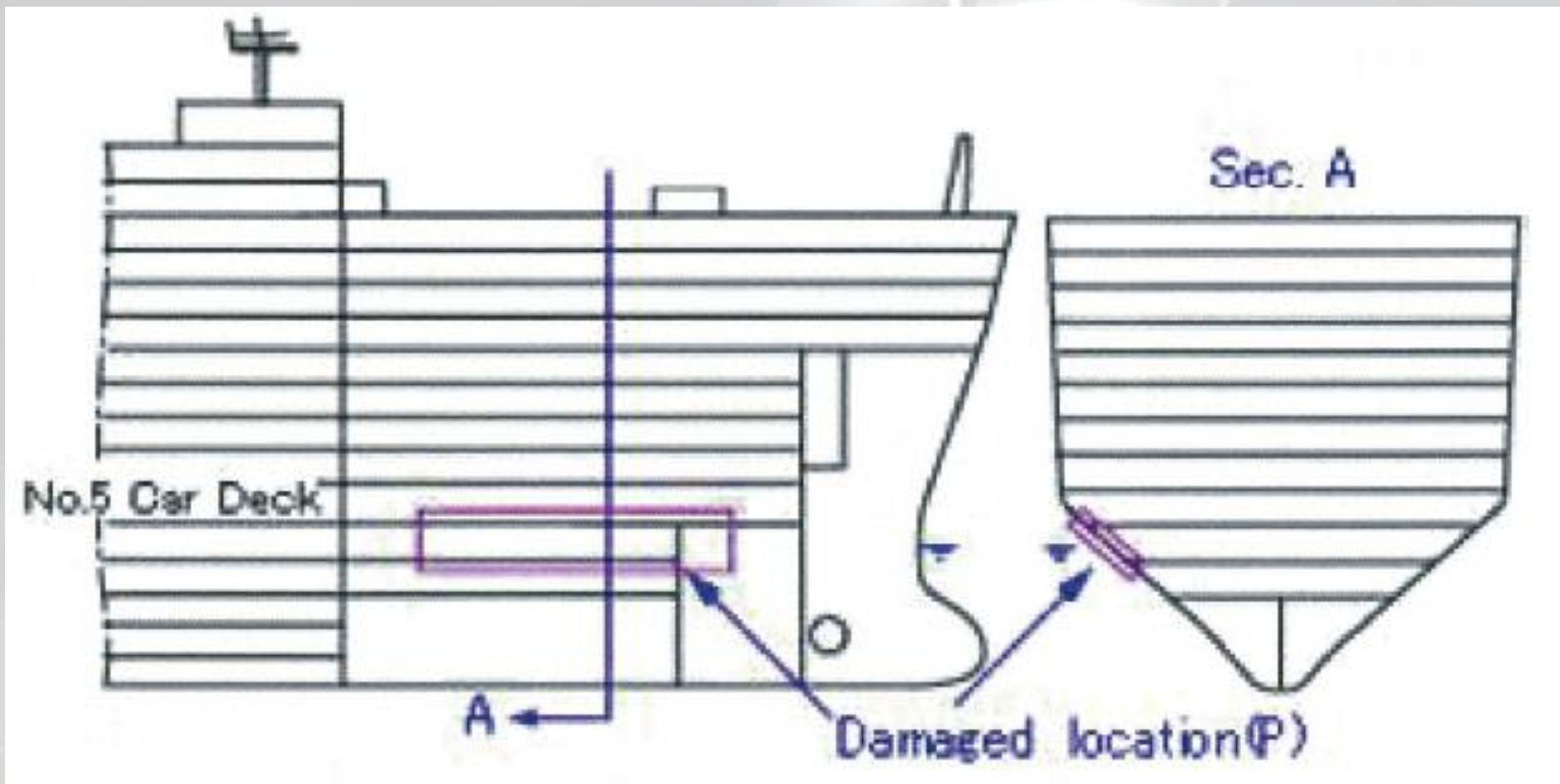


BUCKLING / DEFORMATION

BUCKLING/DEFORMATION EXAMPLE 1

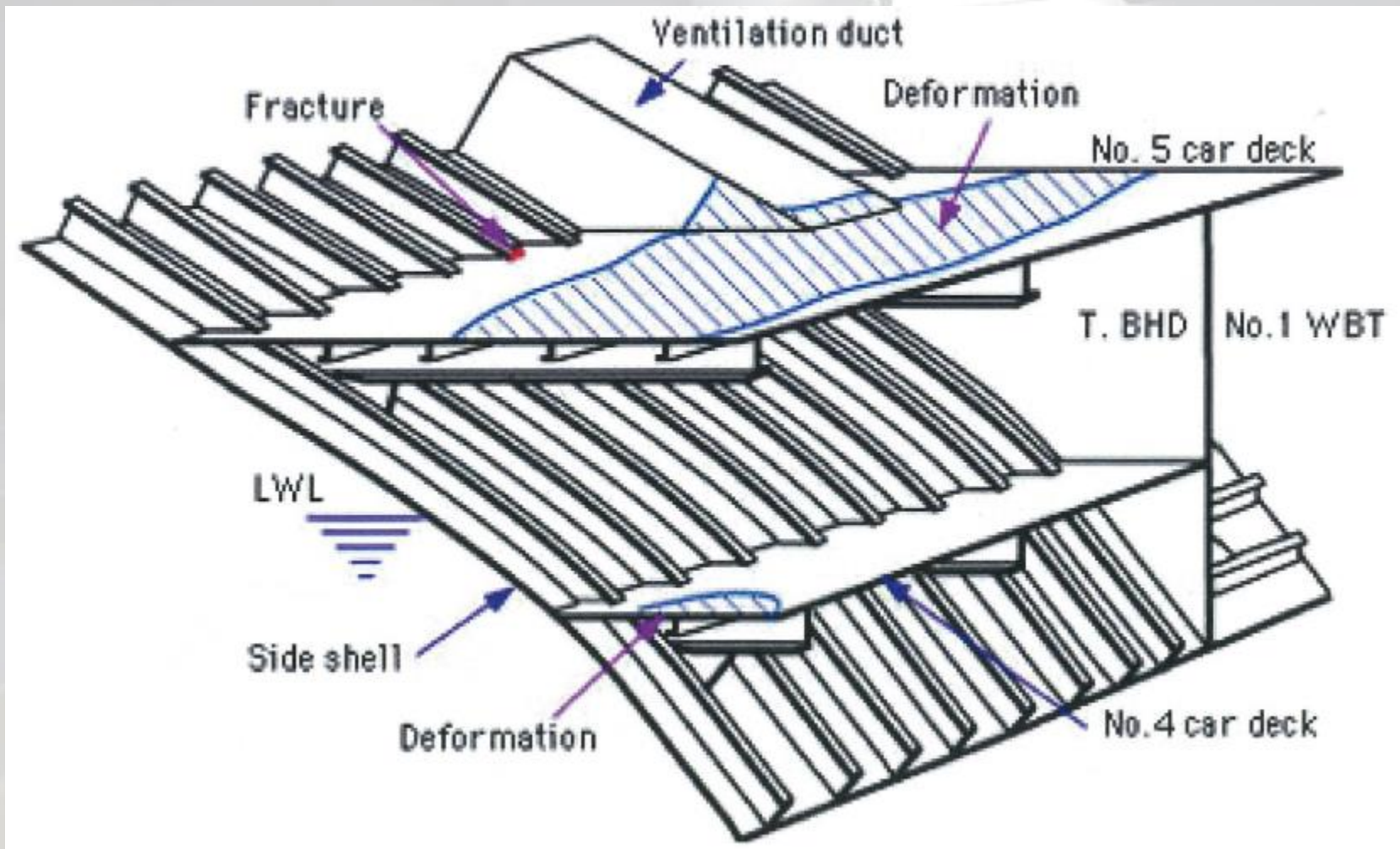
SLAMMING DAMMAGE IN BOW FLARE
OF A CAR CARRIER

-Examples of Hull Damage (Buckling/Deformation Example 1)



Large flare in the forward body above the deckline.

-Examples of Hull Damage (Buckling/Deformation Example 1)



-Examples of Hull Damage (Buckling/Deformation Example 1)

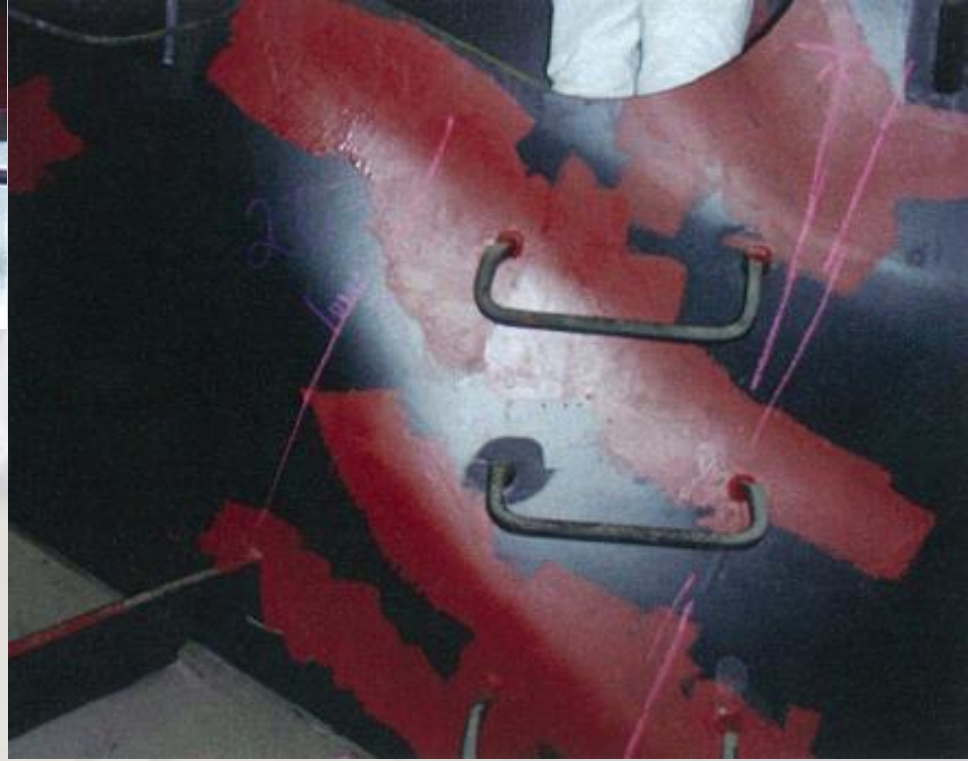


Buckled car deck



Fractured side Frame

-Examples of Hull Damage (Buckling/Deformation Example 1)





BUCKLING / DEFORMATION

BUCKLING/DEFORMATION EXAMPLE 2

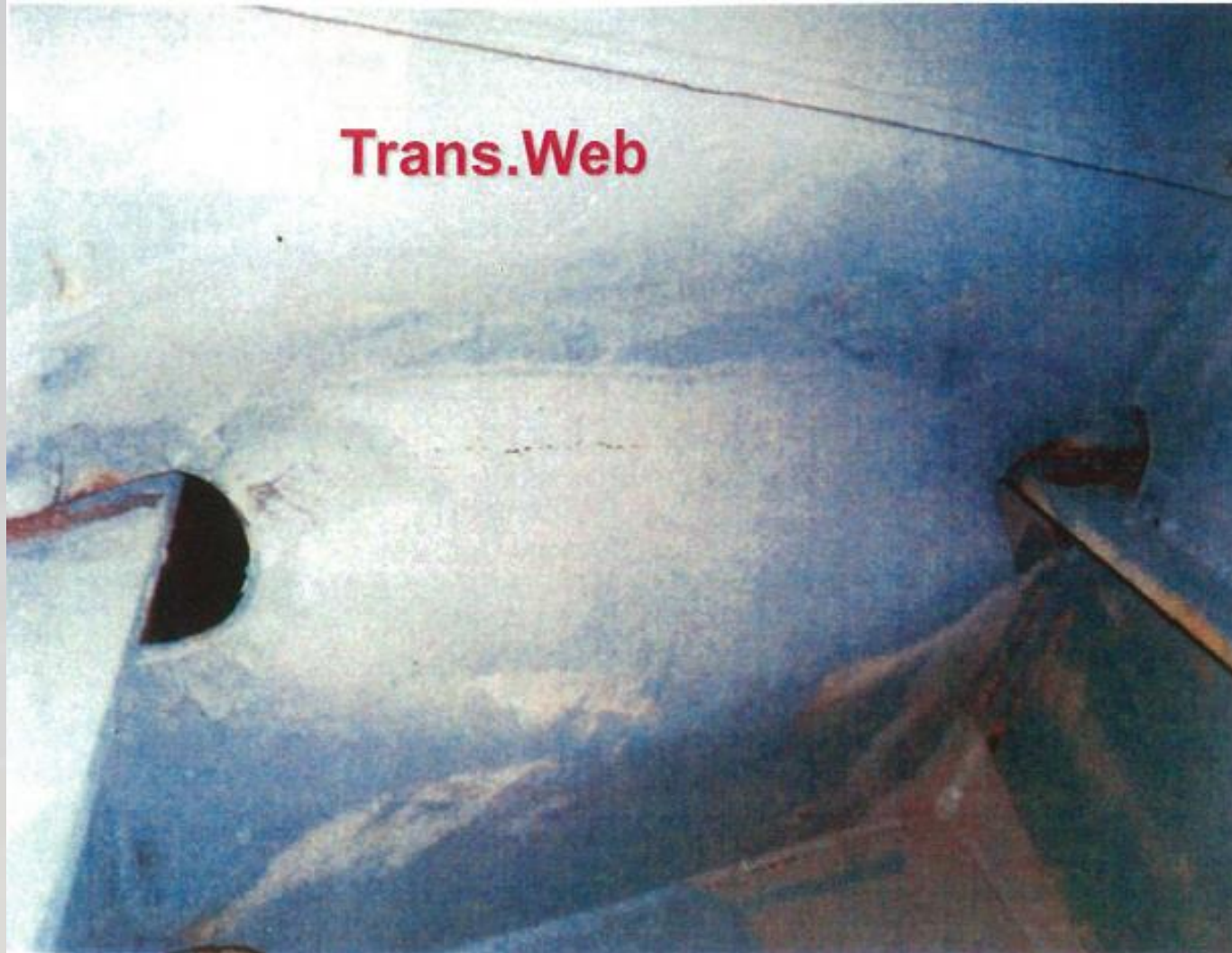
BOW FLARE SLAMMING DAMAGE ON A
CONTAINER CARRIER

-Examples of Hull Damage (Buckling/Deformation Example 2)



Buckling at Side Longitudinal & Side Shell Plate

-Examples of Hull Damage (Buckling/Deformation Example 2)



Buckling at T.Ring

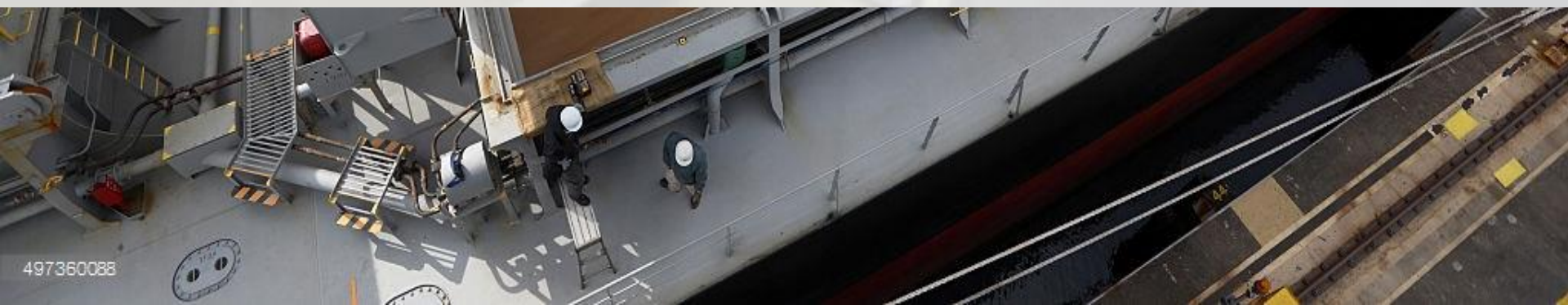
4. Class/Statutory Survey Check Points



-Survey Check Points



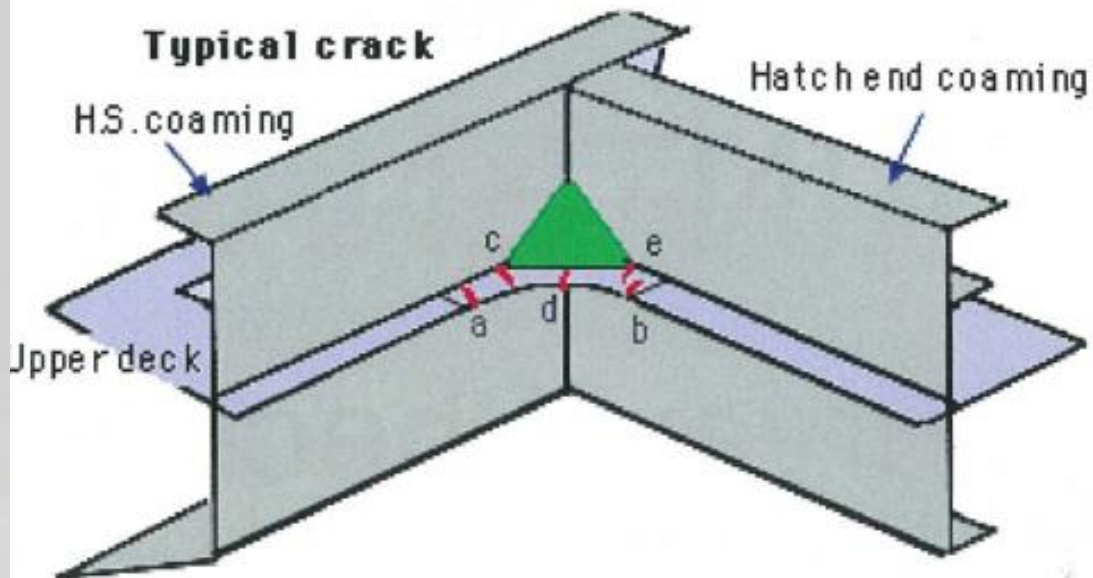
BULK CARRIERS



497360088

~ Deck Area ~

Hatch Opening Corner



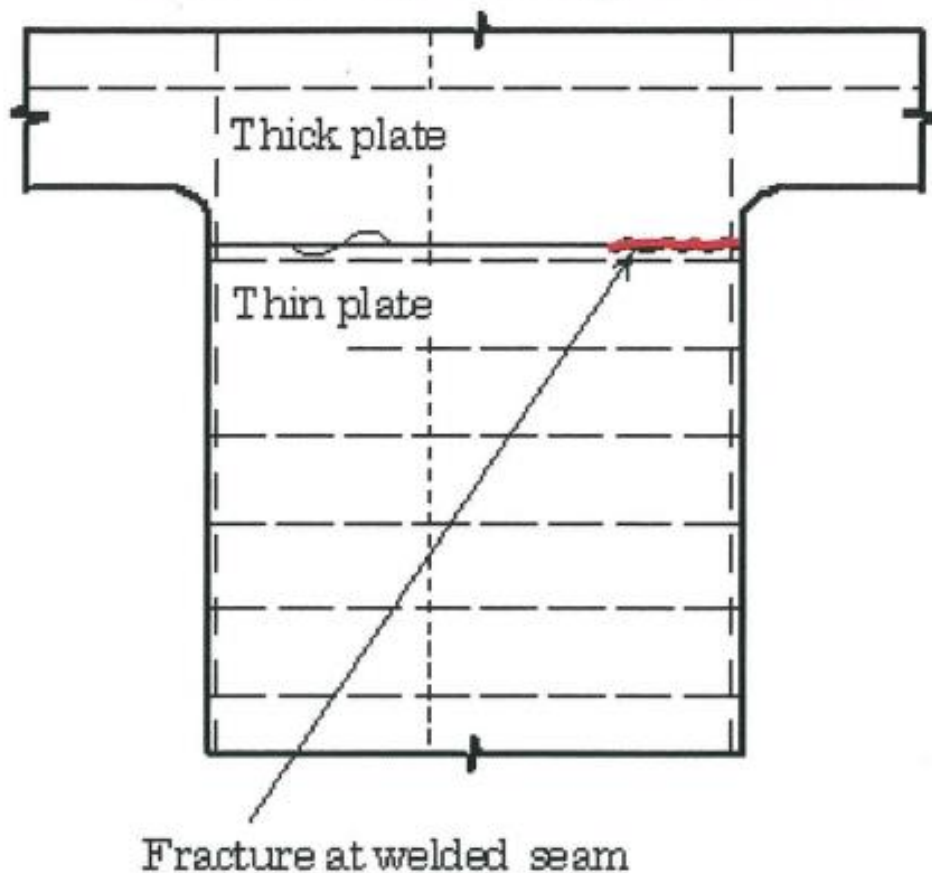
Typical crack at hatch corner

- a. Crack along hatch side: due to high tensile stress
- b. Crack along hatch end: due to high torsional stress
- c. Crack at fitting on hatch corner plate
- d. Crack or notch due to corrosion/wastage or rubbing of wire
- e. Crack due to welding defect

Special attention should be given to deck openings; the corners of cargo hatch in particular.

~ Deck Area ~

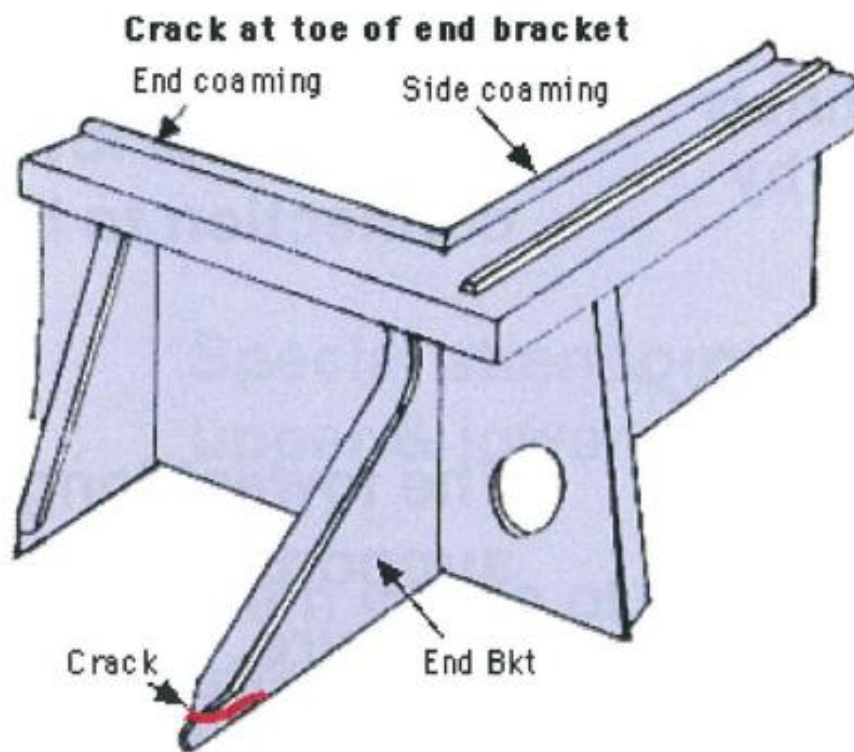
Hatch Opening Corner



Special attention should be given to deck openings; the corners of cargo hatch in particular.

~ Deck Area ~

Hatch Side Coaming end bracket

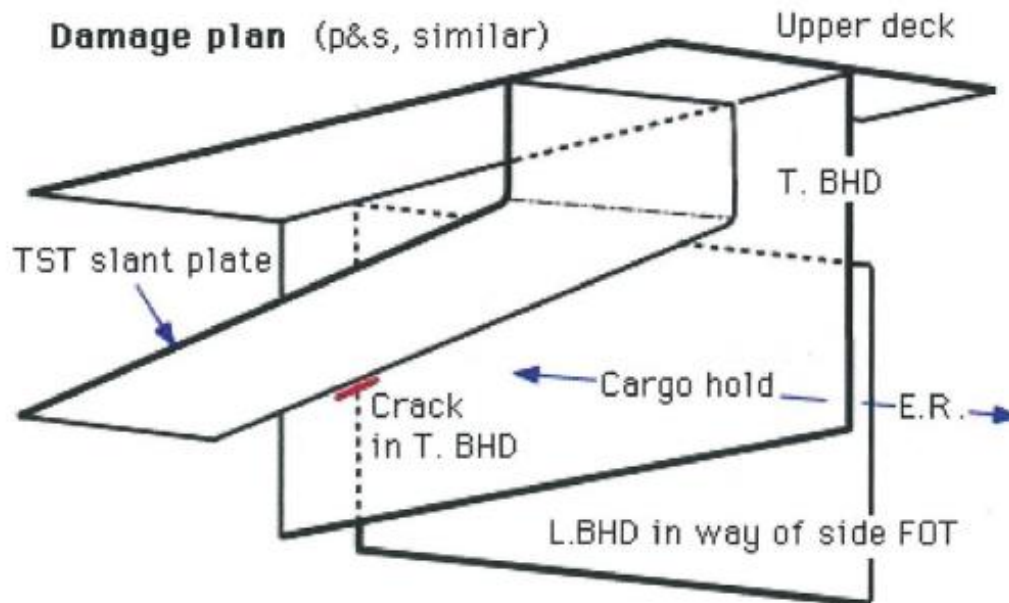


Special attention should be also given to the toe of end bracket of the hatch side coaming. Cracks in the end bracket may lead to more serious damage such as fracture of the deck structure.

~ Topside Tank Structure ~

Slant Plate of Top Side Tank

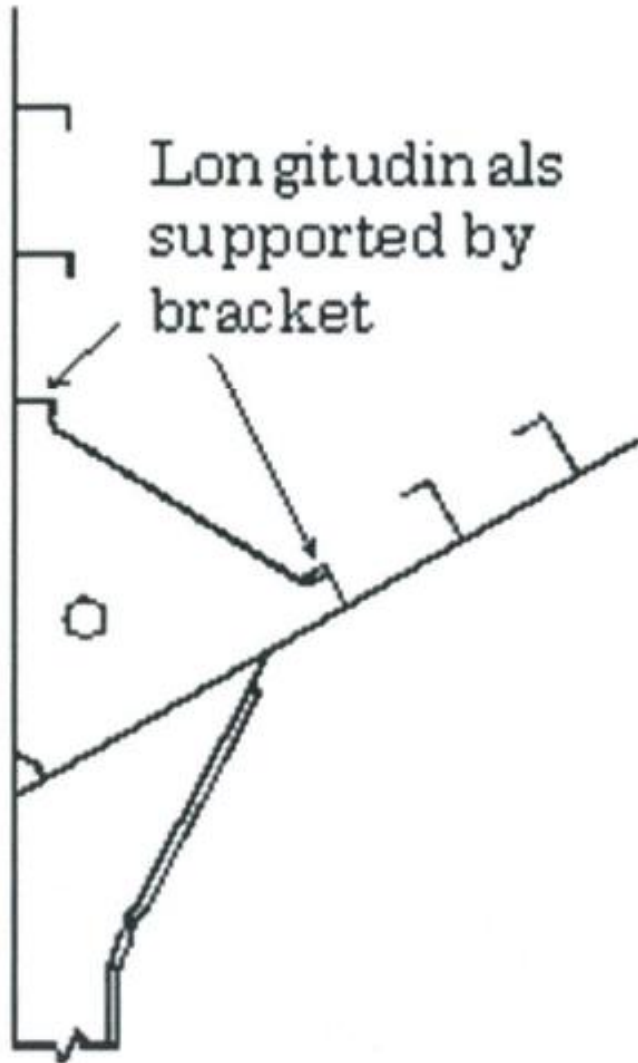
Special attention should be given to the slant plate of top side tank where it connects to the Coll. BHD and E/R Fwd BHD.



The above connections may crack due to the discontinuous structure

~ Topside Tank Structure ~

Lowest Longitudinal in TST

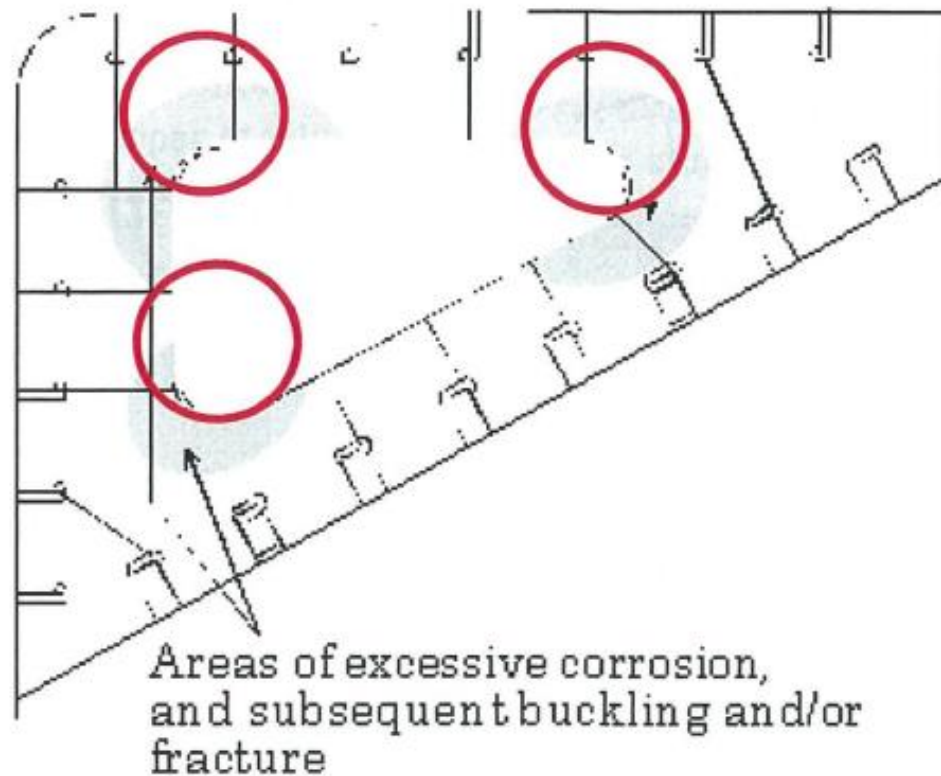


Special attention should be given to the lowest longl. at the connection to the trans.web.

The lowest longl. is usually supported by a bracket as shown in figure, therefore a smaller scantling may be adopted.

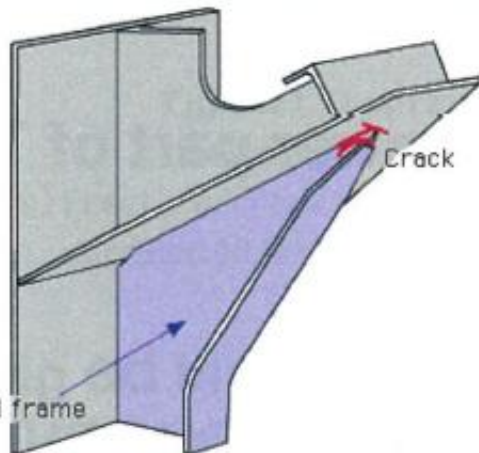
~ Topside Tank Structure ~

Corner of T.Ring

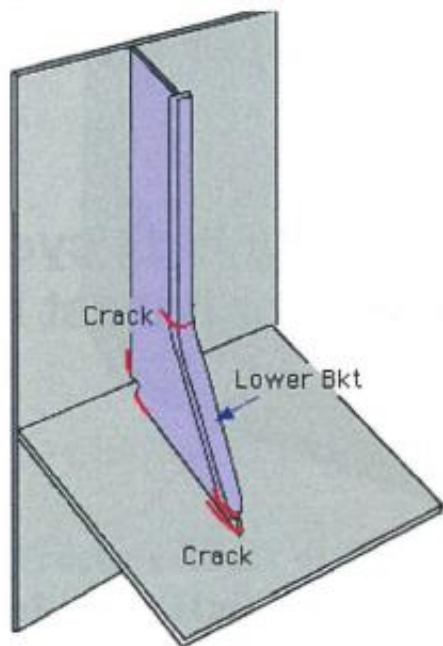


Special attention should be given to the corner of T.Ring. One possible cause of damage is stress concentration at corner.

~ Side Structure of the Cargo Hold ~



**Upper & Lower toe of Hold Frame
Upper Bracket**

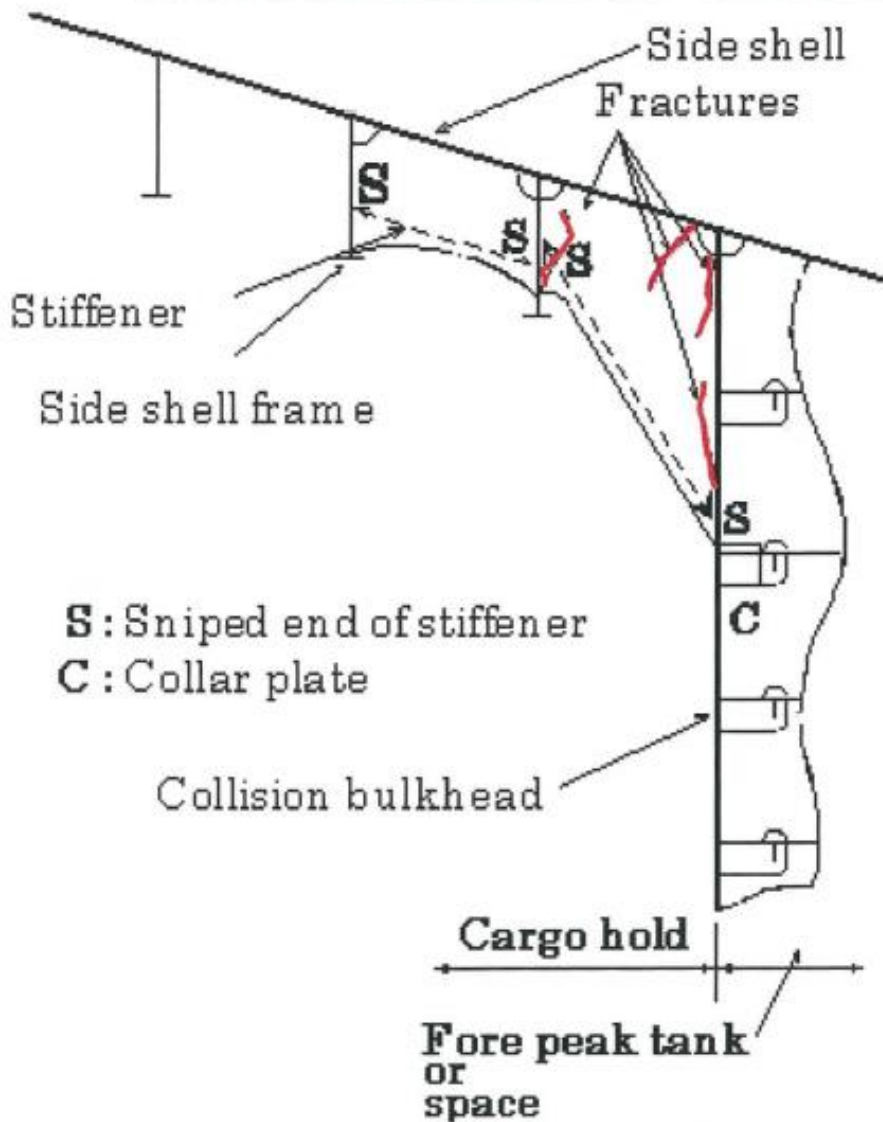


**Special attention should be given to
upper & lower end of hold frame.**

**Main cause of probable damage is
stress concentration of load from sea
wave**

Lower Bracket

~ Side Structure of the Cargo Hold ~

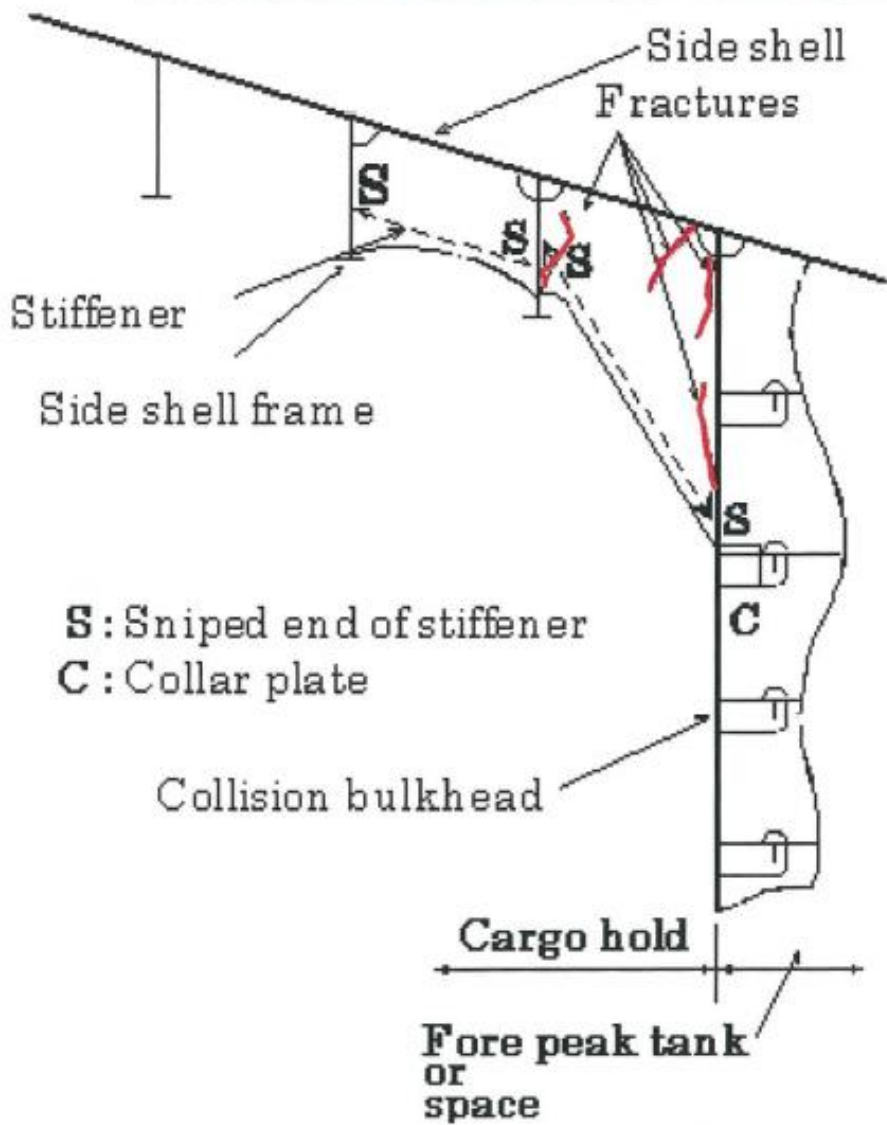


Connection to Coll.BHD

Special attention should be given to the bracket at the connection to Coll.BHD of FPT.

Supporting bracket may be cracked due to discontinuous structure.

~ Side Structure of the Cargo Hold ~

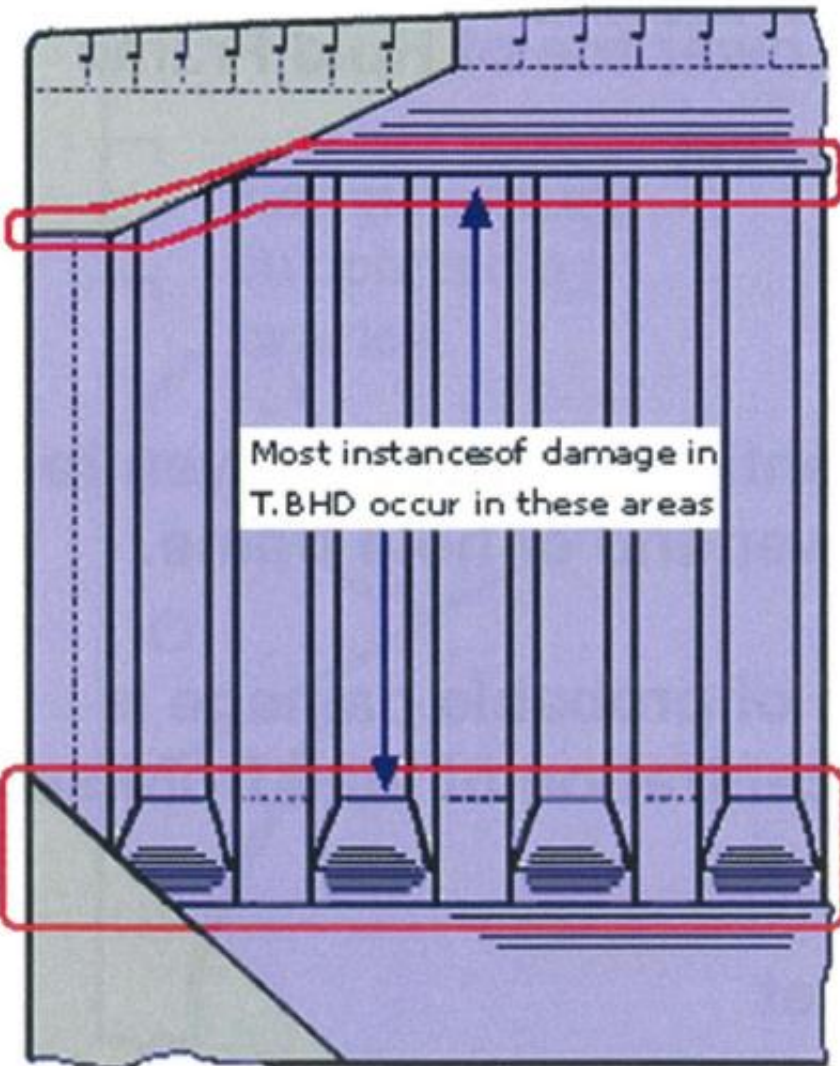


Connection to Coll.BHD

Special attention should be given to the bracket at the connection to Coll.BHD of FPT.

Supporting bracket may be cracked due to discontinuous structure.

~ T.BHD in Cargo Hold ~



Upper & Lower part of T.BHD

Special attention should be given to the upper & lower part of T.BHD at the connection to the upper stool and lower stool.

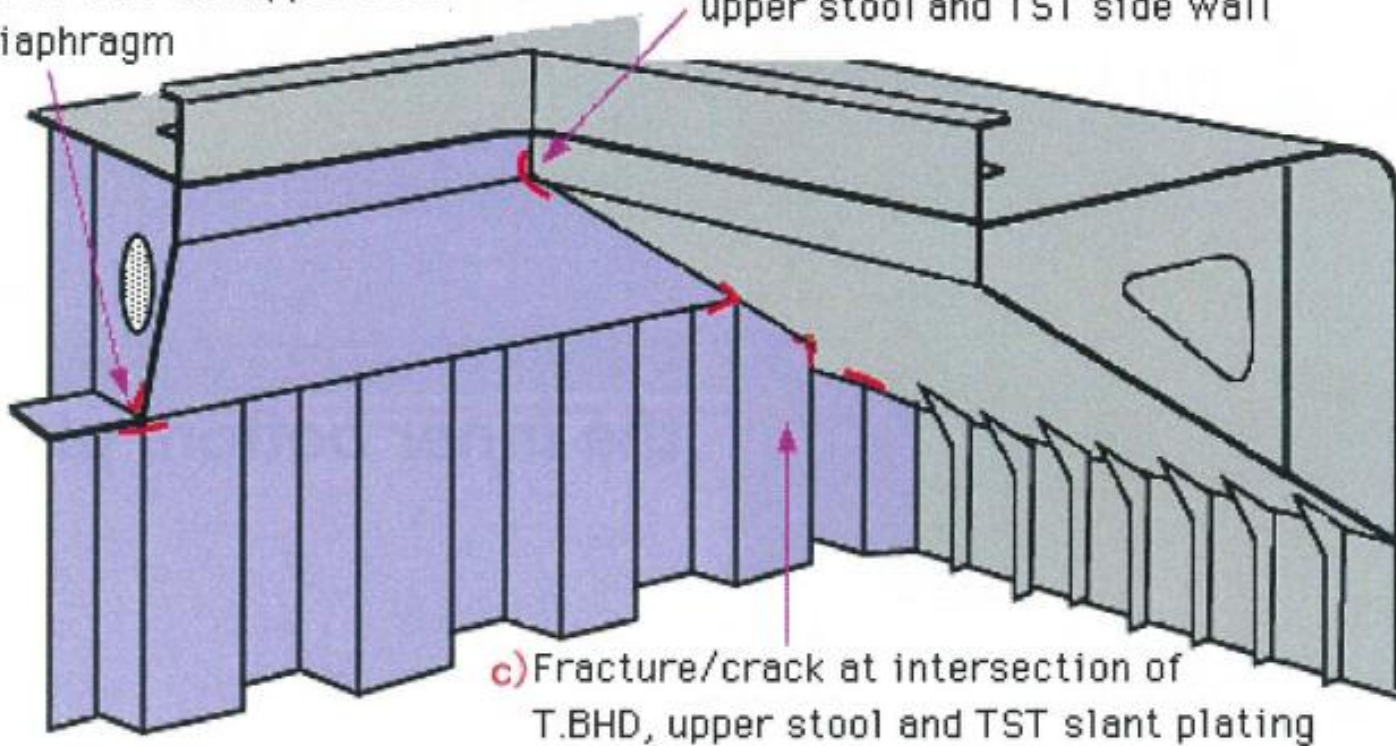
Cracks are caused by high cyclic stress due to cargo or ballast in cargo hold.

~ T.BHD in Cargo Hold ~ Upper part of T.BHD

Typical fracture/crack in upper area of T.BHD
(including intersection of upper stool and TST)

b) Fracture/crack at intersection
of T. BHD and upper stool
diaphragm

a) Fracture/crack at intersection of
upper stool and TST side wall



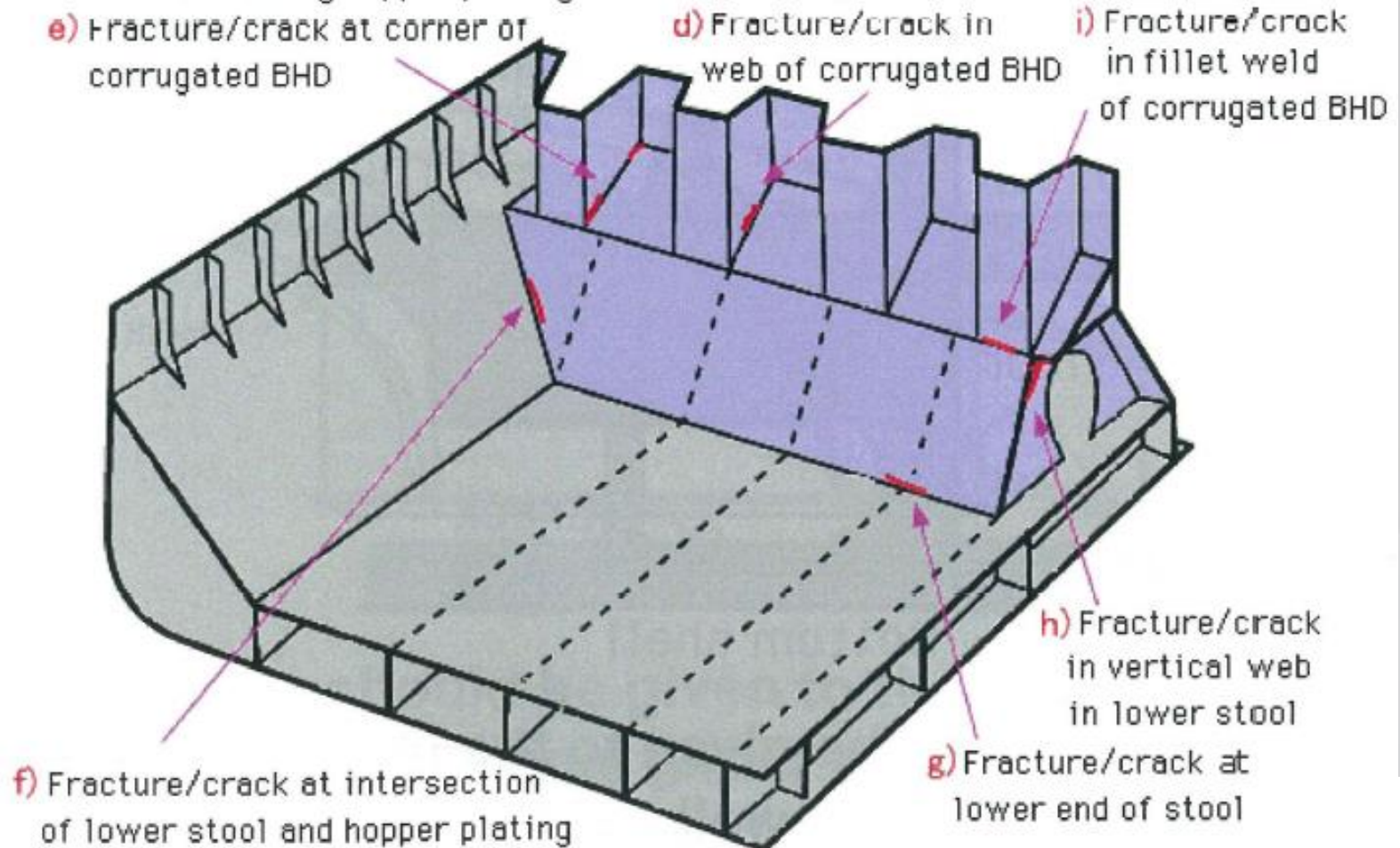
c) Fracture/crack at intersection of
T.BHD, upper stool and TST slant plating

~ T.BHD in Cargo Hold ~

Lower part of T.BHD

Typical fracture/crack in lower area of T.BHD

(including hopper plating and lower stool)



~ D.Bottom Tank incl. Hopper Tank ~

Hopper Plate of Bilge Hopper Tank

Typical damage to the bilge hopper structure

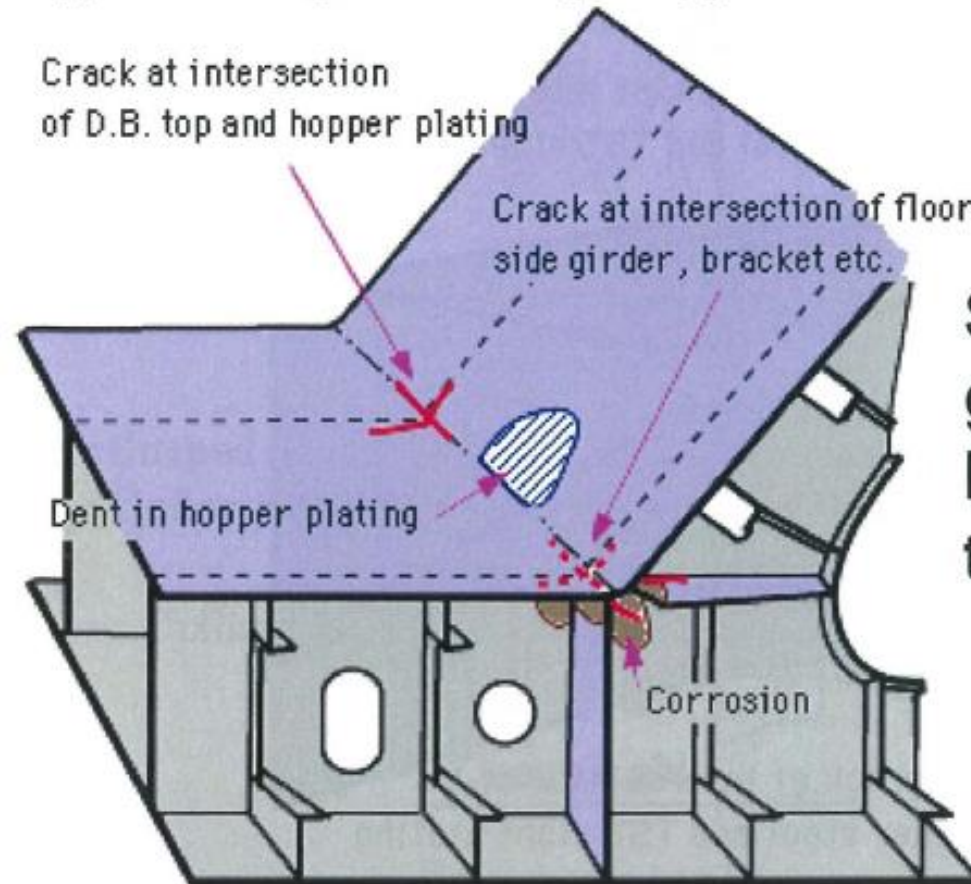
Crack at intersection
of D.B. top and hopper plating

Crack at intersection of floor,
side girder, bracket etc.

Dent in hopper plating

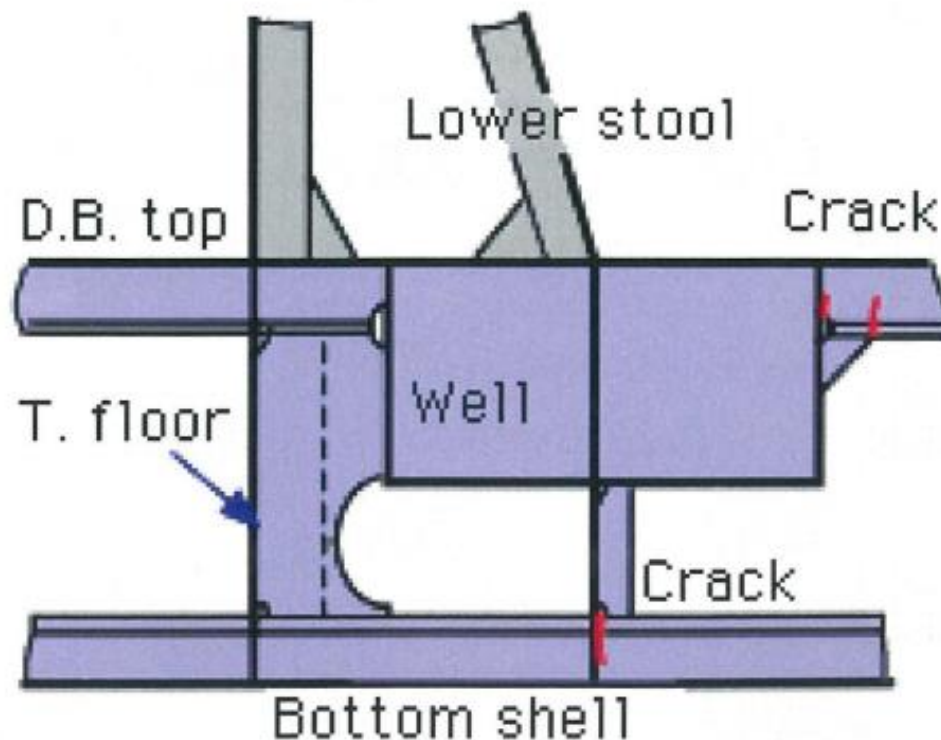
Corrosion

Special attention should be given to the connection between the hopper plate and the inner bottom plate.



~ D.Bottom Tank incl. Hopper Tank ~

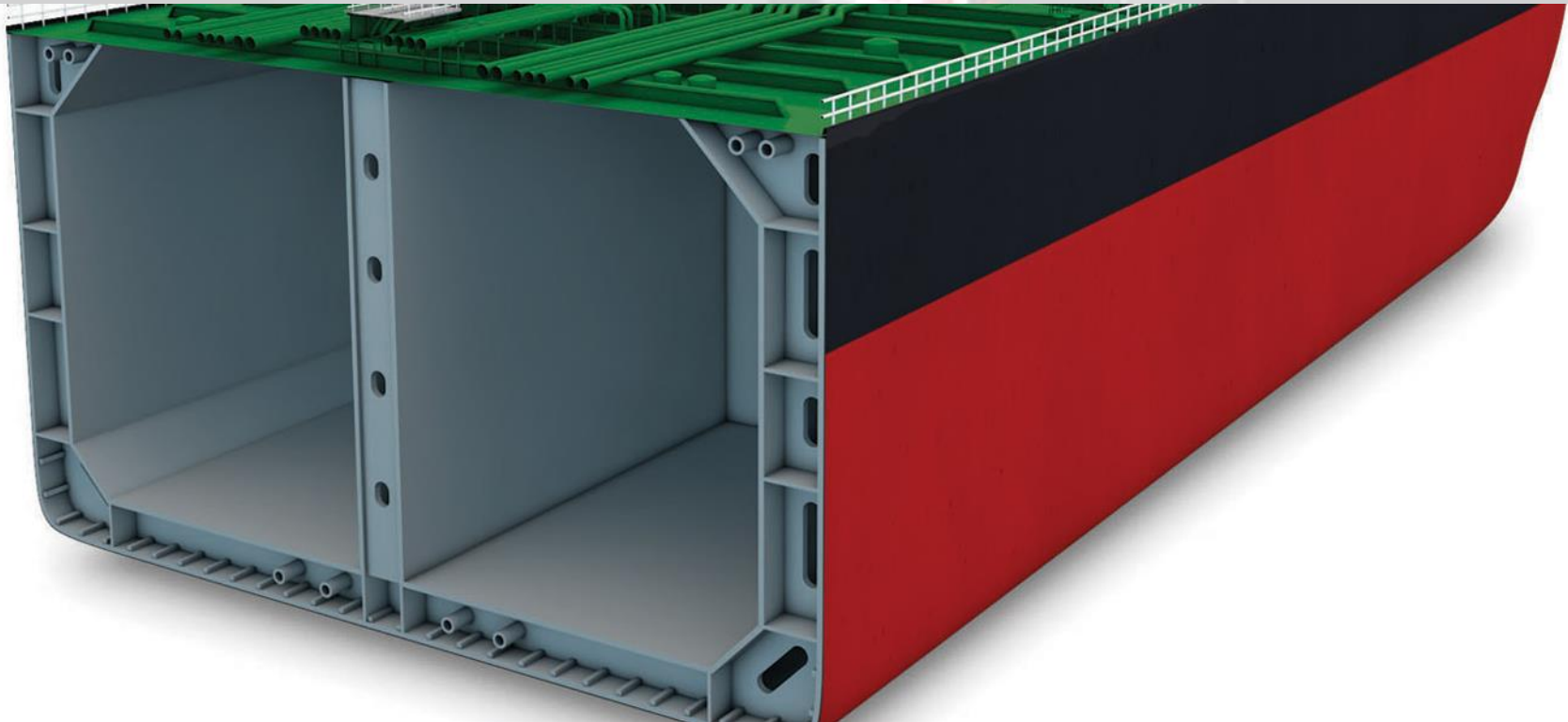
Inner bottom longl. & bottom longl.



Special attention should be given to the inner bottom longl. & bottom longl. near the bilge well.



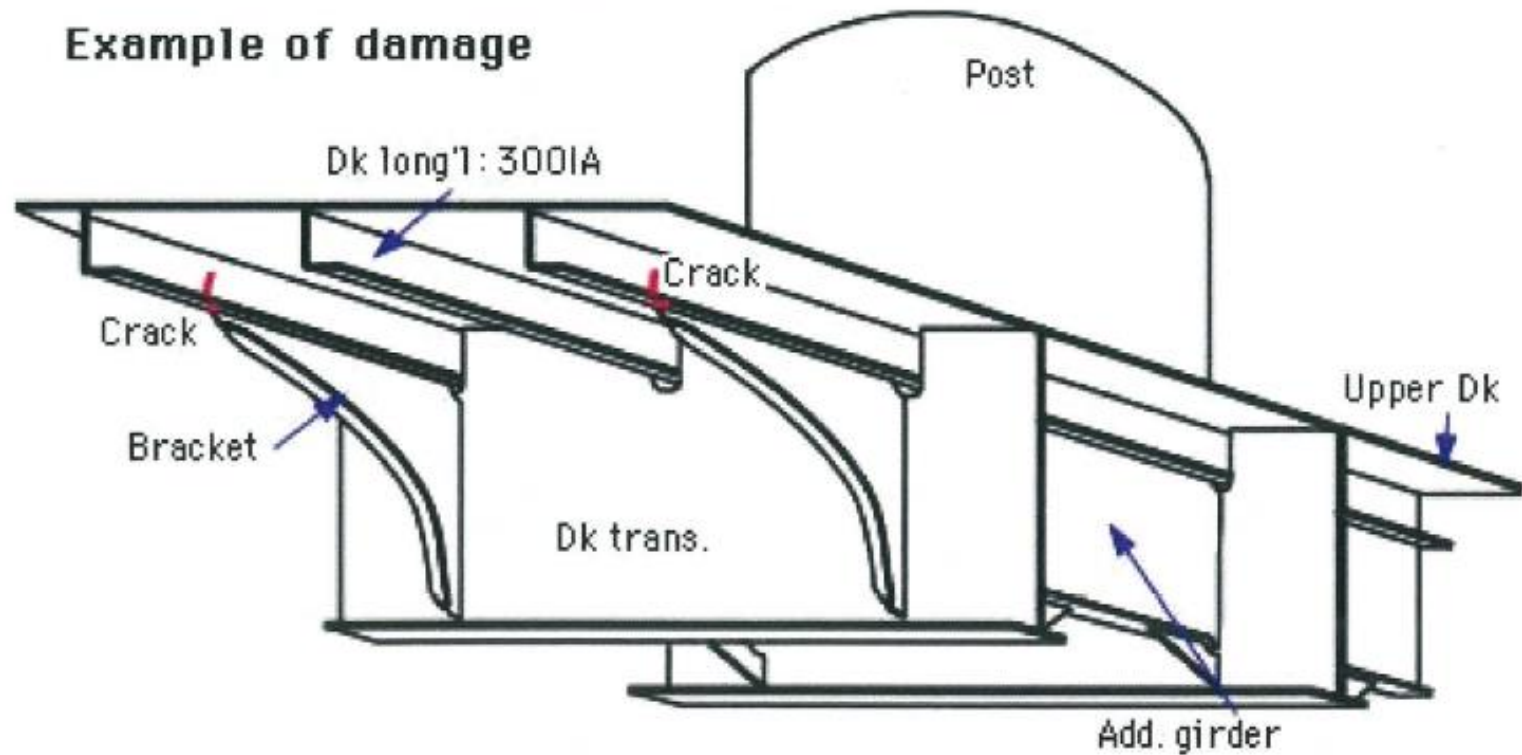
DOUBLE HULL OIL TANKERS



~ Deck Area ~

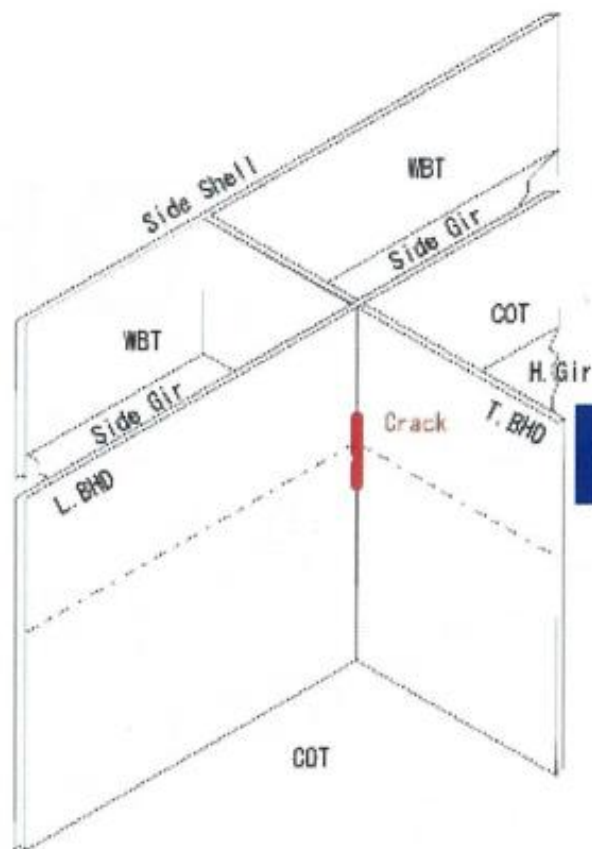
Deck Longitudinal

Example of damage



Special attention should be given to the deck longl. at the connection to the additional girder under the deck machinery.

~ T.BHD in Cargo Tank ~ Connection between T.BHD and L.BHD

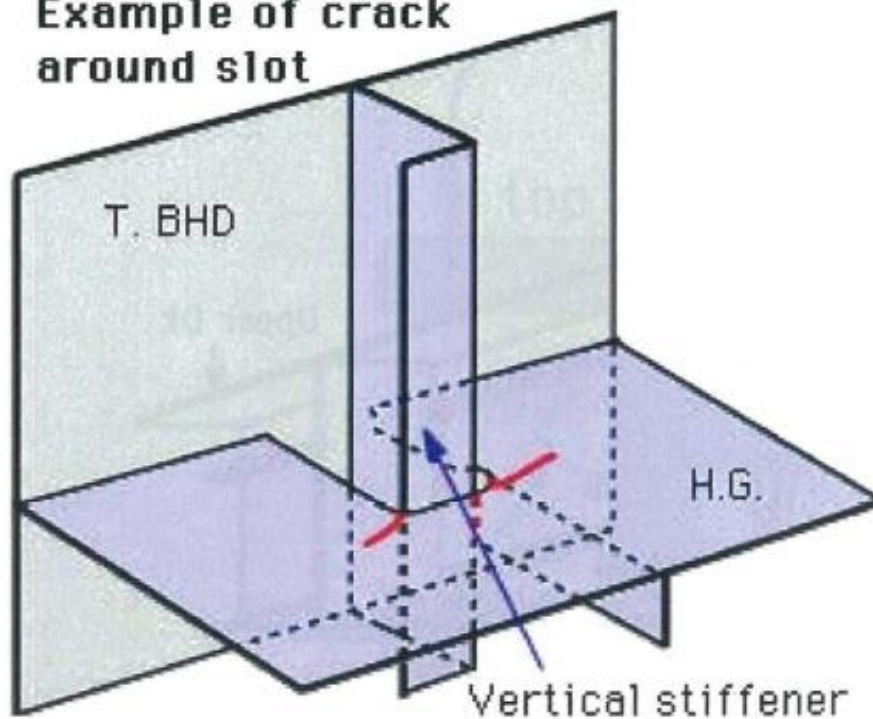


Special attention should be given to the connection between T.BHD and outside L.BHD at the horizontal girder level.

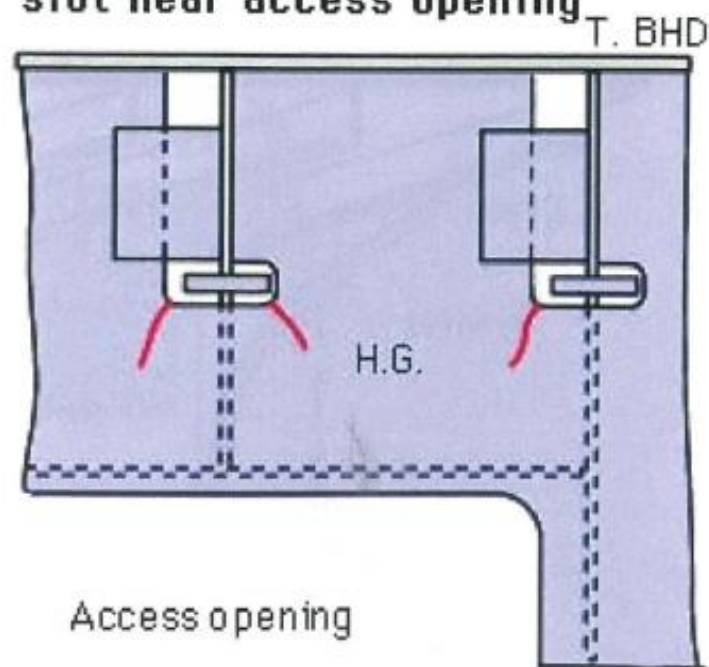
~ T.BHD in Cargo Tank ~

Horizontal Girder Slots

Example of crack around slot



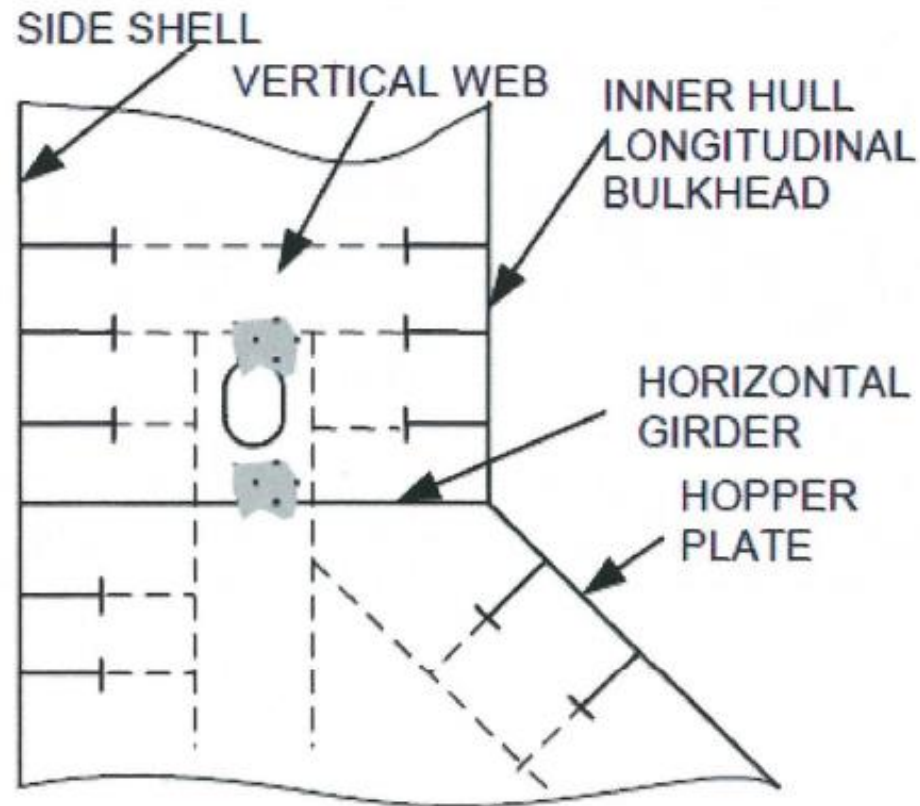
Example of crack around slot near access opening



Special attention should be given to the slot on horizontal girders for vertical stiffener penetration.

~ Wing Ballast Tank ~

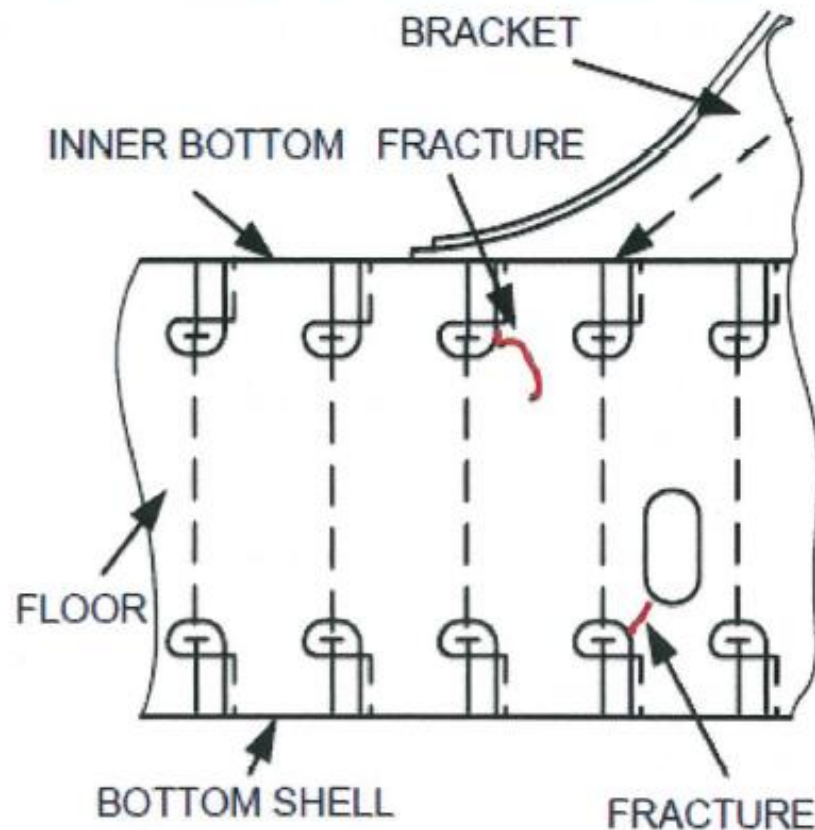
Trans.Web



Special attention should be given to the area around the manhole of the trans.web in the wing ballast tank.

~ Bottom Ballast Tank incl. Hopper ~

Floor of the Double Bottom Tank



Special attention should be given slot of Floor under Bracket associated to L.BHD.

CONTAINER CARRIERS



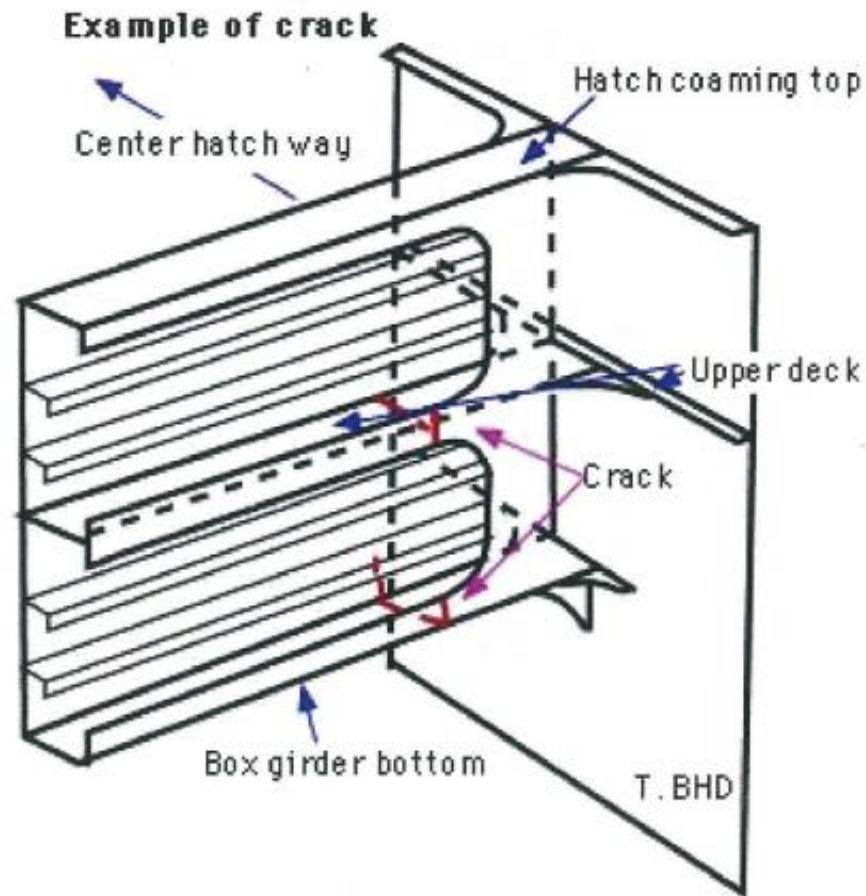
~ Shell Plates ~

Shell Plates with internal structural members



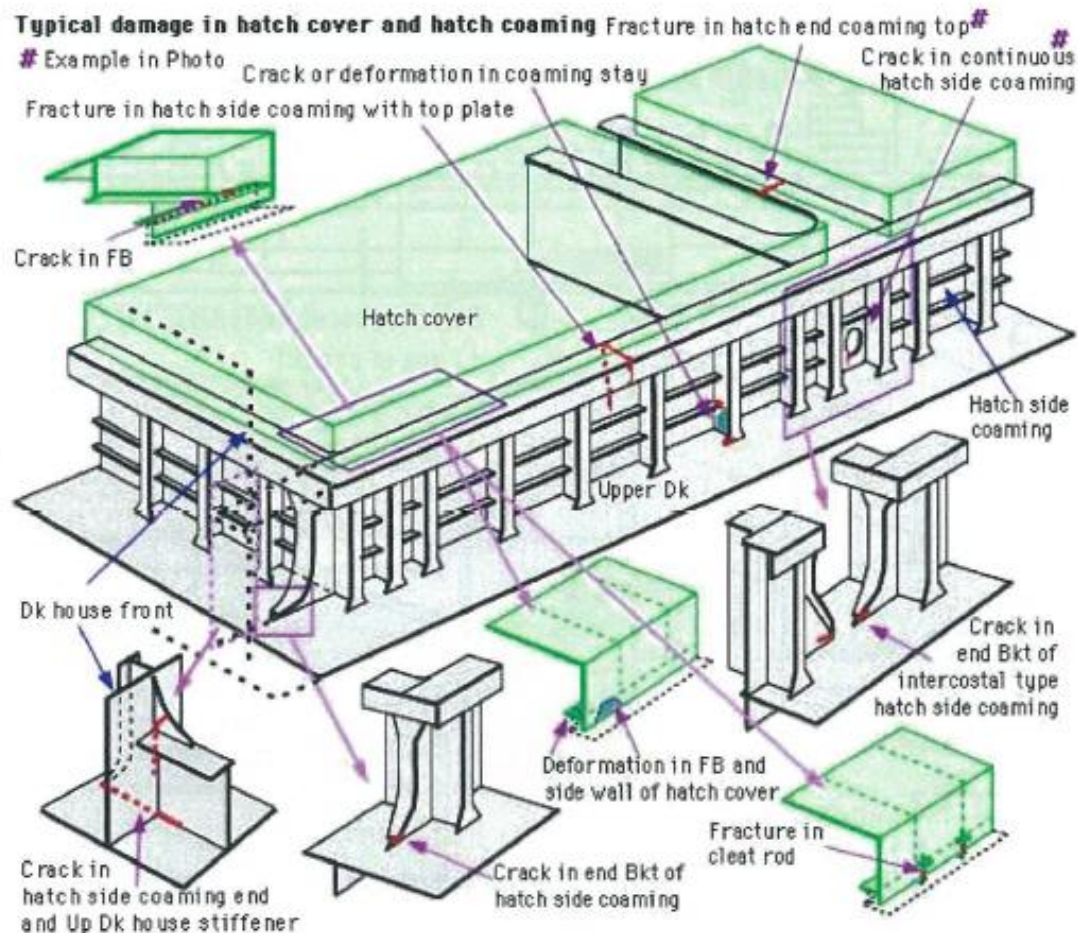
Special attention should be given to buckling damage at the shell plate internal structural members due to bow flare slamming damage.

~ Deck Area ~ **Deck Box Girder**



Special attention should be given to the deck box girder.

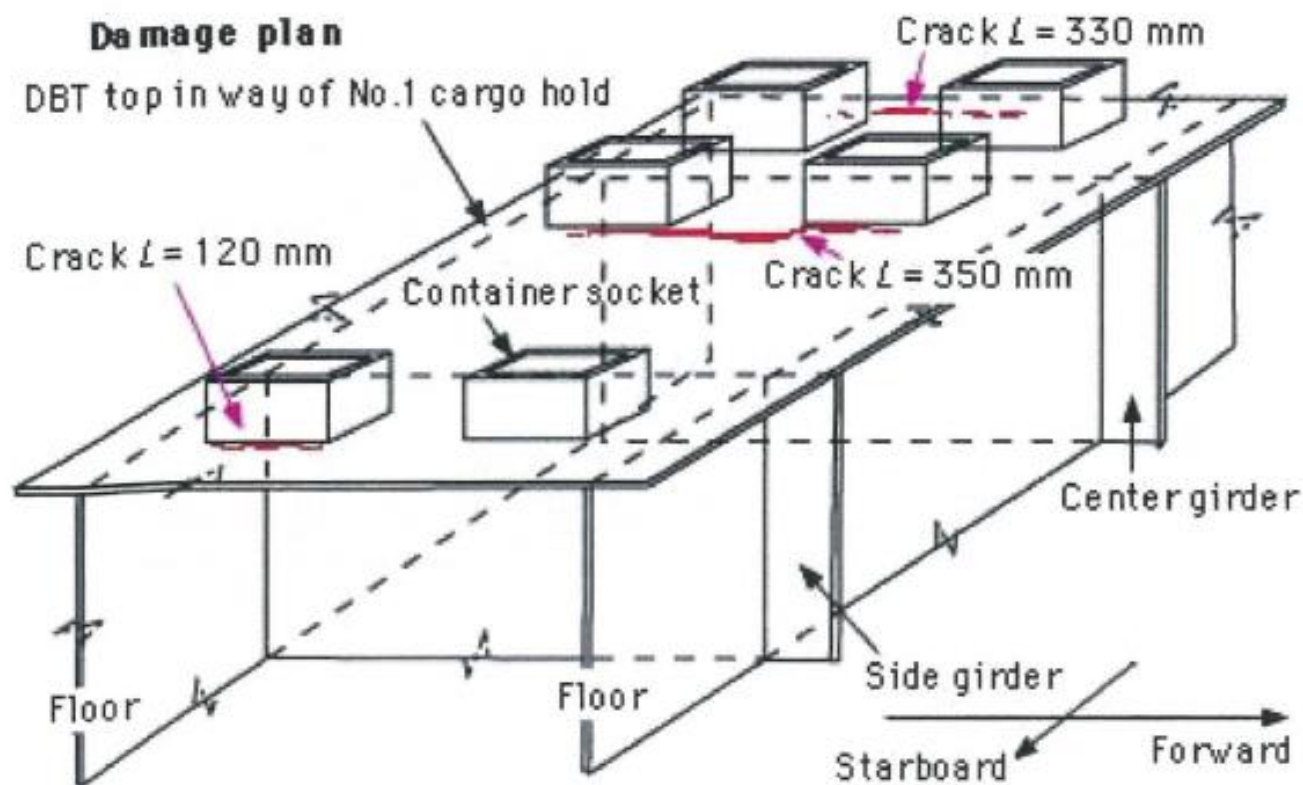
~ Deck Area ~



Special attention should be given to hard spots of hatch covers and hatch coamings

~ Cargo Hold ~

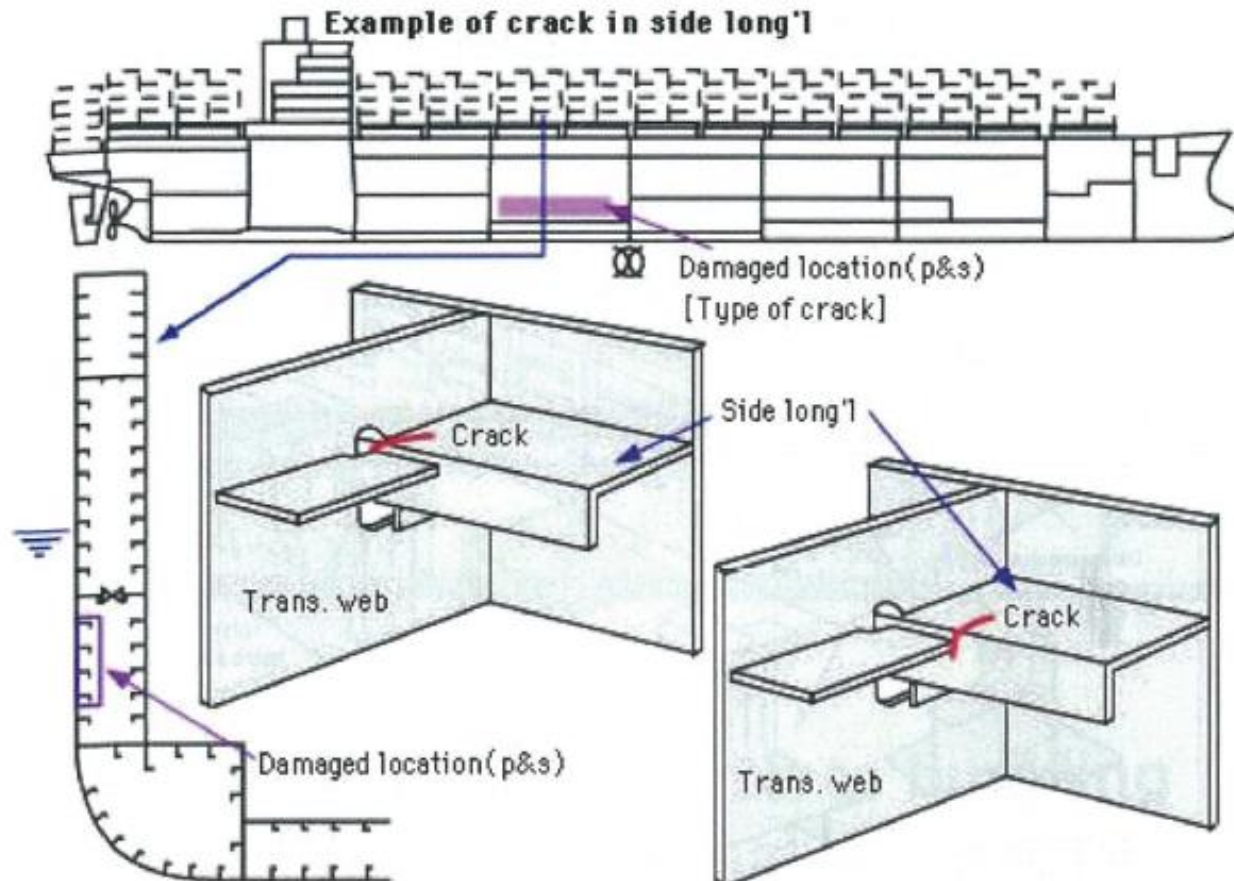
Area Around Container Socket on Inner Bottom Plate



Special attention should be given to the inner bottom plate around the container sockets

~ Side Tank ~

Side Longl. in Side WBT



Special attention should be given to the side longl. in the side WBT of container carriers.

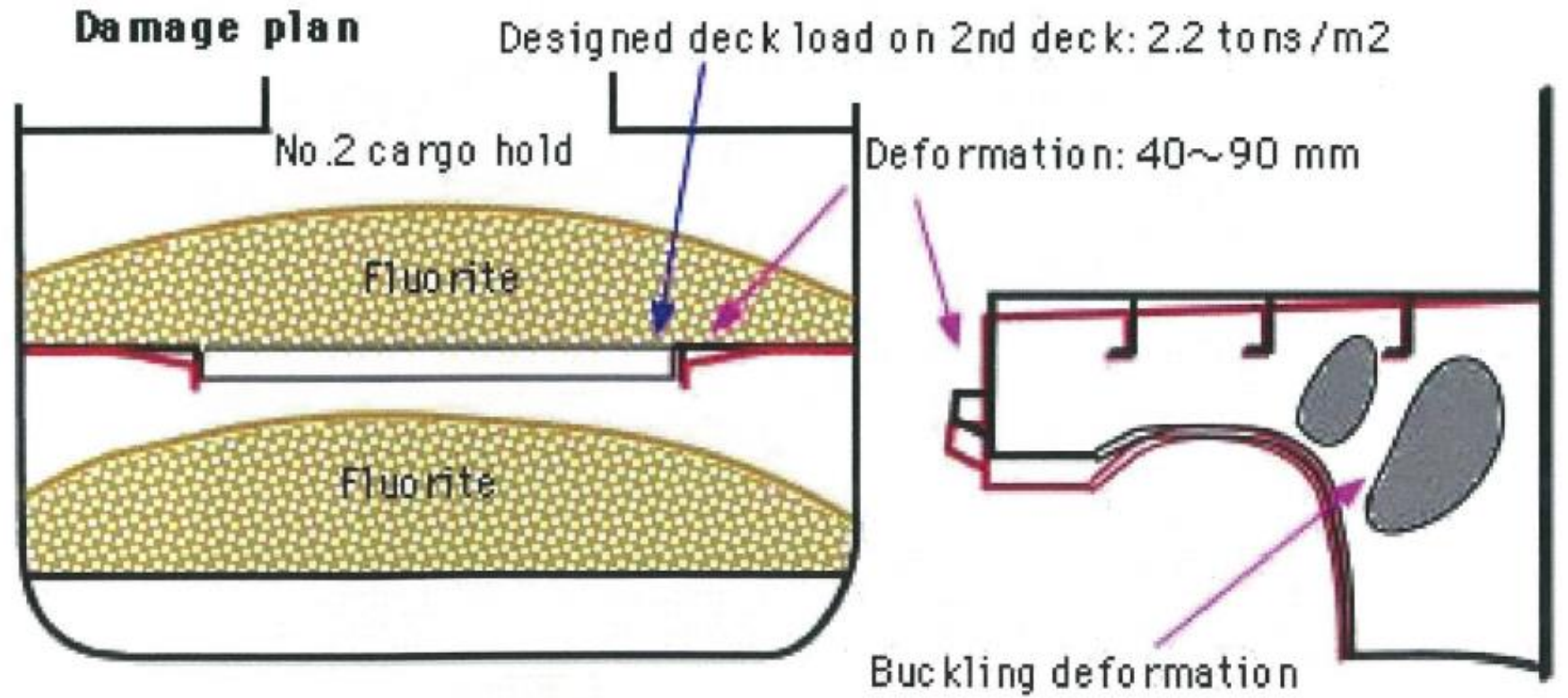
-Survey Check Points



GENERAL CARGO SHIPS

~ Cargo Hold ~

2nd Deck in Cargo Hold



Special attention should be given to 2nd deck of cargo holds.

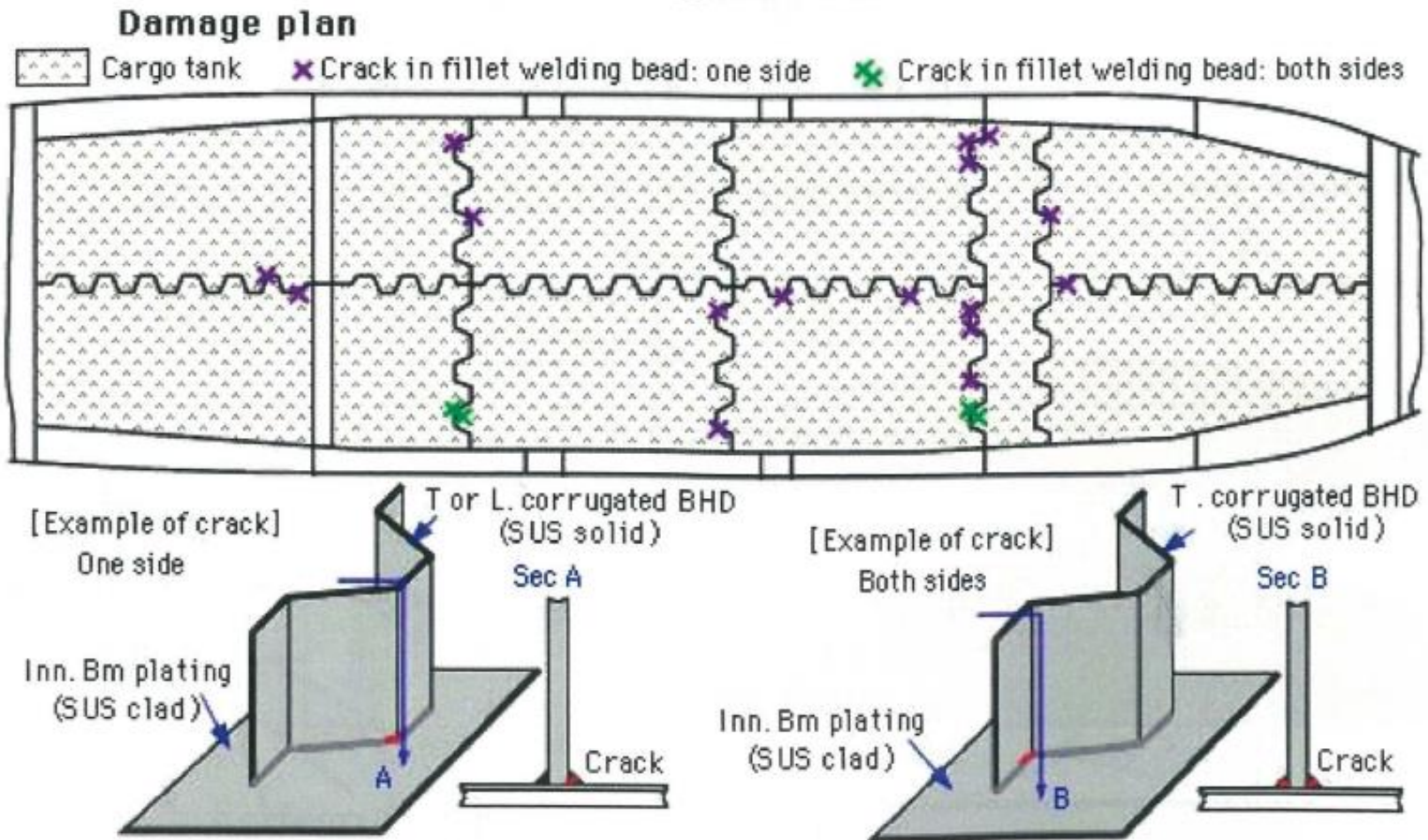
-Survey Check Points



CHEMICAL TANKERS

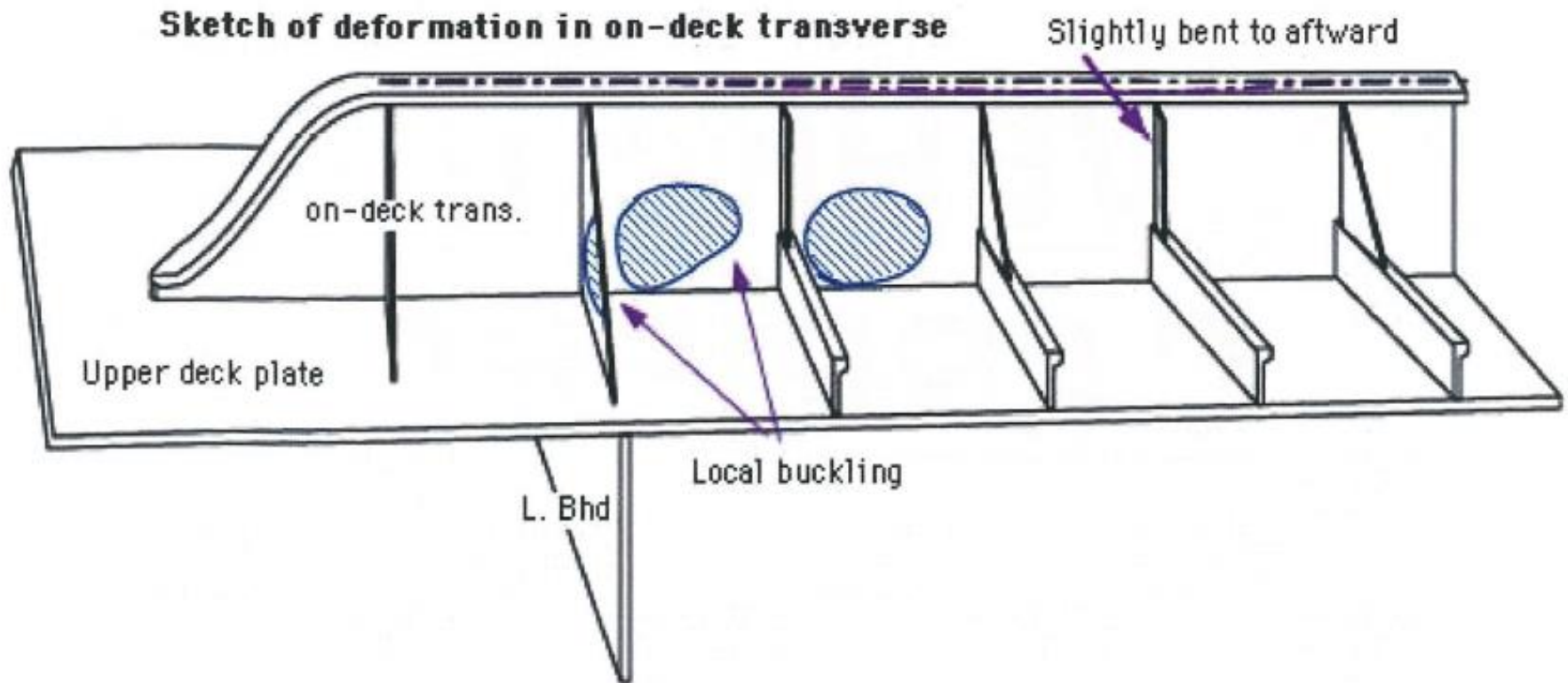


~ Cargo Tank ~



Special attention should be given to the connection between the Corr.BHD and the inner bottom plates.

~ Deck Area ~



Special attention should be given to buckling in On-Deck Trans.

~ Cofferdam / Access Trunk ~



Special attention should be given to the cofferdam and access trunk adjacent to heated cargo tanks

-Survey Check Points

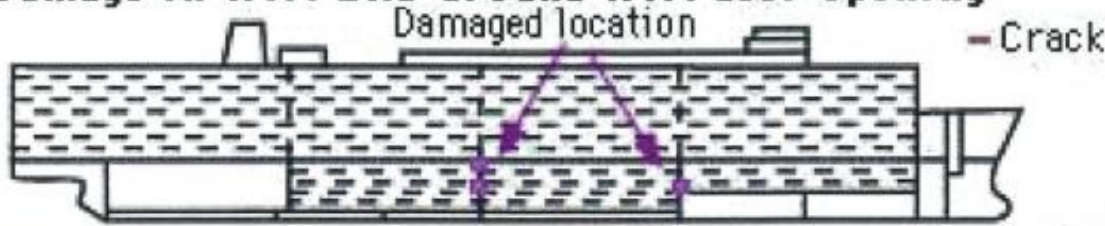


VEHICLE CARRIERS

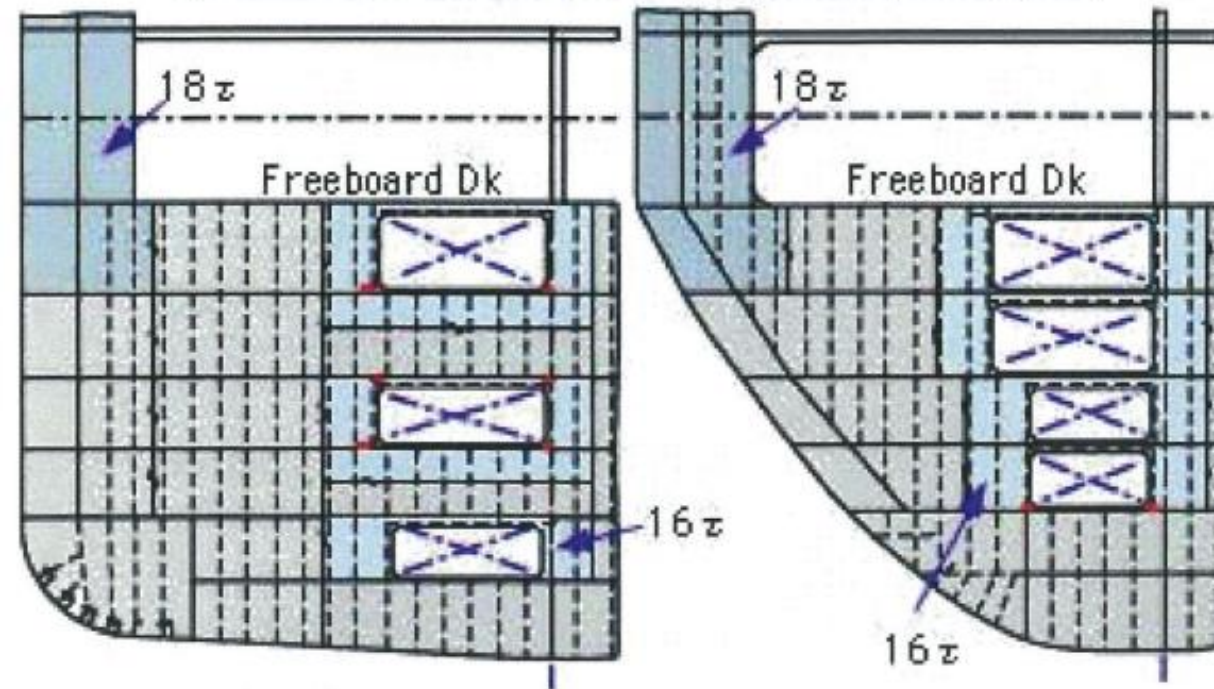
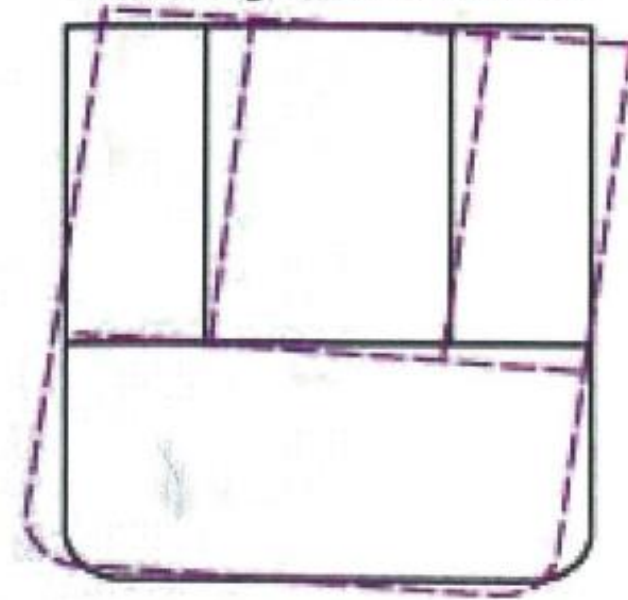


~ Cargo Hold ~

Damage in W.T. BHD around W.T. door opening



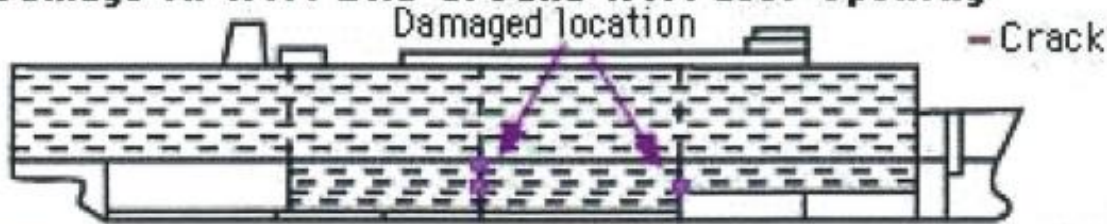
Racking deformation



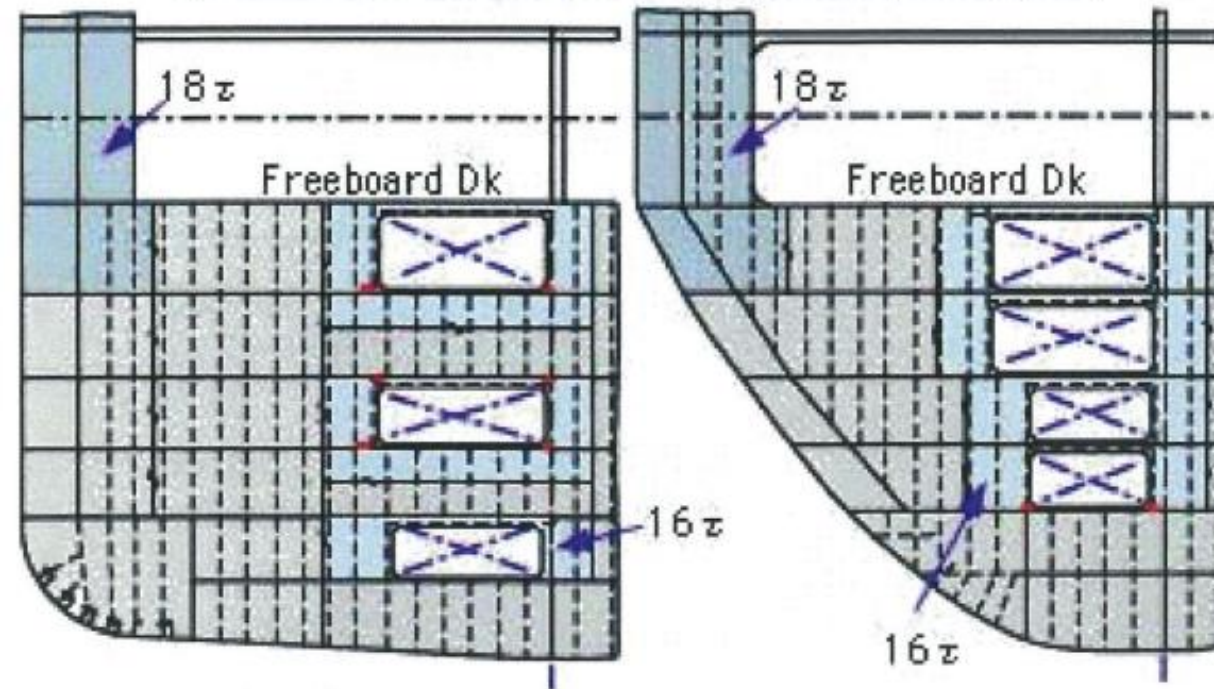
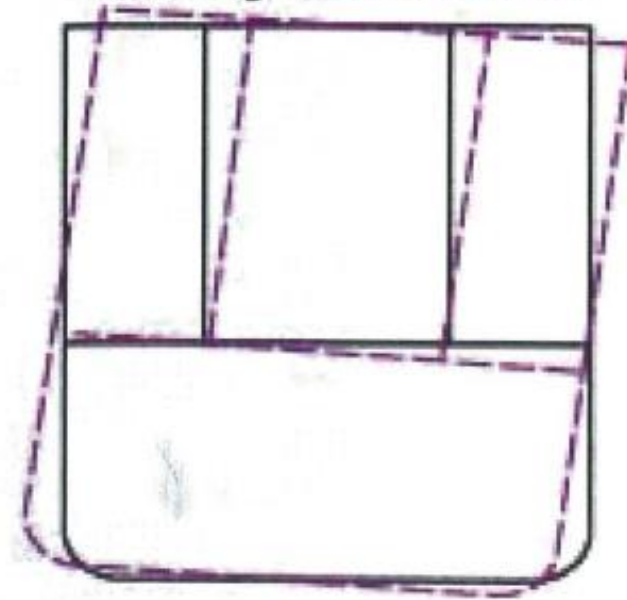
Special attention should be given to water tight door openings in bulkhead due to racking deformation from rolling

~ Cargo Hold ~

Damage in W.T. BHD around W.T. door opening



Racking deformation



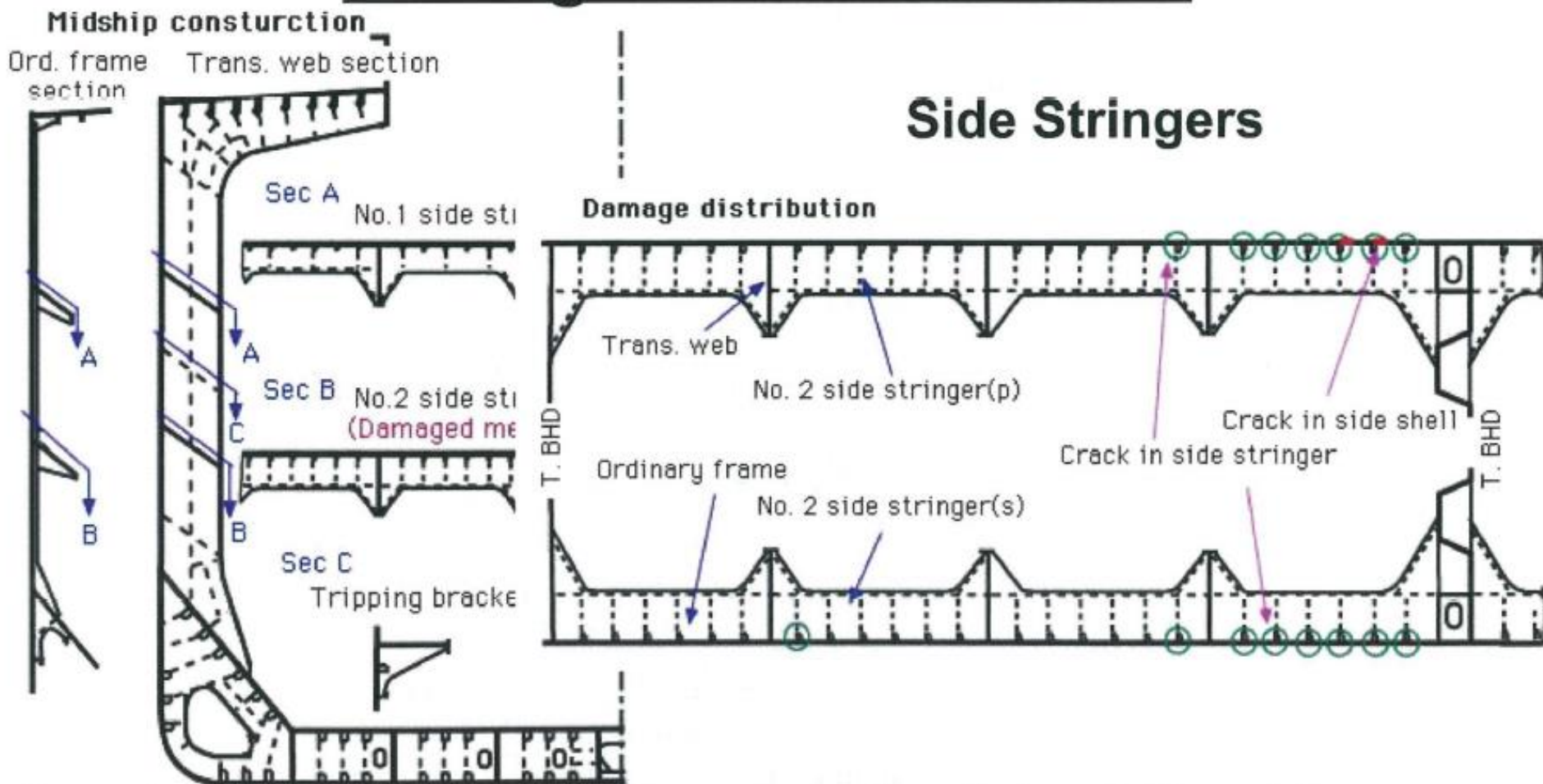
Special attention should be given to water tight door openings in bulkhead due to racking deformation from rolling

-Survey Check Points



CHIP CARRIERS

~ Cargo/Ballast Hold ~



Special attention should be given to slots of the side stringers where they penetrate the hold frame.

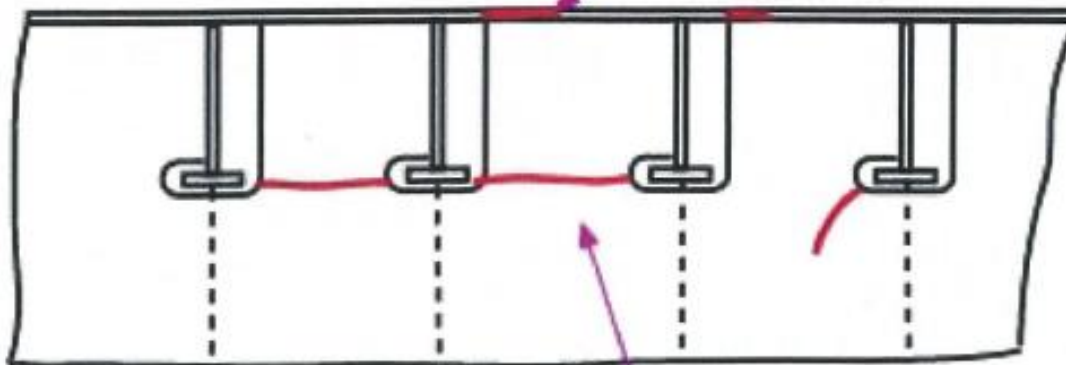
~ Cargo/Ballast Hold ~

Cracks around the slot of side stringer

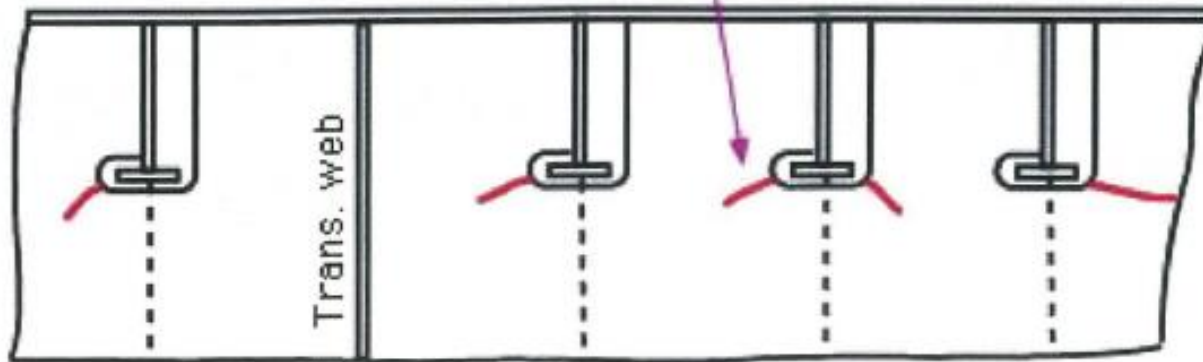
Example of crack on port side

Crack in side shell

$L = 400 \text{ mm}$

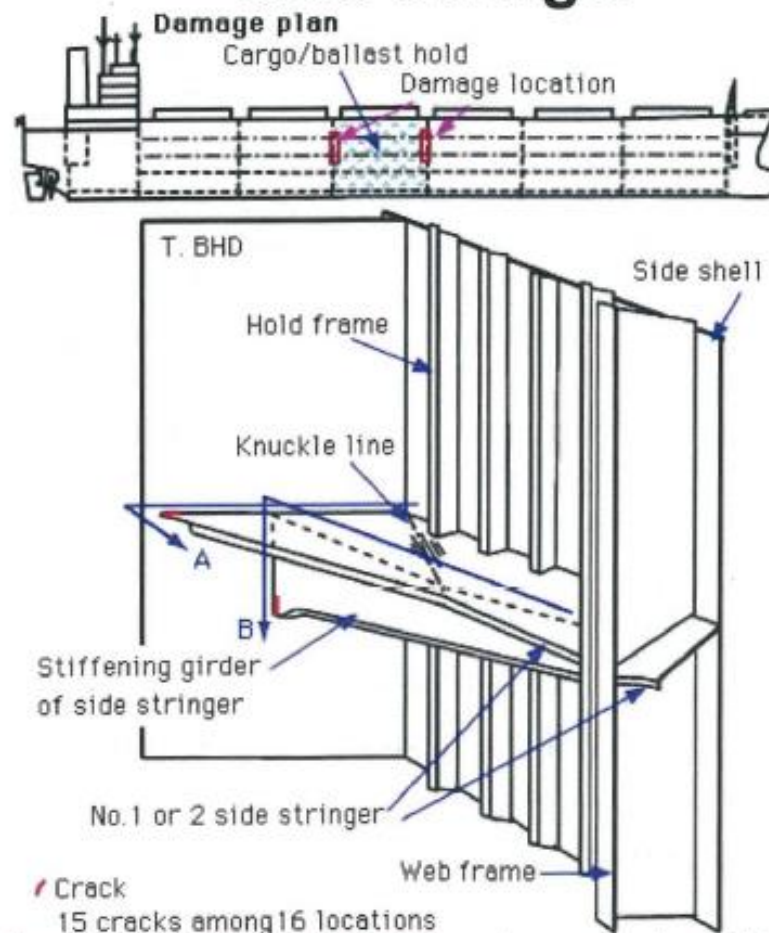


Crack in side stringer



~ Cargo/Ballast Hold ~

Side Stringer



Special attention should be given to the connection between the side stringer and T.BHD.

-Survey Check Points

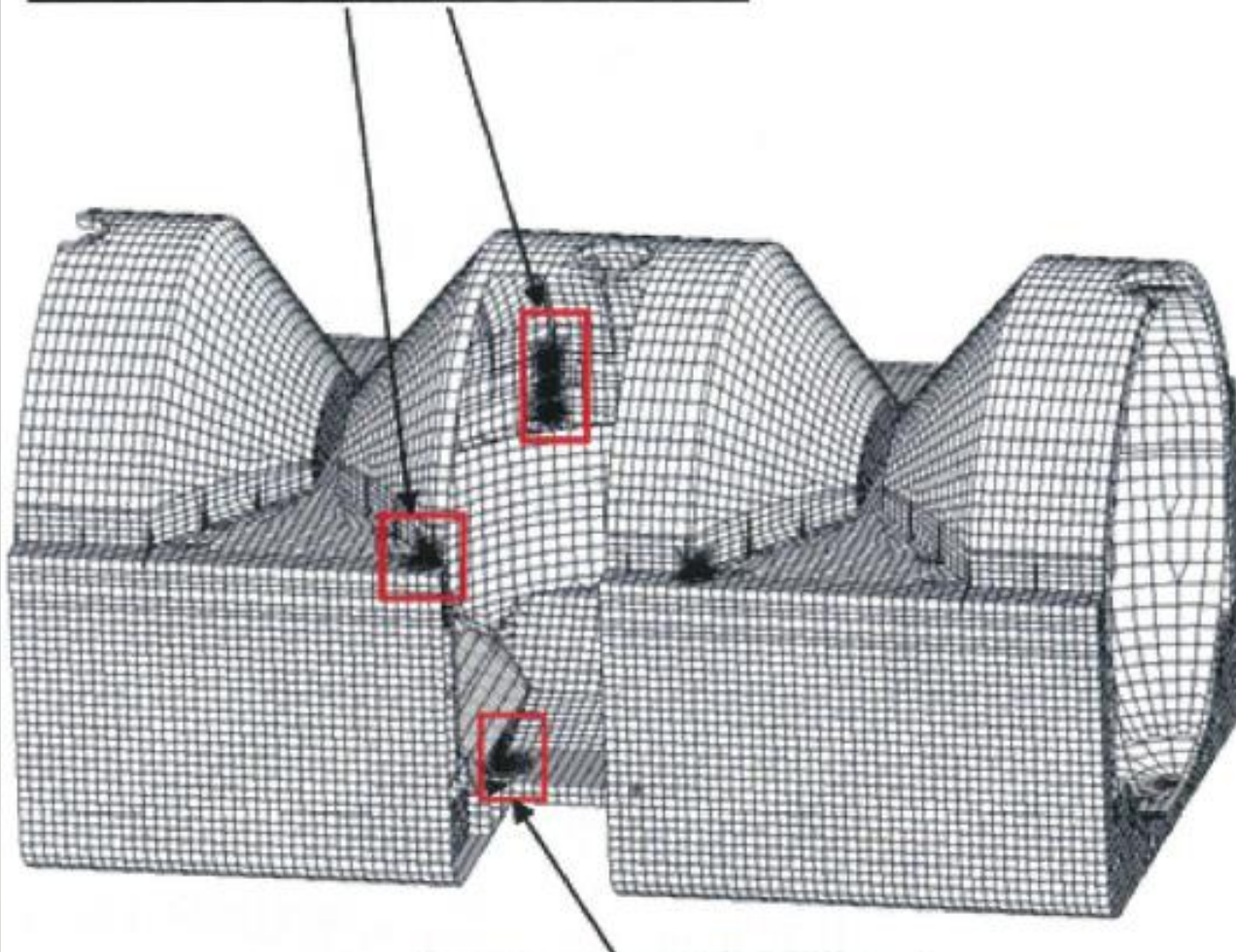


LNG TANKER



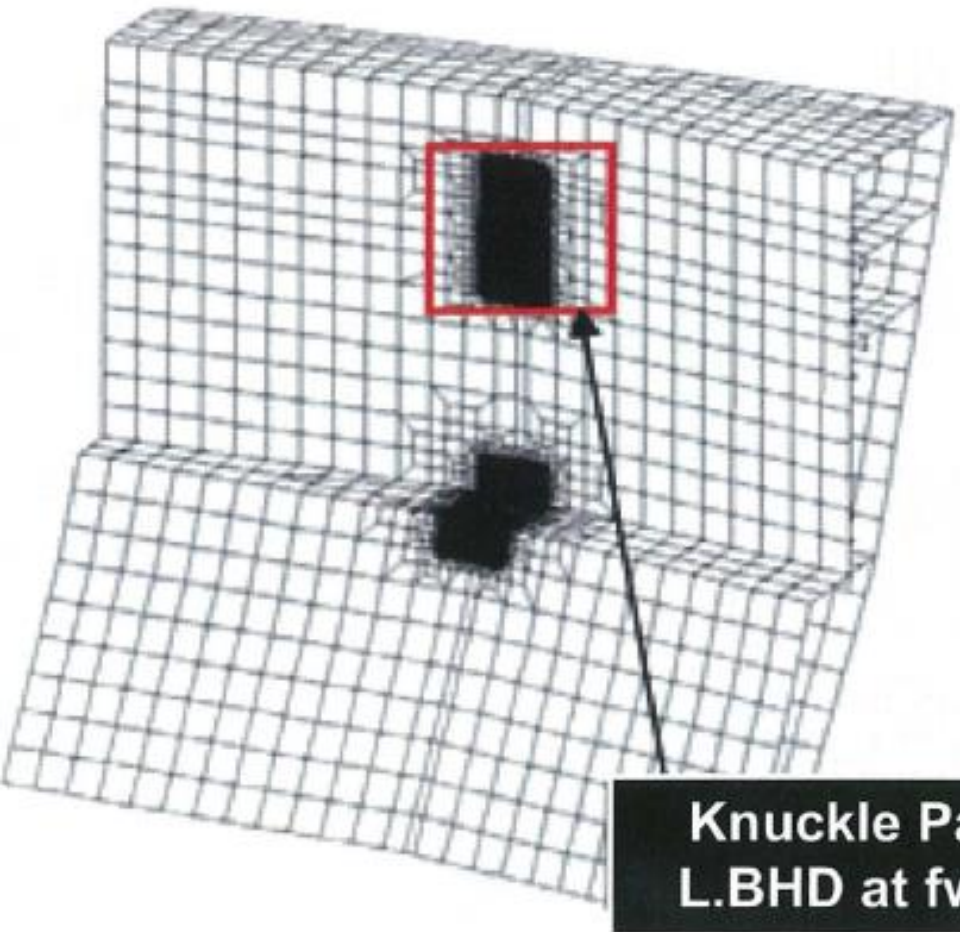
-Survey Check Points: LNG Tanker

Lower End of Tank Cover

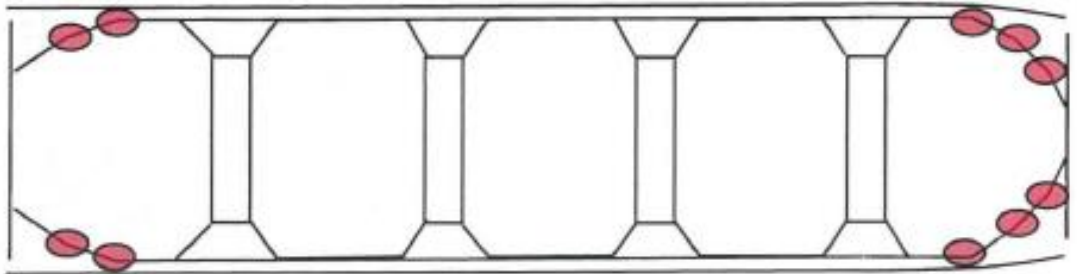


End of Center Girder

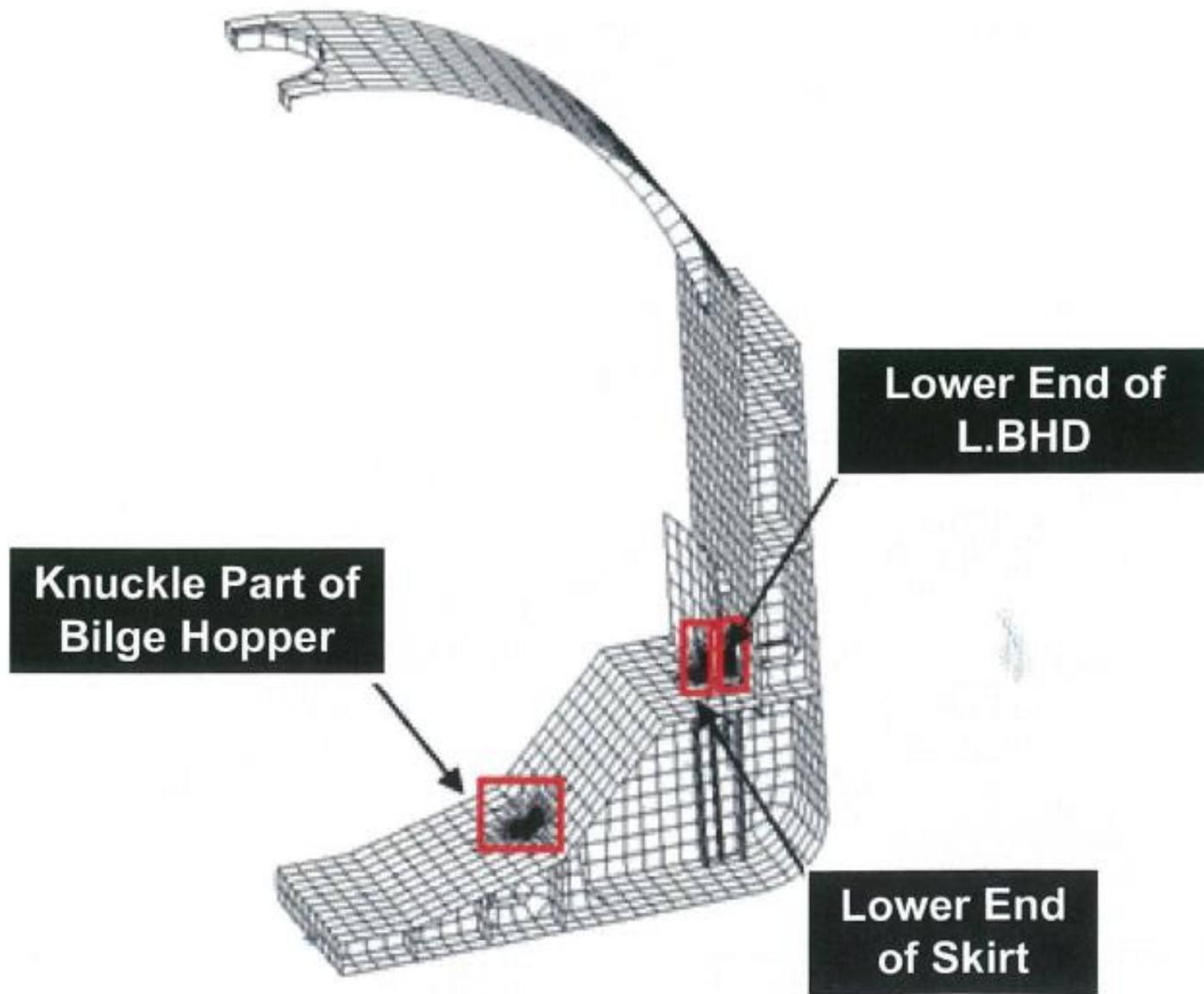
-Survey Check Points: LNG Tanker



Knuckle Part of L.BHD at fwd/aft



-Survey Check Points: LNG Tanker





5. Repair Guidance



General Cargo Ship Example of Upper Deck Regions

Sketch of damage

Sketch of repair

(example)

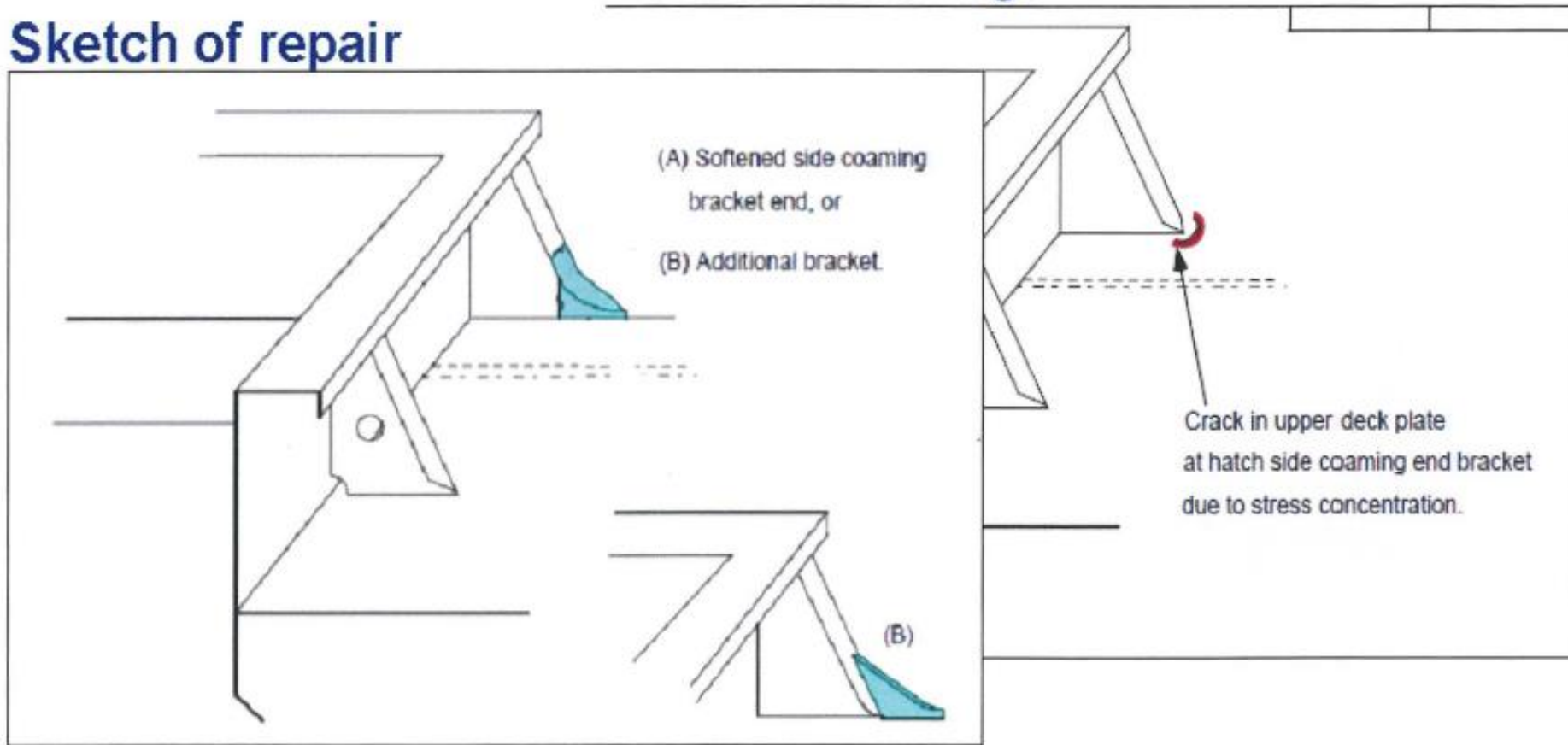
Web plate of coaming end bracket / coaming stay partly renewed

Heavy corrosion and tear in hatch side coaming bracket / hatch end coaming stay

General Cargo Ship Upper Deck Regions

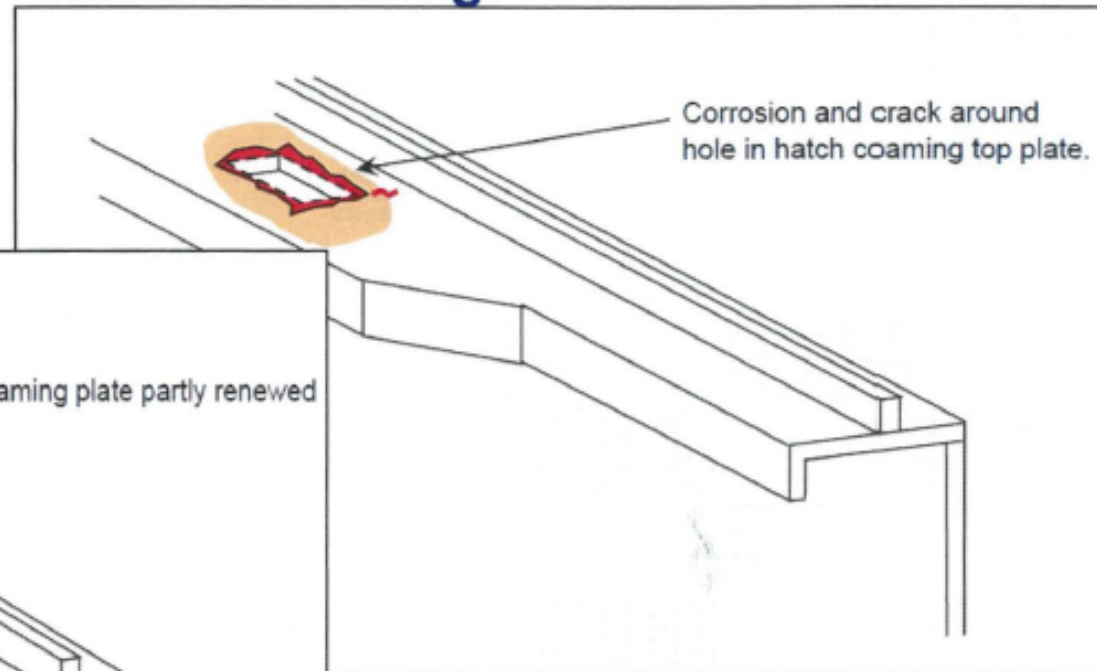
Sketch of damage

Sketch of repair

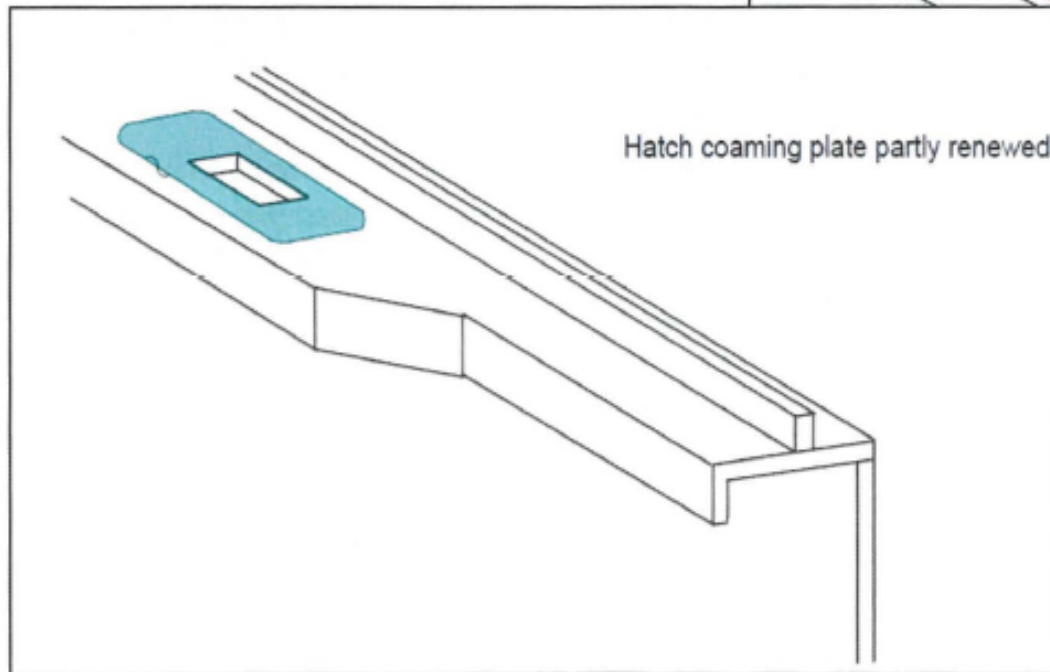


General Cargo Ship Upper Deck Regions

Sketch of damage



Sketch of repair

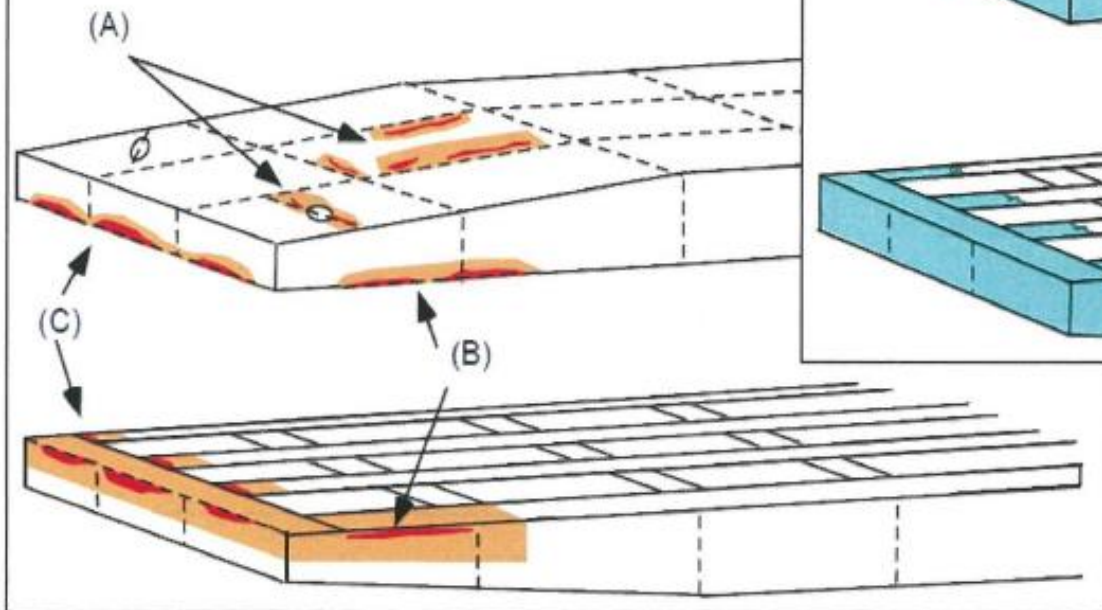


General Cargo Ship Upper Deck Regions

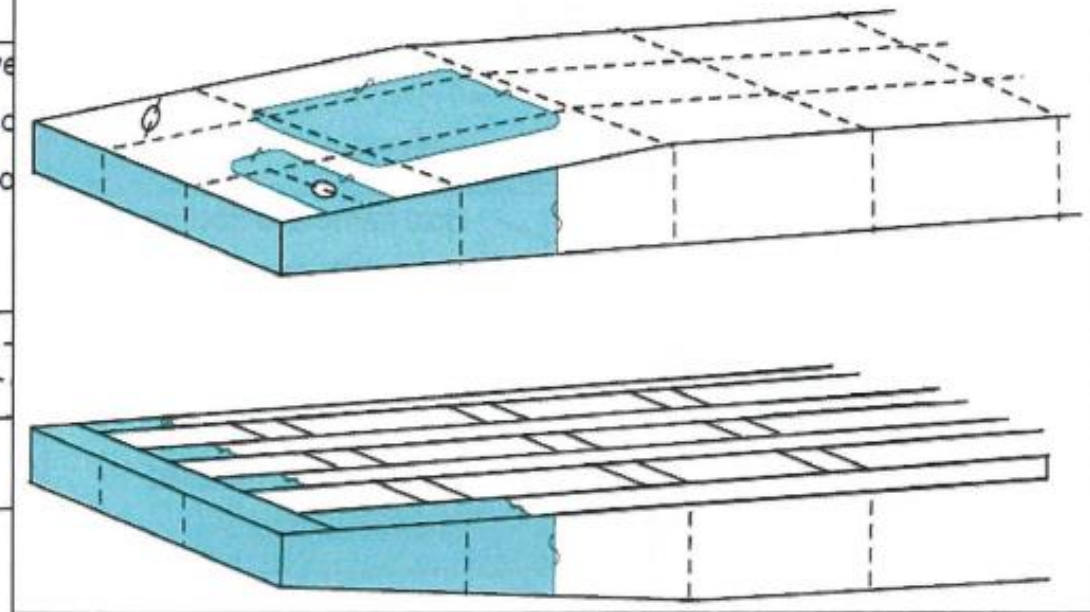
Sketch of repair

Sketch of damages

- (A) Corrosion and hole in top plate of pontoon hatch cover
- (B) Corrosion and hole in side plate / web plate of pontoon
- (C) Corrosion and hole in end plate / end face plate of pontoon



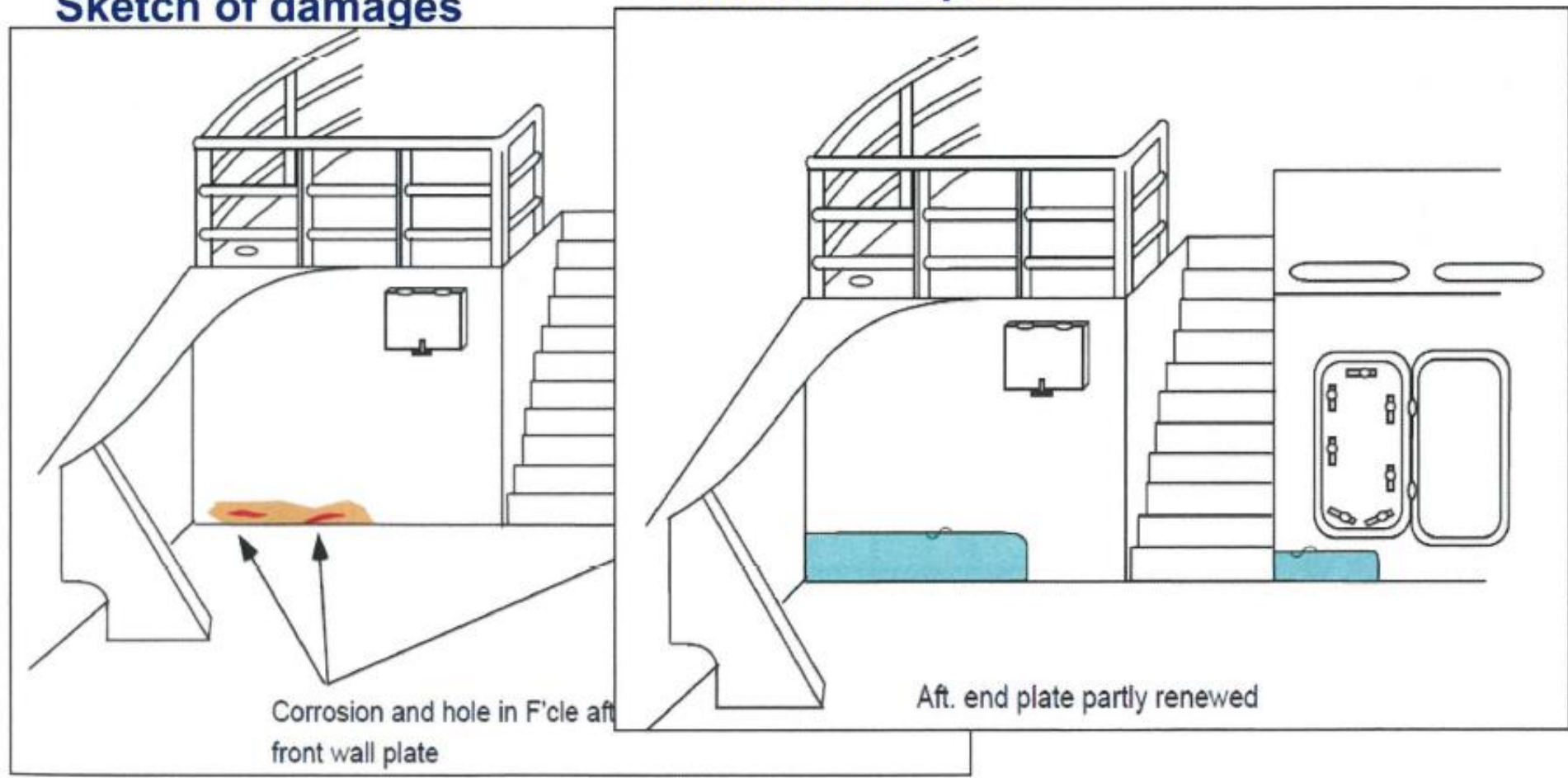
Holed / heavy corroded parts partly renewed



General Cargo Ship Upper Deck Regions

Sketch of damages

Sketch of repair

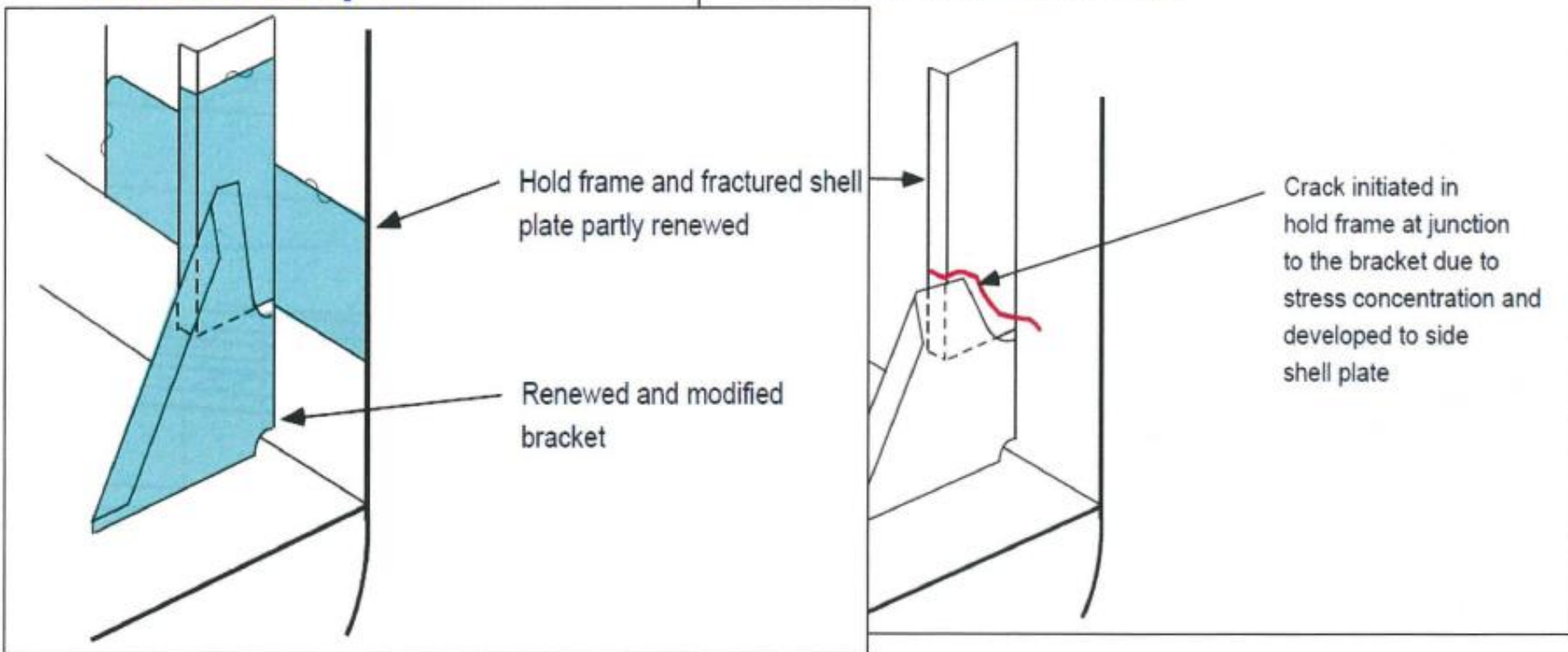


General Cargo Ship Cargo Hold Regions

Sketch of damage

Crack in shell plate resulted from fracture of hold frame at the connection of lower bracket.

Sketch of repair

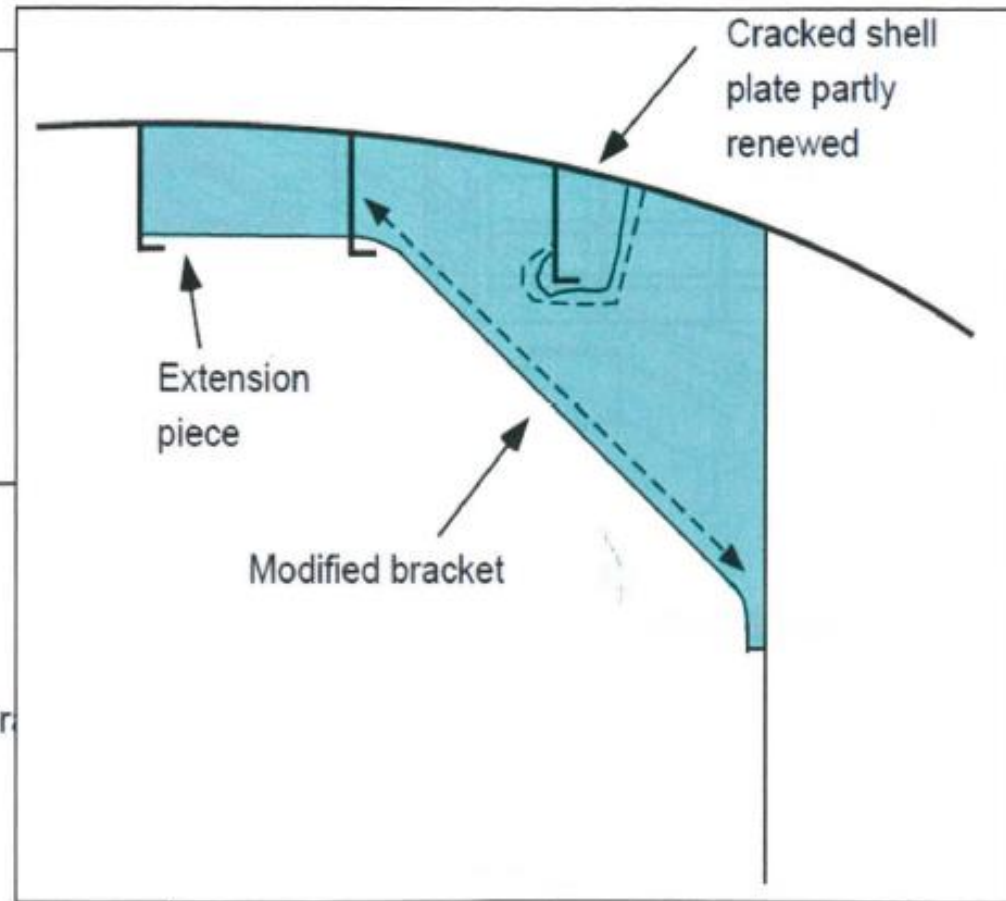
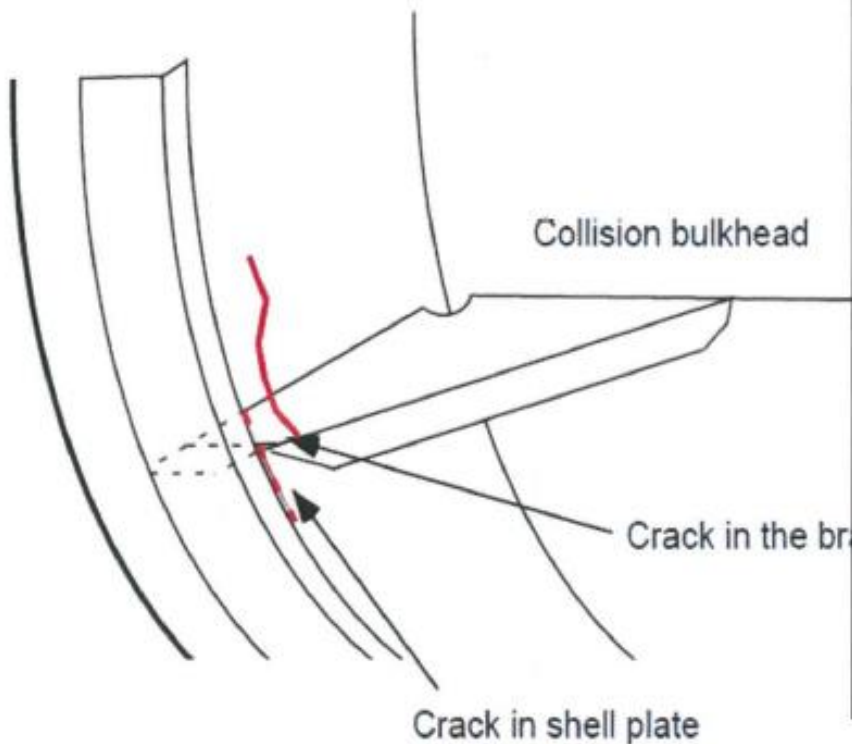


General Cargo Ship Cargo Hold Regions

Sketch of repair

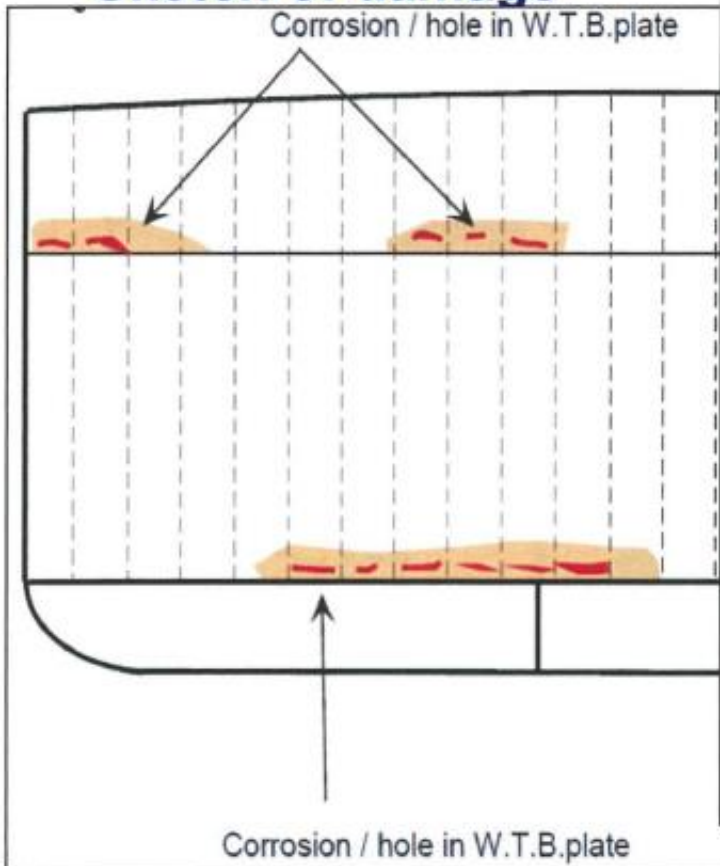
Sketch of damage

Crack in shell plate resulted from crack in balancing bracket on the collision bulkhead.

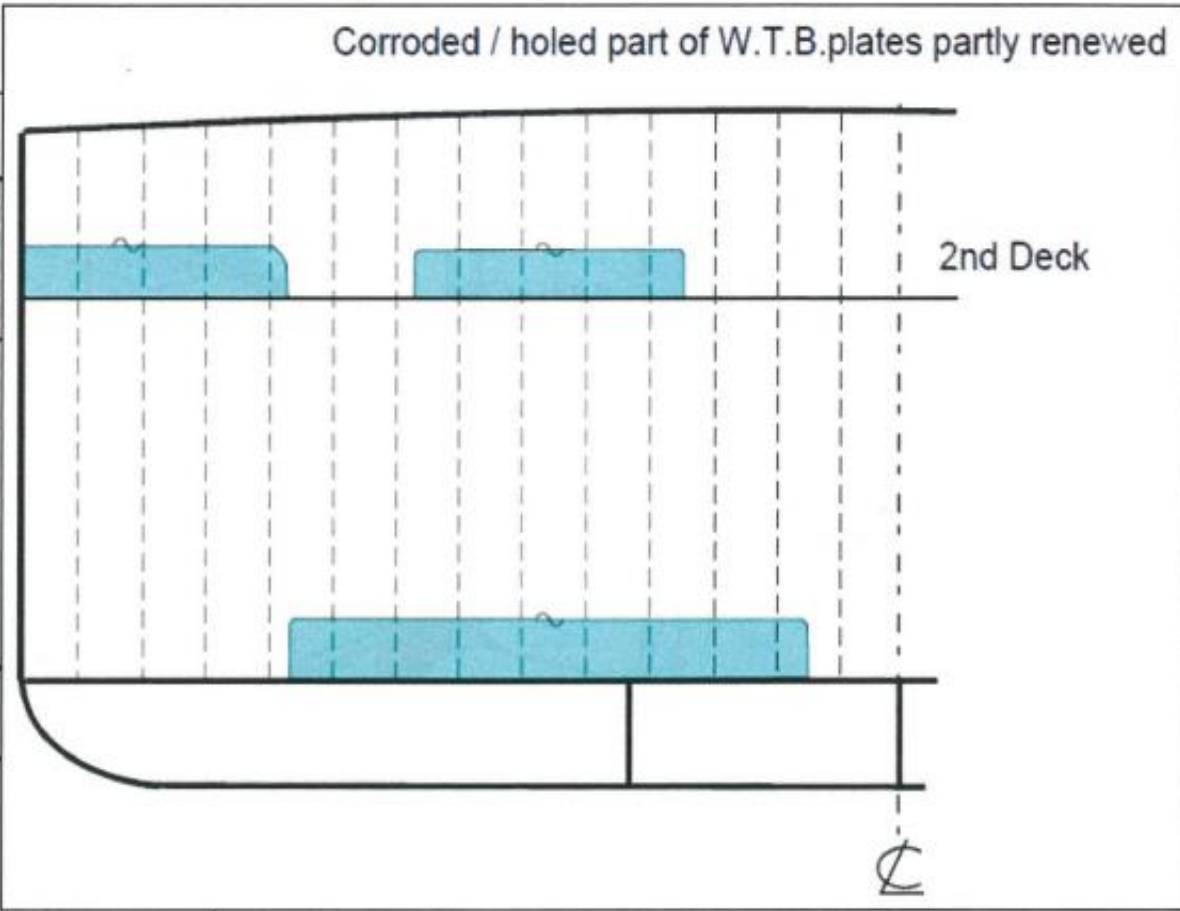


General Cargo Ship Cargo Hold Regions Sketch of repair

Sketch of damage

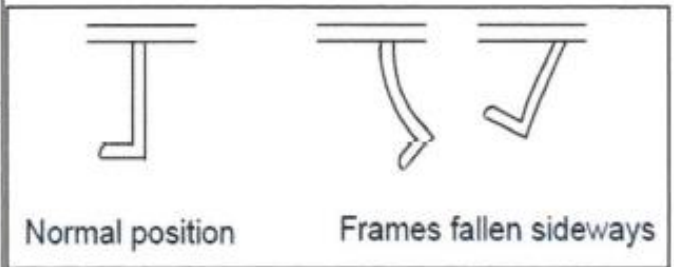
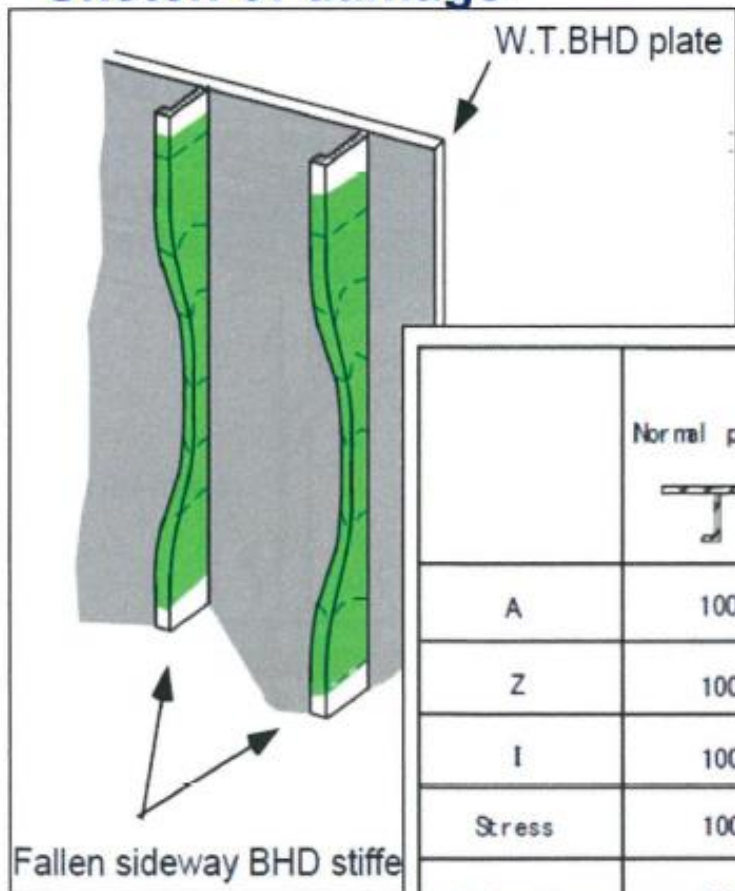


Corroded / holed part of W.T.B. plates partly renewed

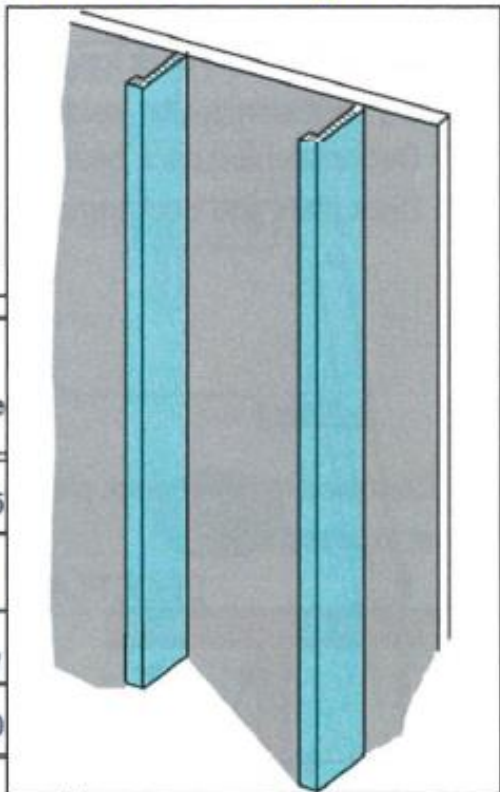


General Cargo Ship Cargo Hold Regions

Sketch of damage



Sketch of repair



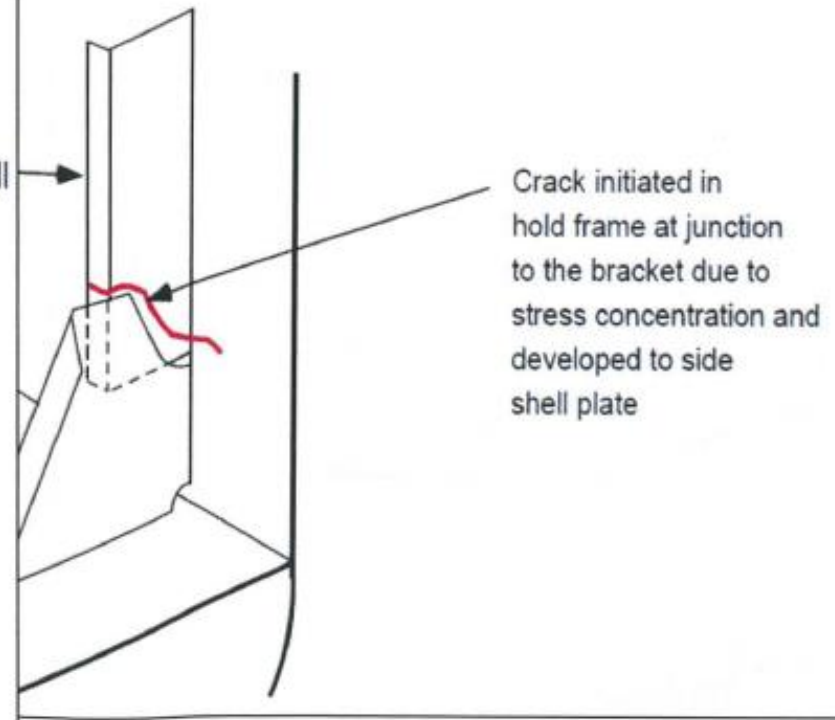
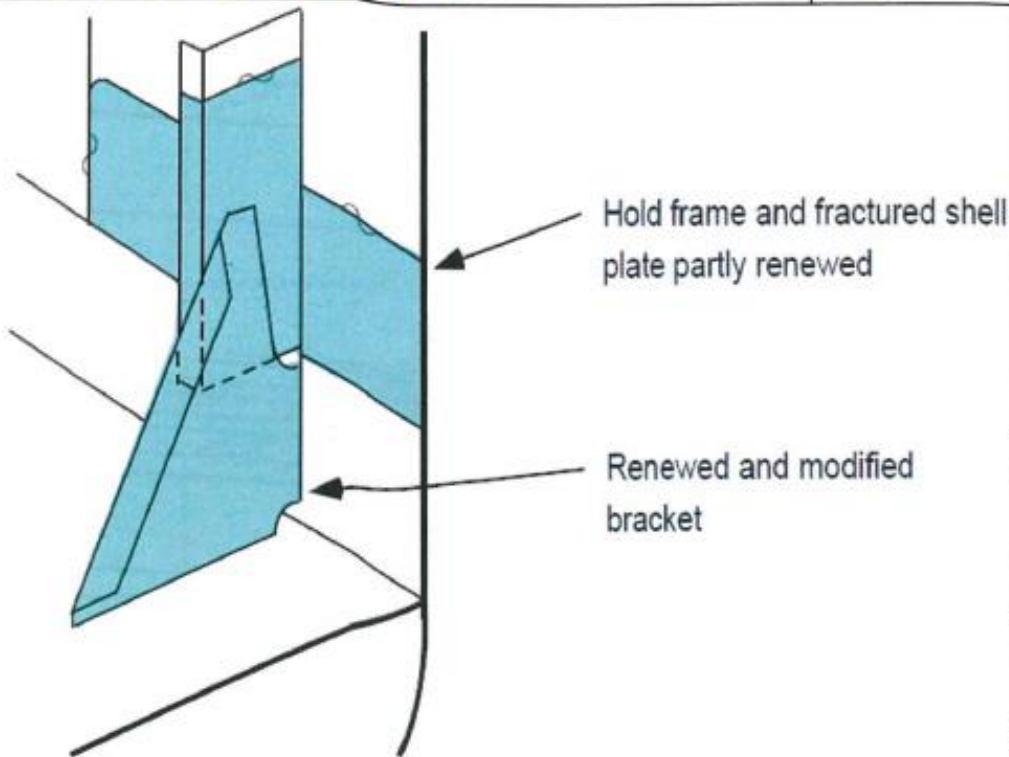
	Normal position	15 degrees	30 degrees	45 degree
A	100	100	100	100
Z	100	92.6	66.1	57.7
I	100	89.7	58.1	42.0
Stress	100	108	151	174
Deflection	100	111.4	170.0	238.0

General Cargo Ship Cargo Hold Regions

Sketch of damage

Crack in shell plate resulted from fracture of hold frame at the connection of lower bracket.

Sketch of repair

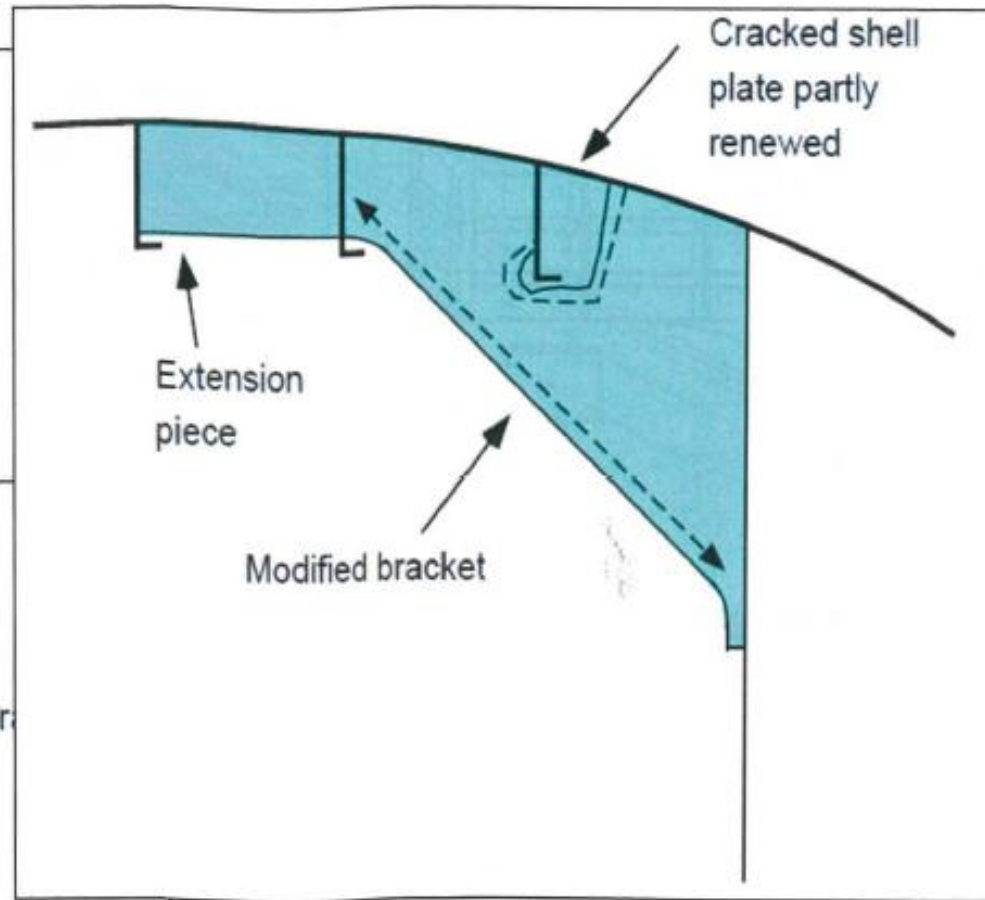
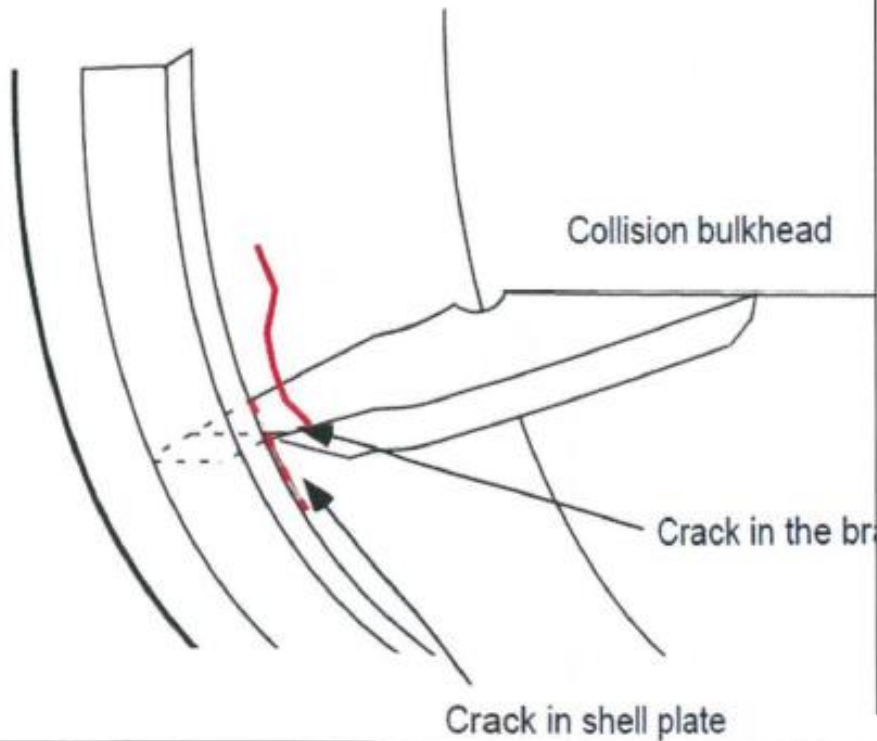


General Cargo Ship Cargo Hold Regions

Sketch of repair

Sketch of damage

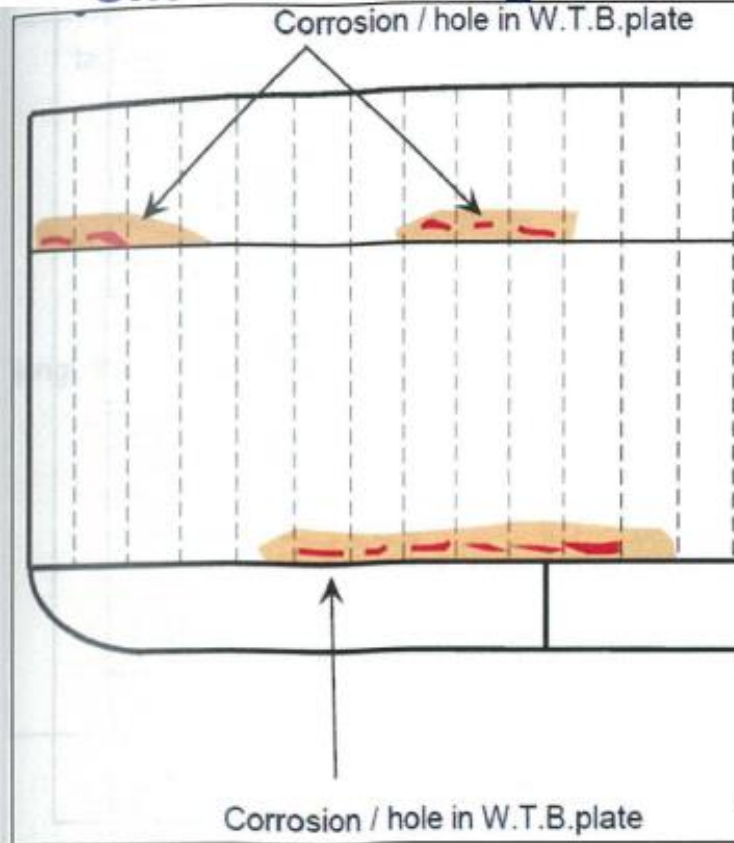
Crack in shell plate resulted from crack in balancing bracket on the collision bulkhead.



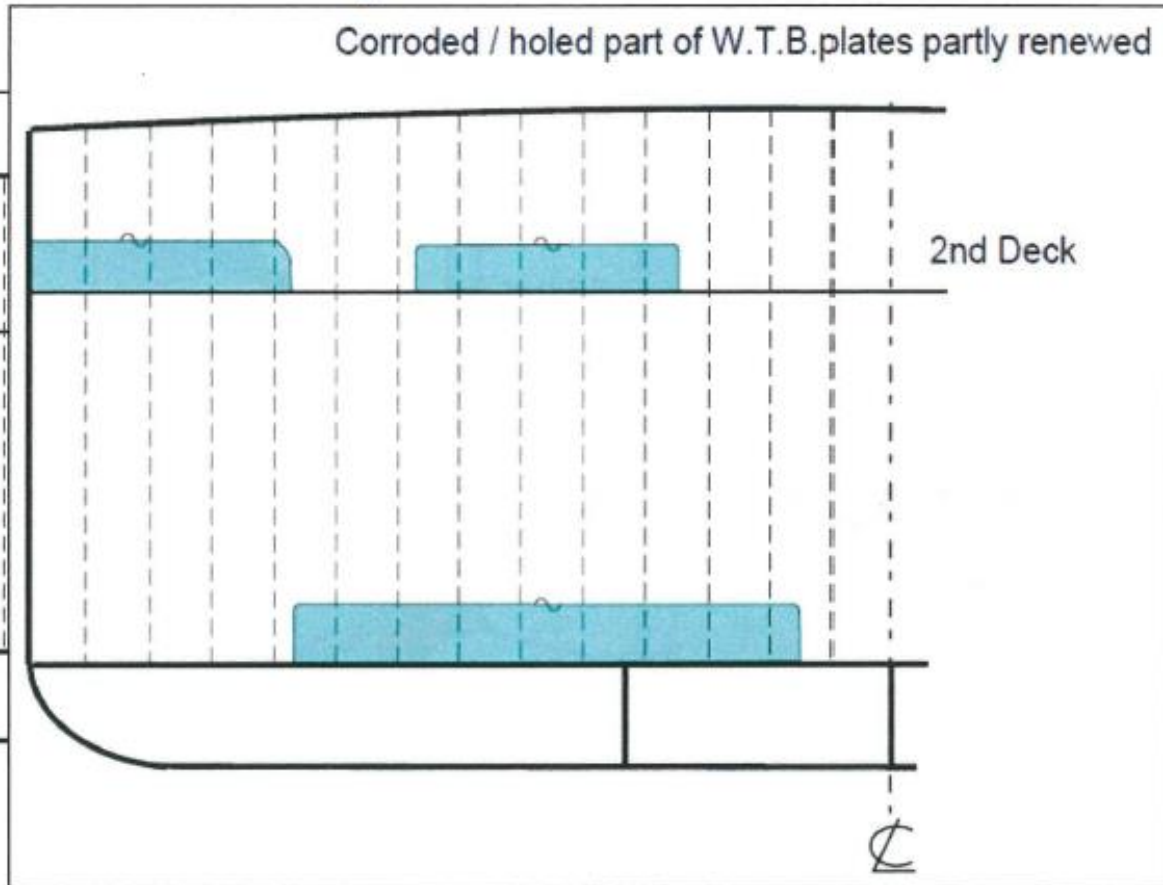
General Cargo Ship Cargo Hold Regions Sketch of repair

Sketch of damage

Corrosion / hole in W.T.B. plate

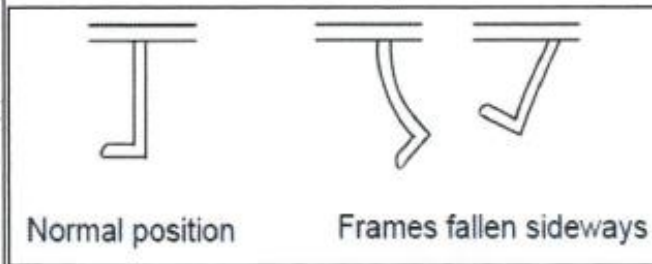
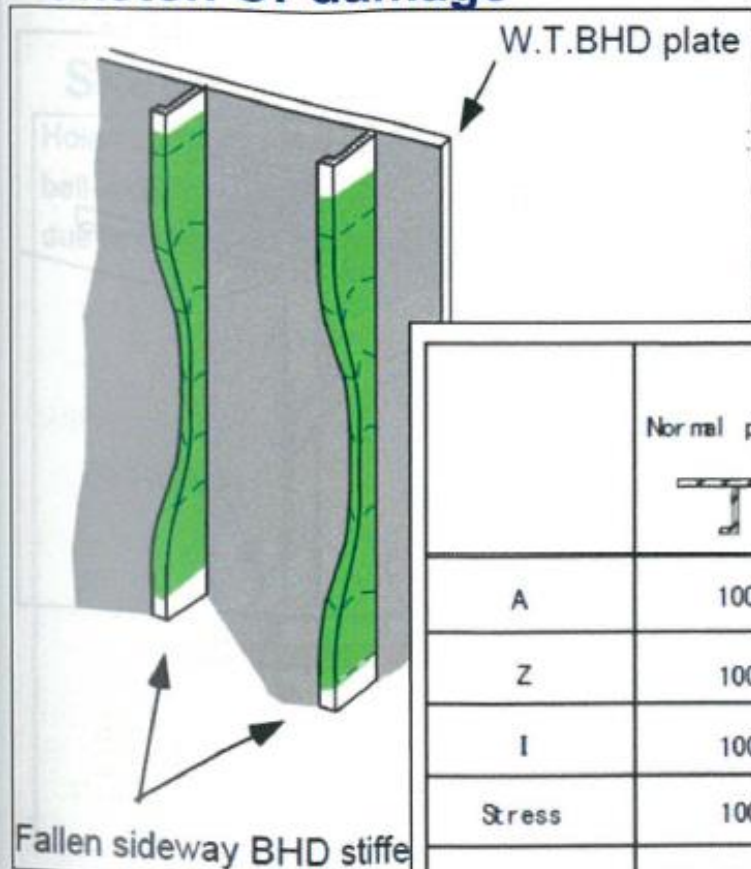


Corroded / holed part of W.T.B. plates partly renewed

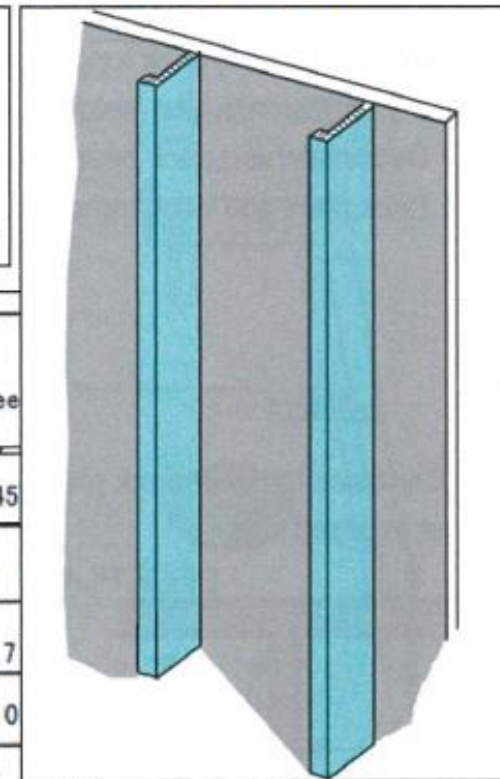


General Cargo Ship Cargo Hold Regions

Sketch of damage



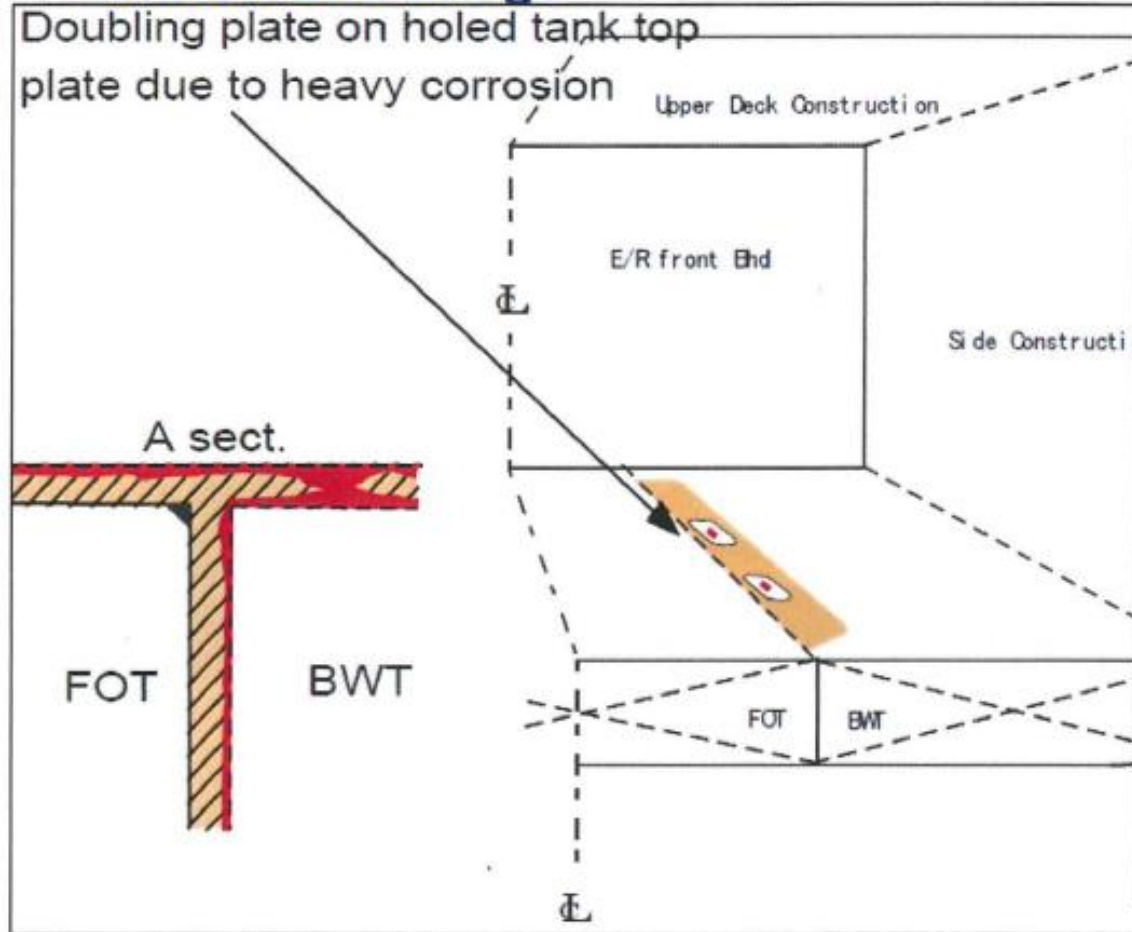
Sketch of repair



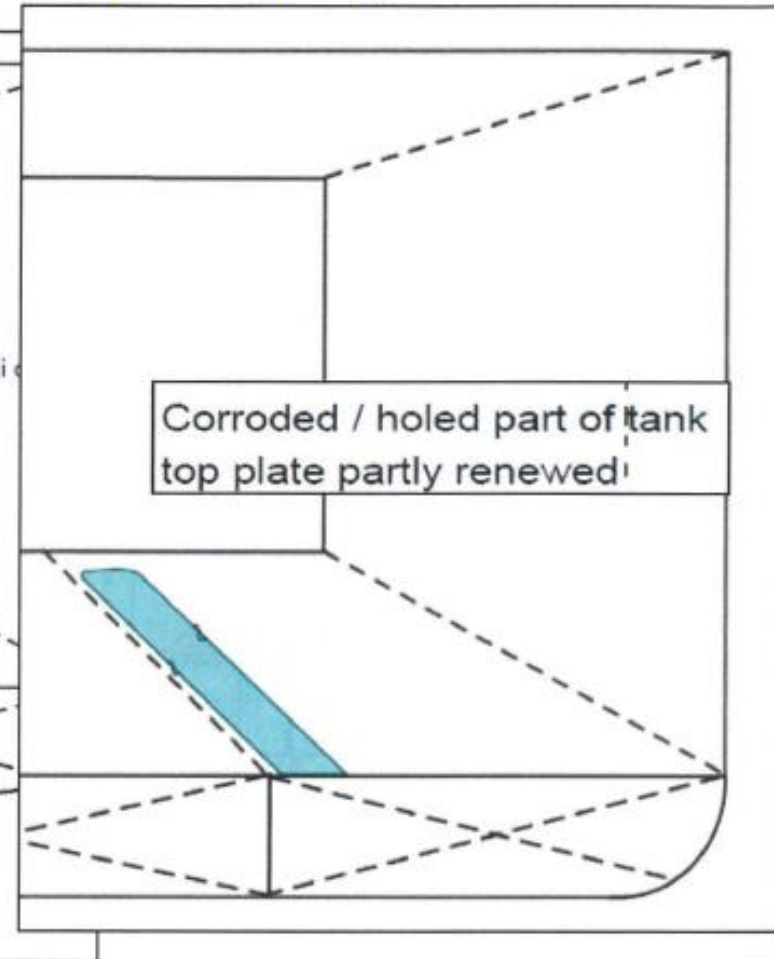
	Normal position	15 degrees	30 degrees	45 degree
A	100	100	100	100
Z	100	92.6	66.1	57.7
I	100	89.7	58.1	42.0
Stress	100	108	151	174
Deflection	100	111.4	170.0	238.0

General Cargo Ship Cargo Hold Regions

Sketch of damage



Sketch of repair

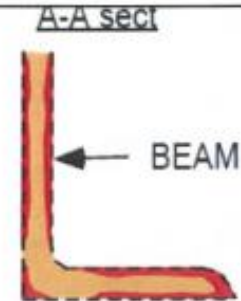
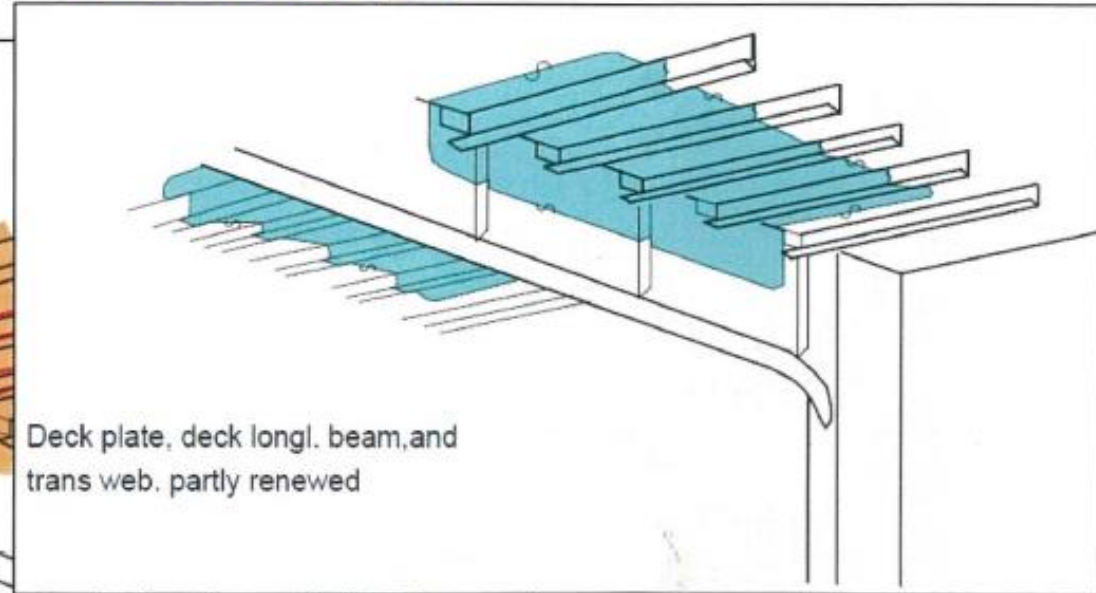
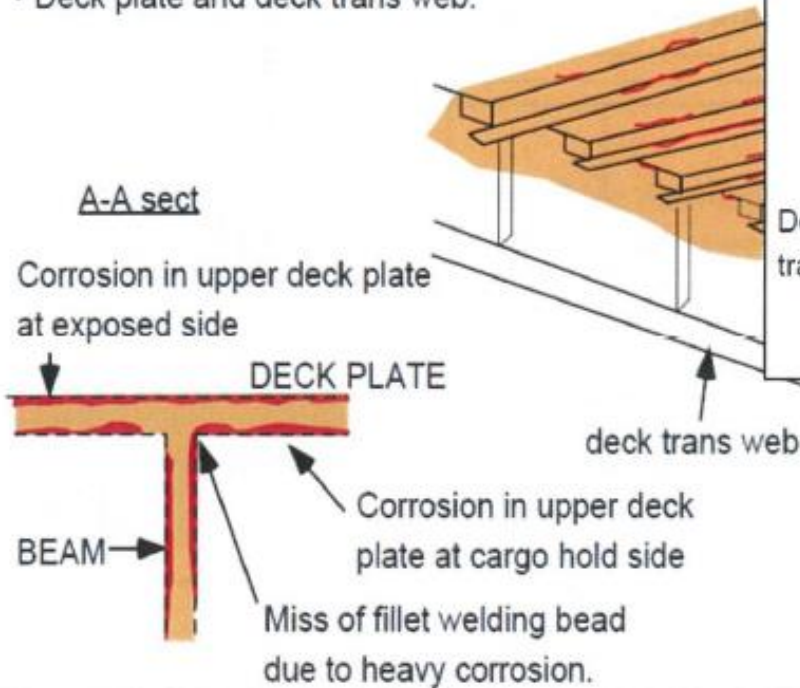


General Cargo Ship Cargo Hold Regions

Sketch of repair

Sketch of damage

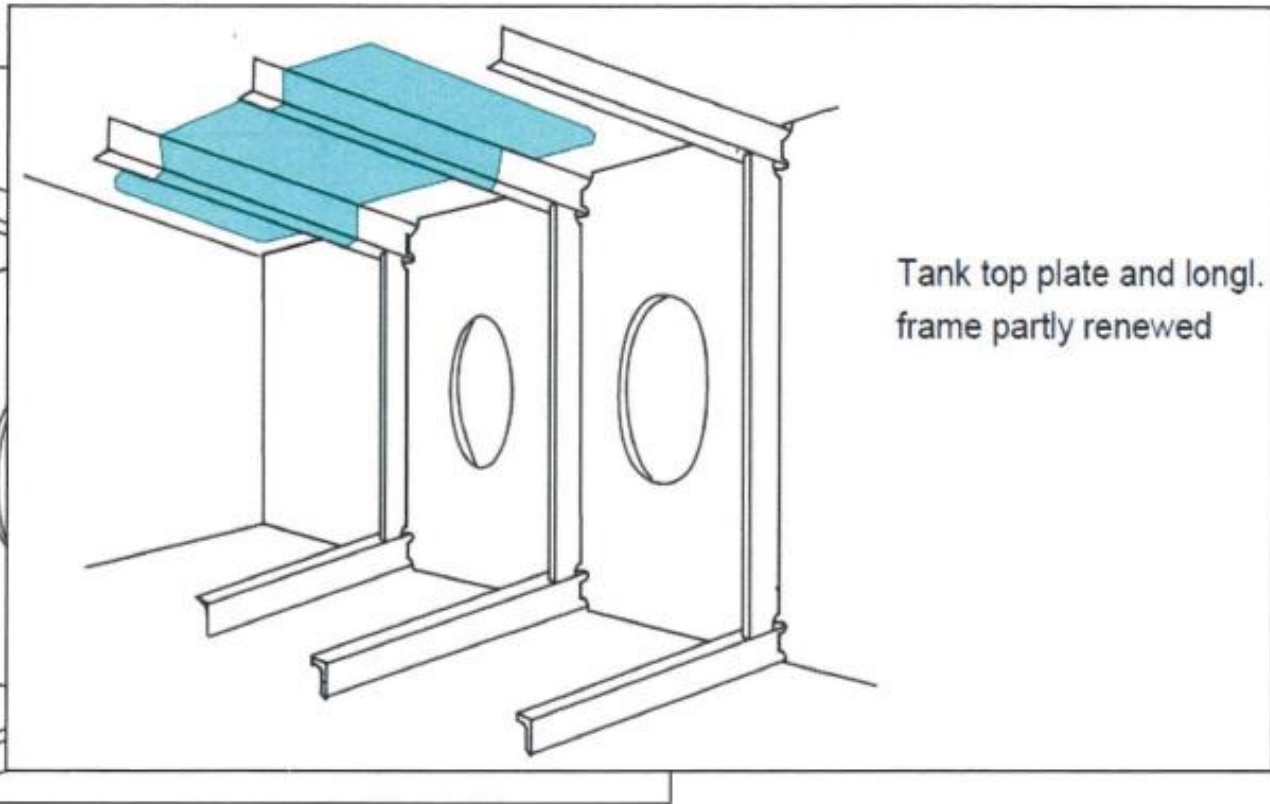
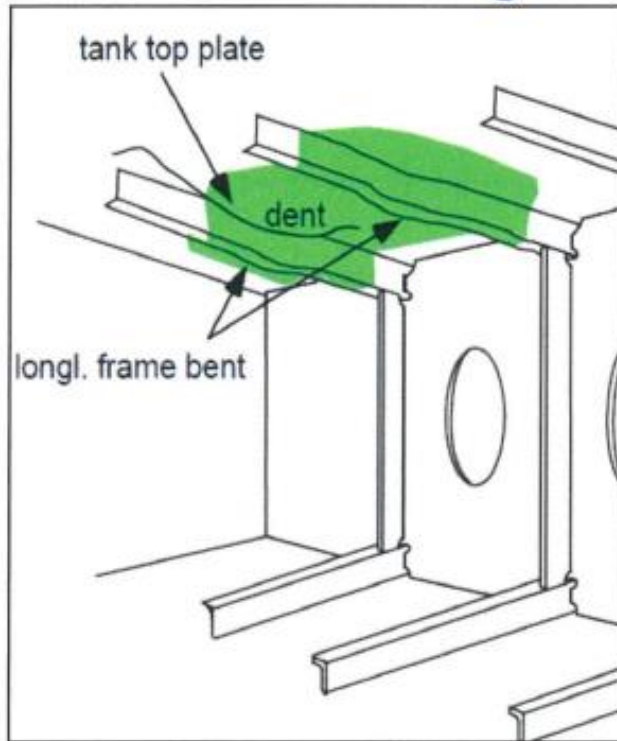
- ① Heavy corrosion in deck longl. beam
- ② Heavy corrosion in fillet welding bead between
 - Deck plate and deck beam, and
 - Deck plate and deck trans web.



General Cargo Ship D.Bottom Tank Regions

Sketch of repair

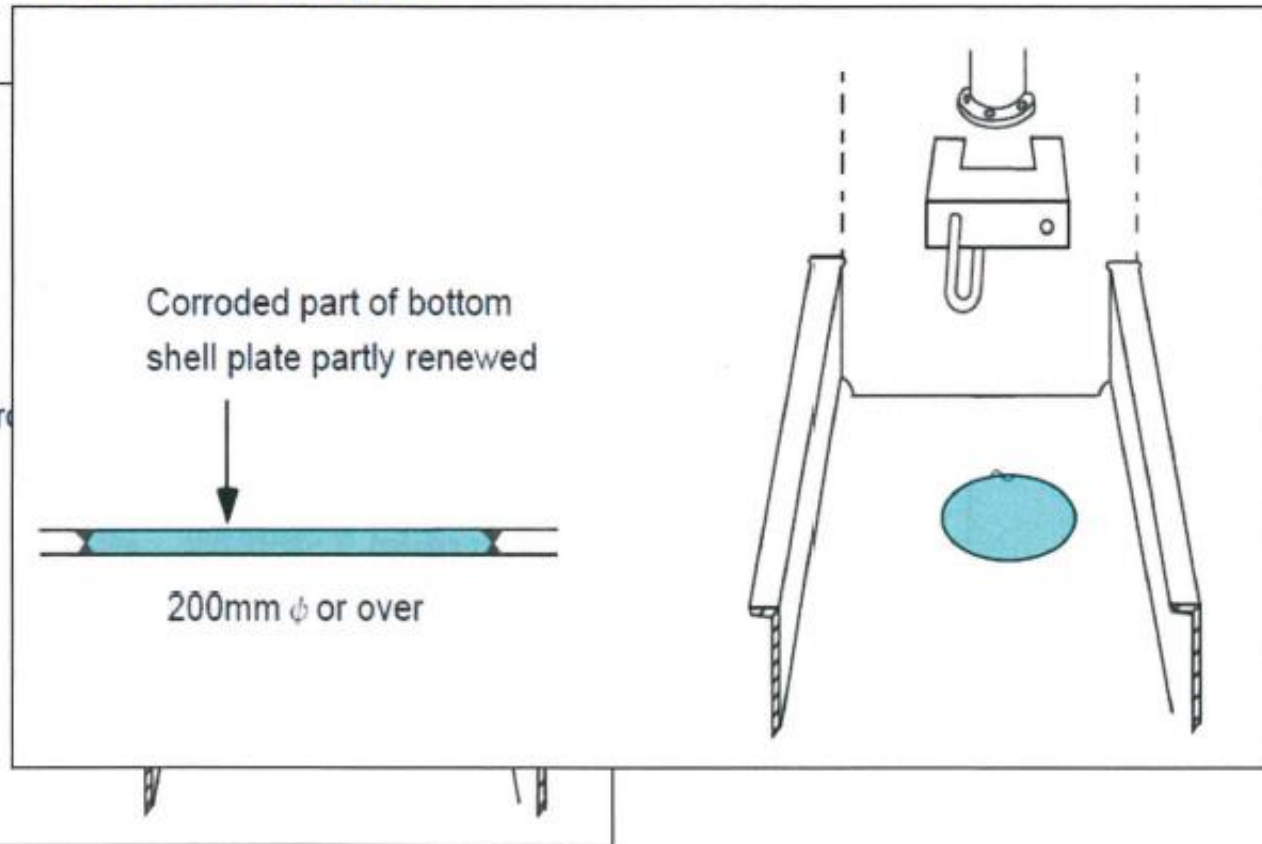
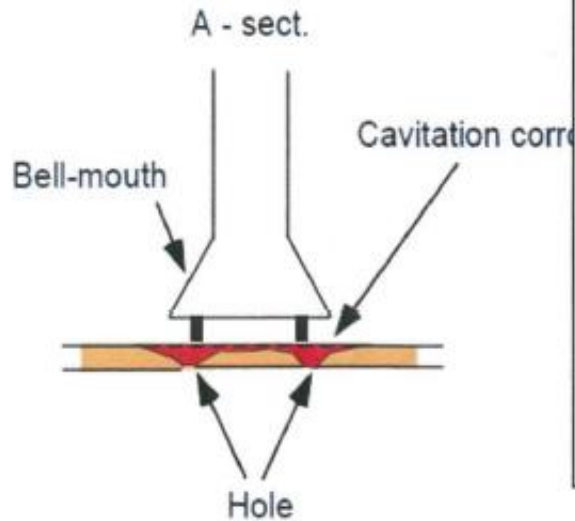
Sketch of damage



General Cargo Ship D.Bottom Tank Regions Sketch of repair

Sketch of damages

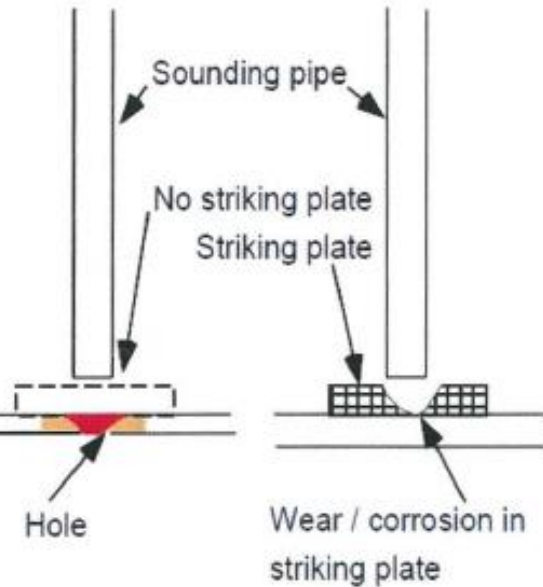
Hole in bottom shell plate around suction bell-mouth in water ballast tank due to cavitation corrosion.



General Cargo Ship D.Bottom Tank Regions Sketch of repair

Sketch of damage

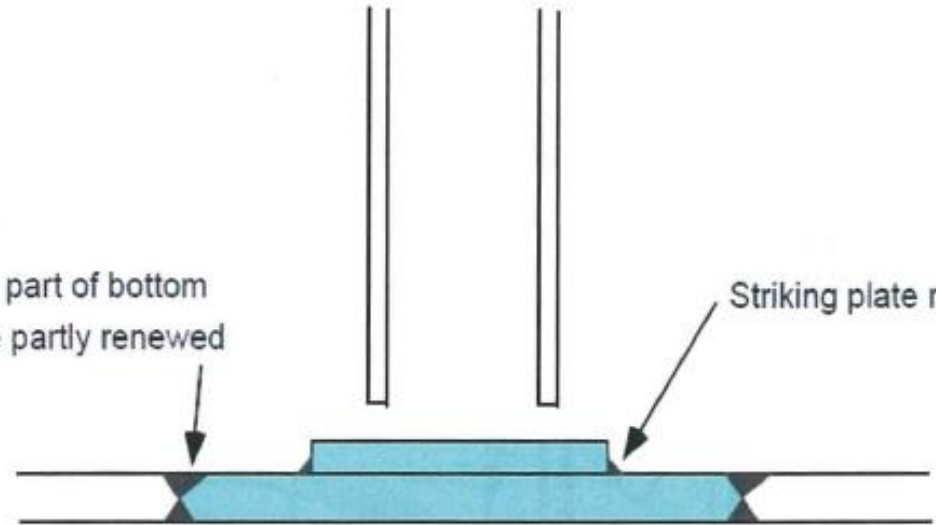
Holes in bottom shell plate underneath sounding pipe in water ballast tanks, bilge tanks and F.O.Tanks due to wear /wastage.



Note : Wear / corrosion in striking plate in FOT is due to sea water from sounding pipe.

Corrosion part of bottom shell plate partly renewed

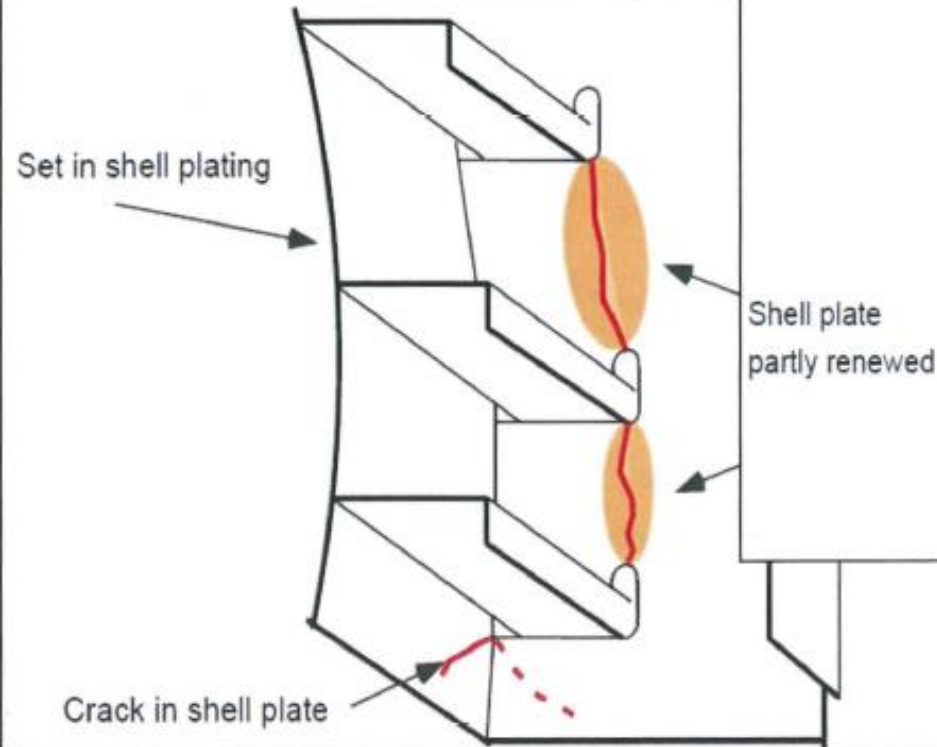
Striking plate renewed



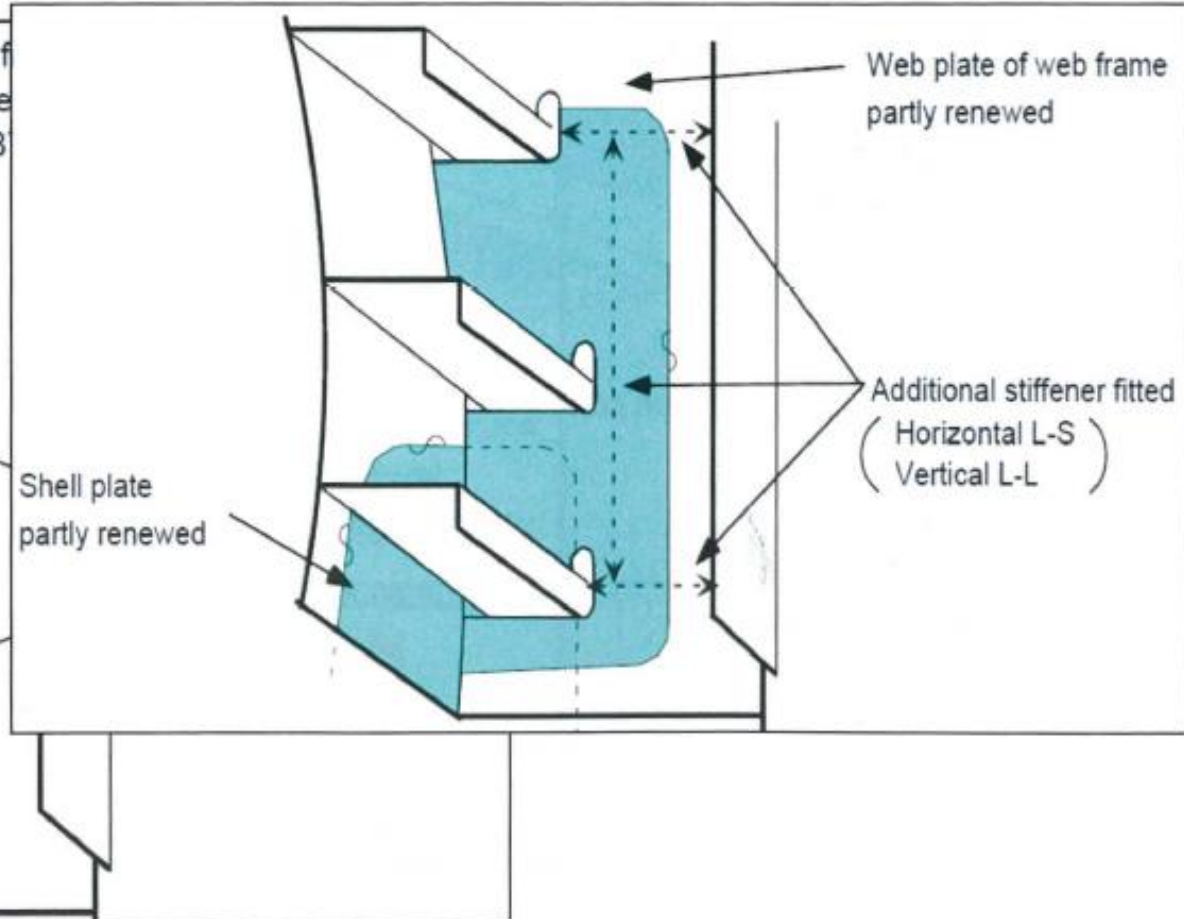
General Cargo Ship FPT Regions

Sketch of damage

Crack in side shell plate resulted in fracture of side transverse web and excessive corrosion in way of WB



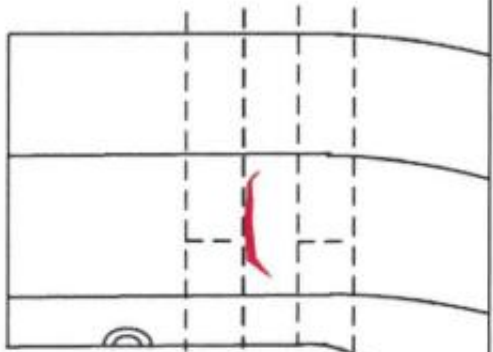
Sketch of repair



General Cargo Ship APT Regions

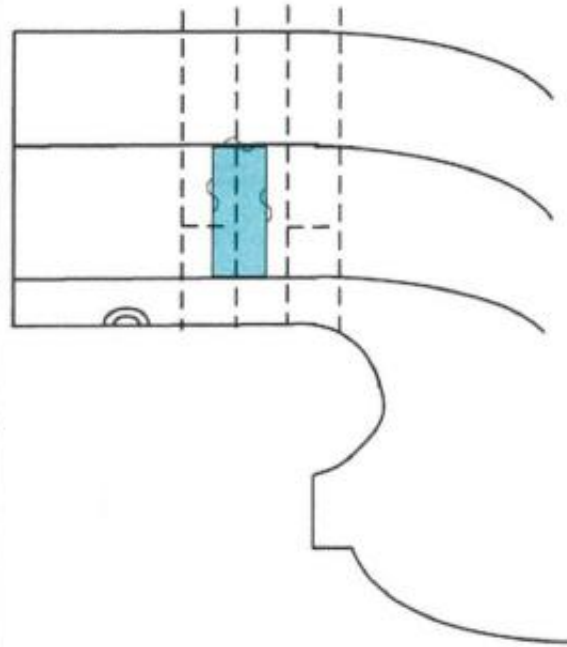
Sketch of damage

Crack in shell plate due to propeller excited vibration.

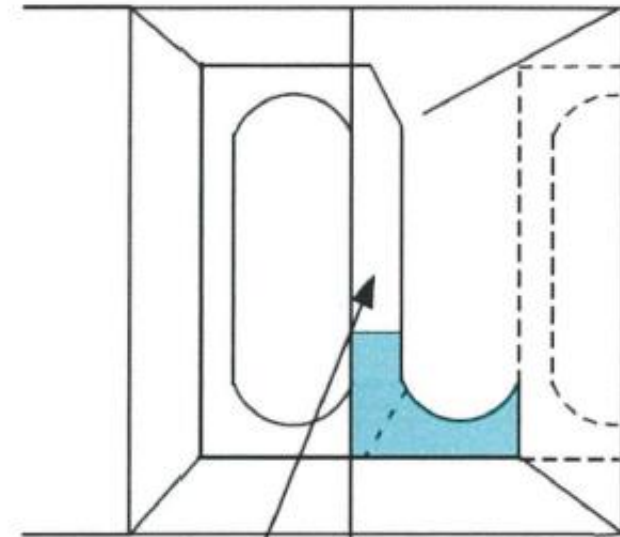


Sketch of repair

Crack in shell plate partly renewed



Modified shell stiffener fitted



Original stiffener

IACS

INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES LTD.

Guidelines for Surveys, Assessment and Repair of Hull Structures

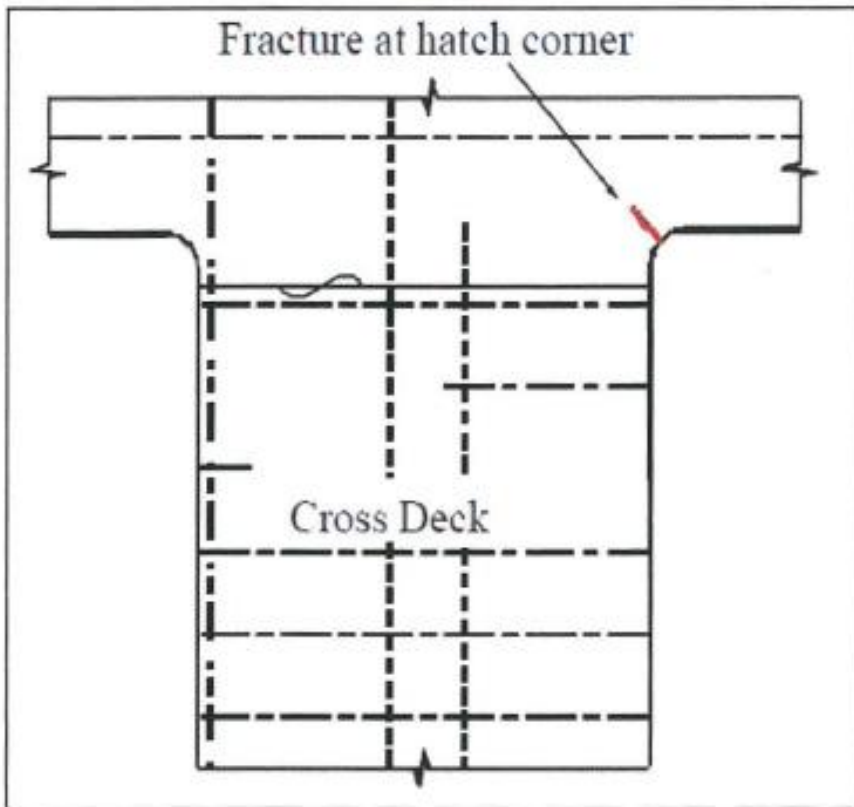


IACS Guidelines for Surveys, Assessment and Repair of Hull Structures Recommendation No.76 – Bulk Carriers

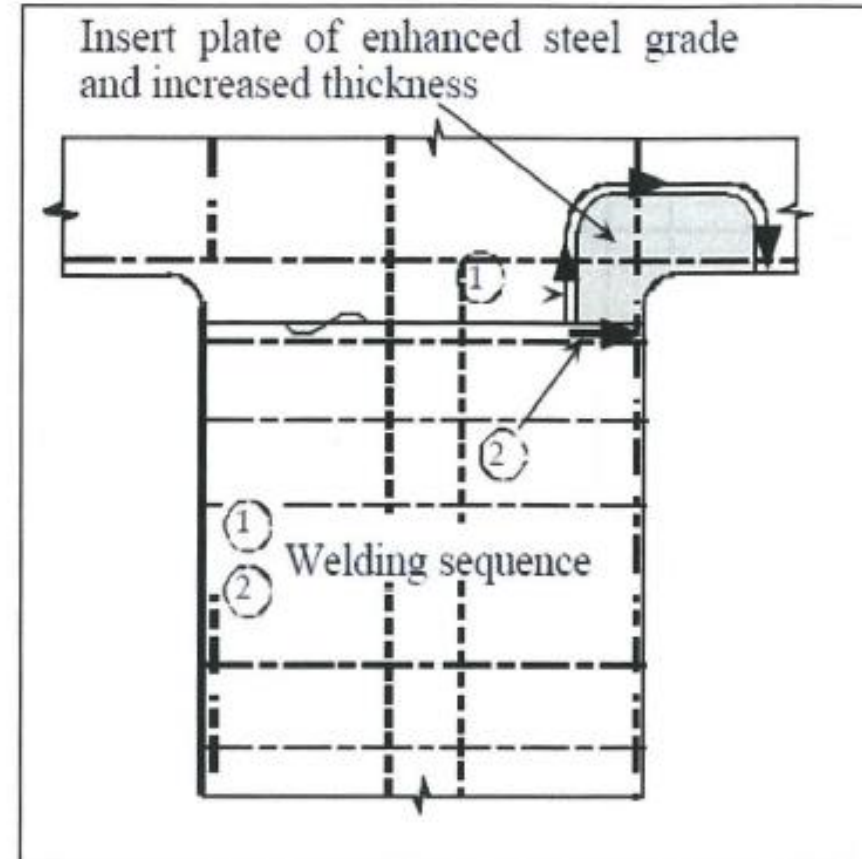


Deck Structure

Sketch of damage

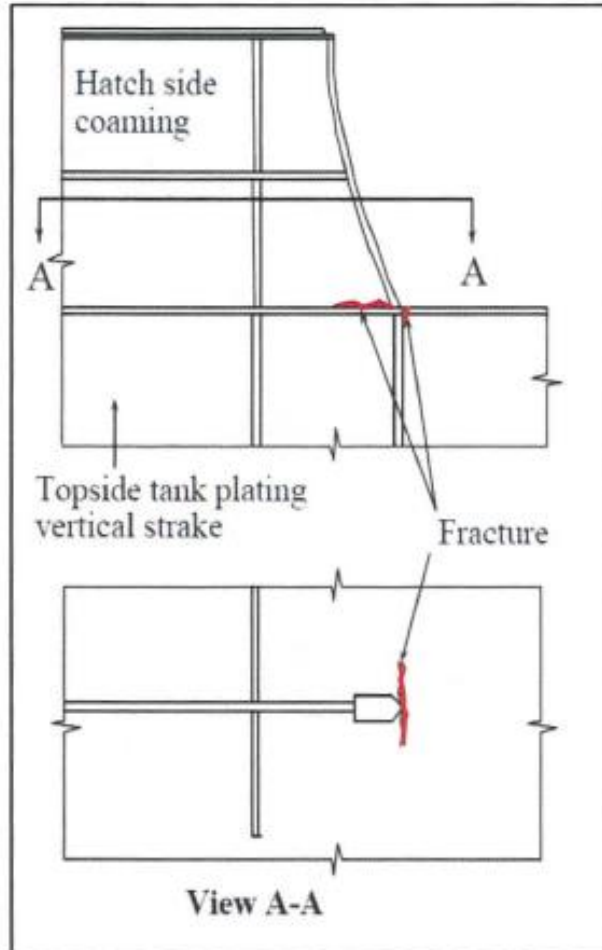


Sketch of repair

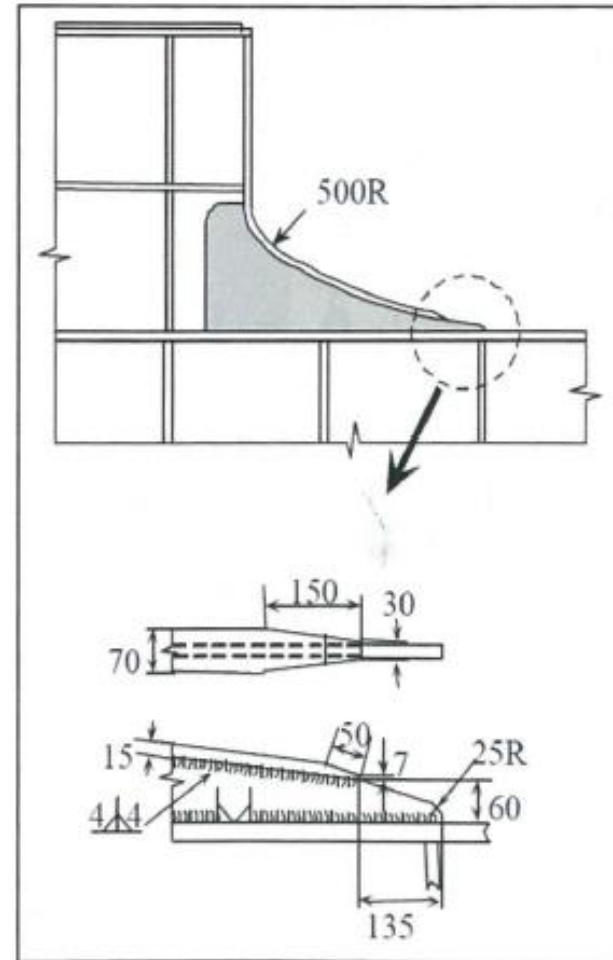


Deck Structure

Sketch of damage

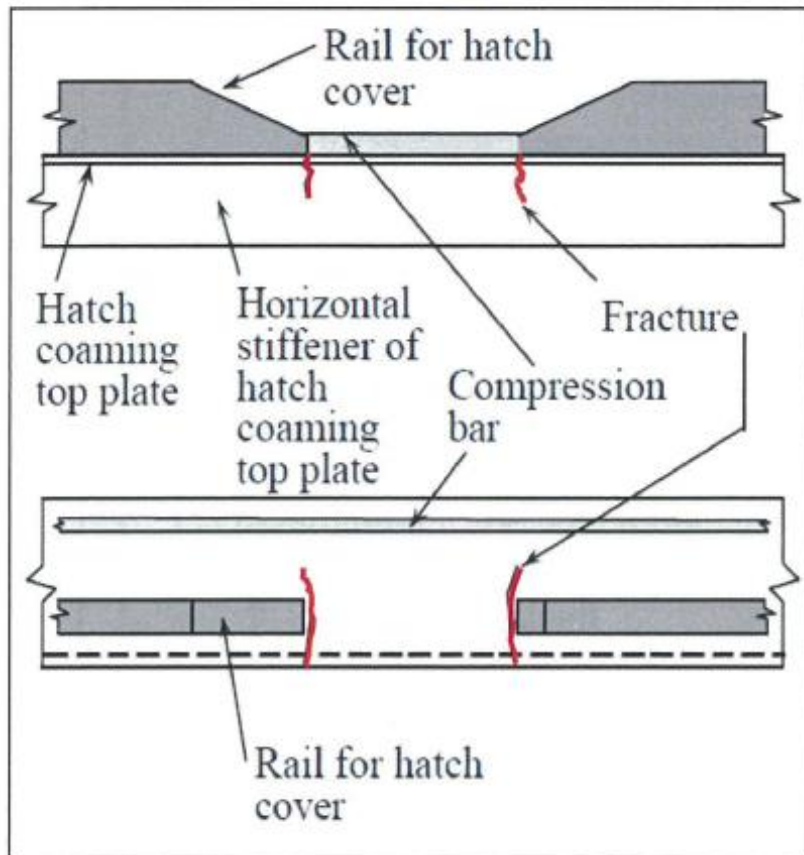


Sketch of repair

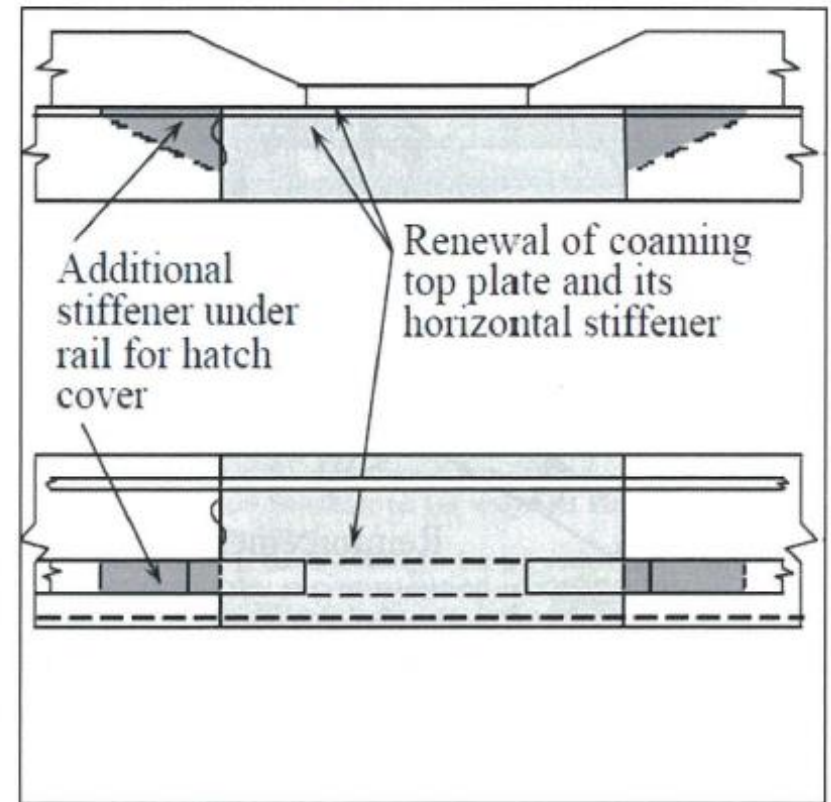


Deck Structure

Sketch of damage

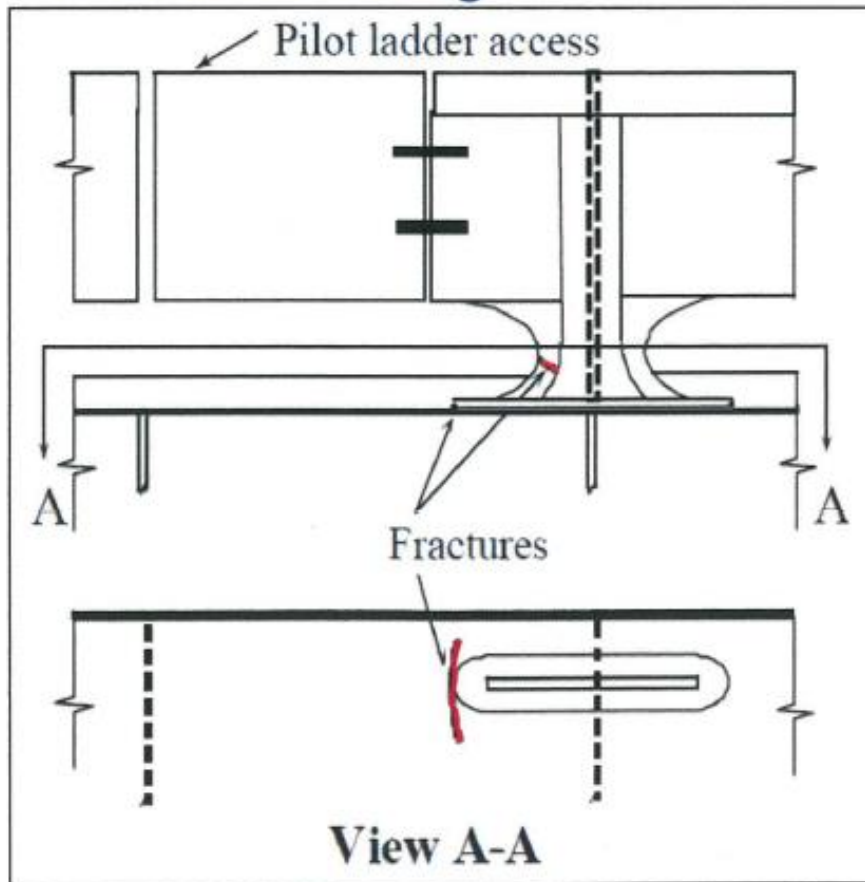


Sketch of repair

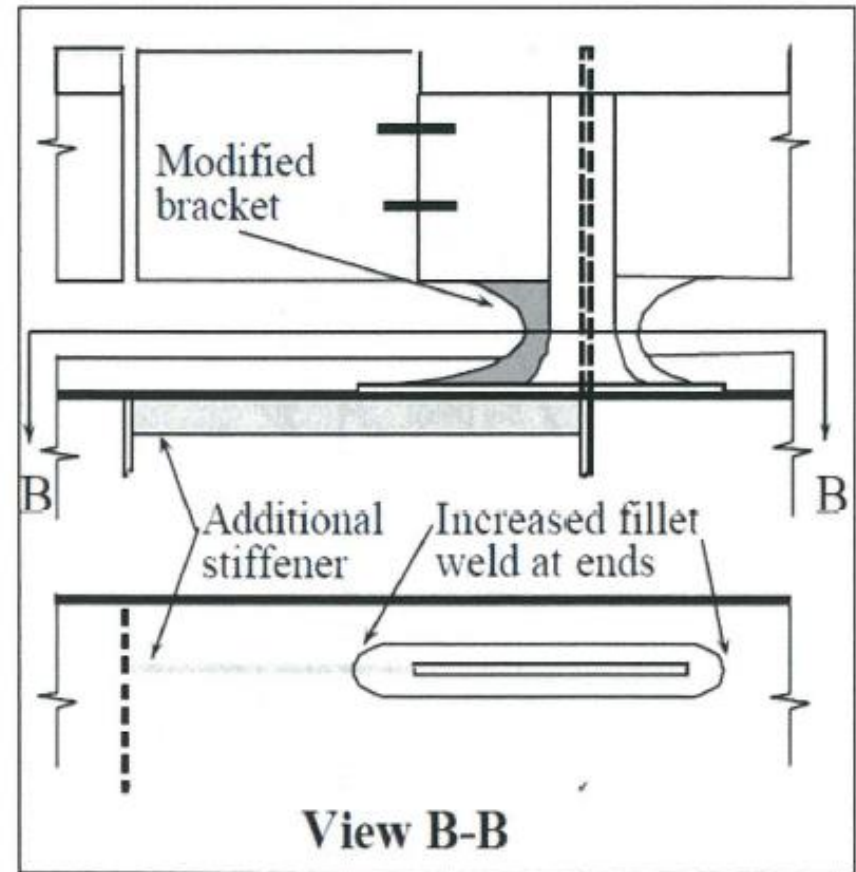


Example of Deck Structure

Sketch of damages

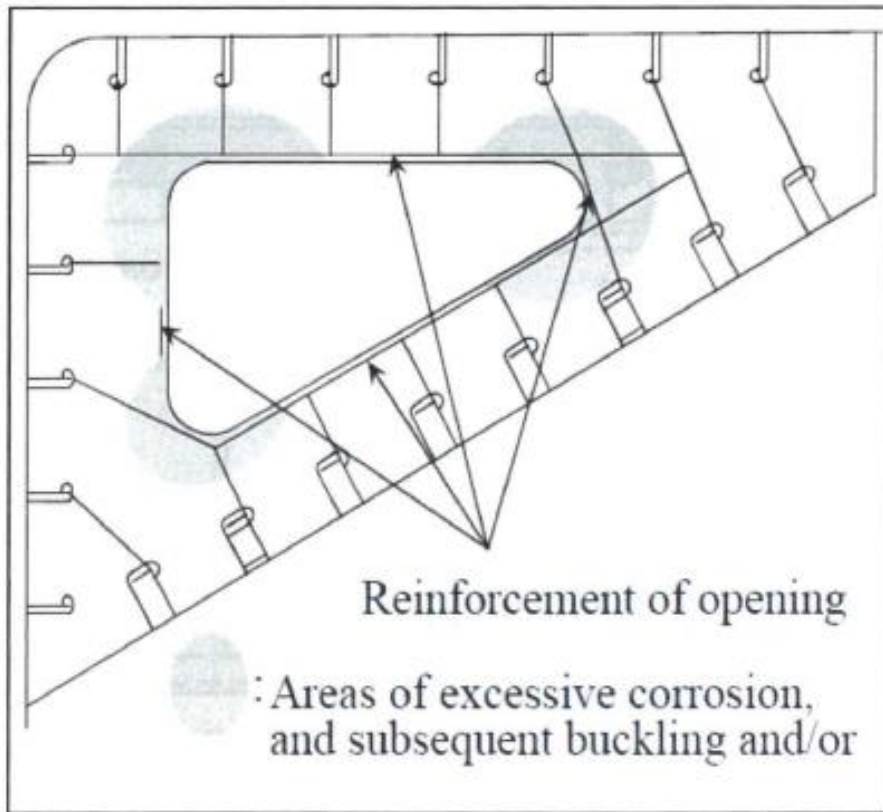


Sketch of repair

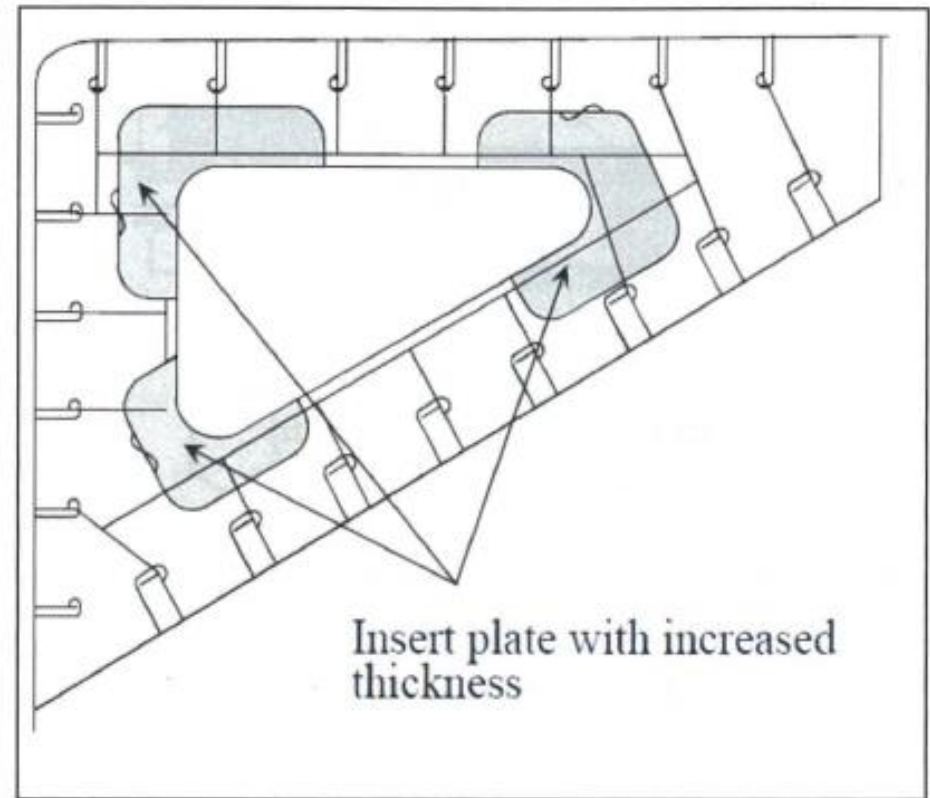


Topside Tank Structure

Sketch of damage

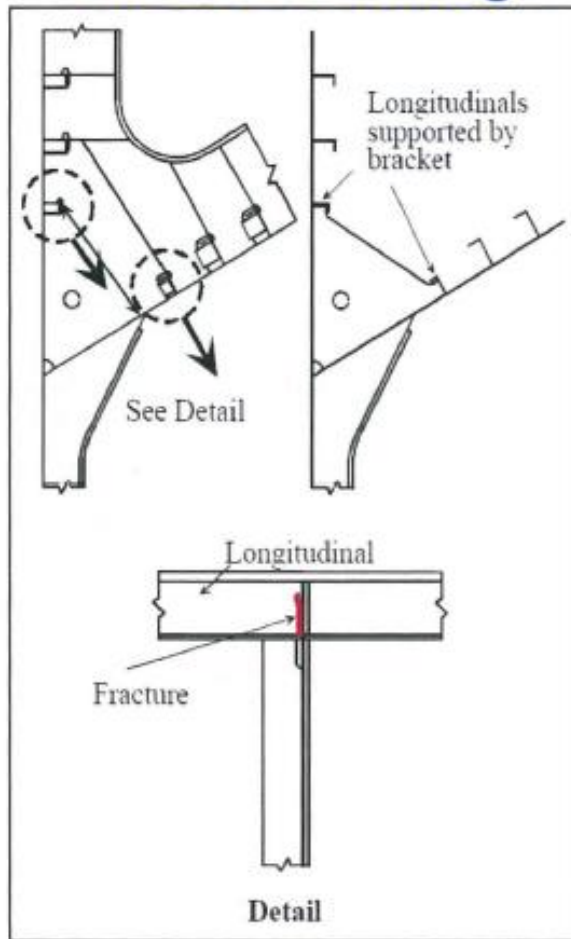


Sketch of repair

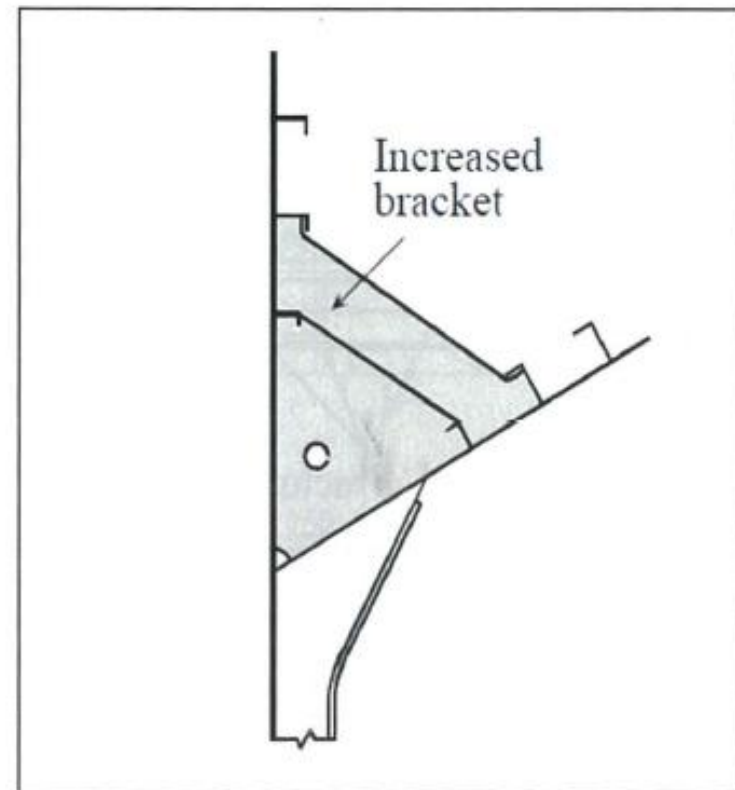


Topside Tank Structure

Sketch of damage

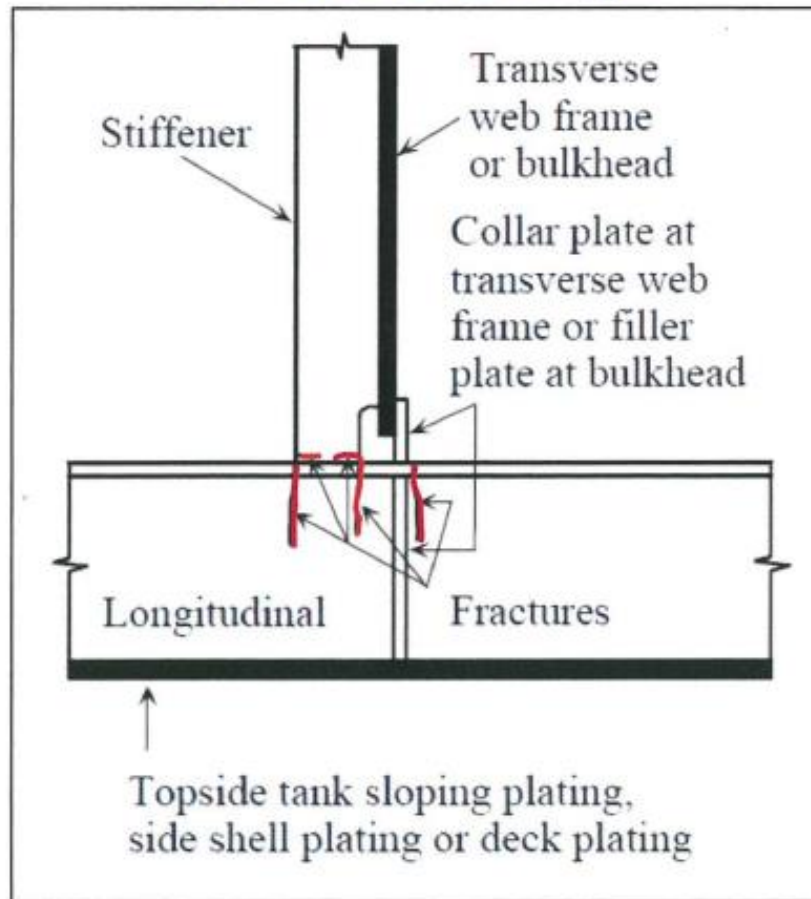


Sketch of repair

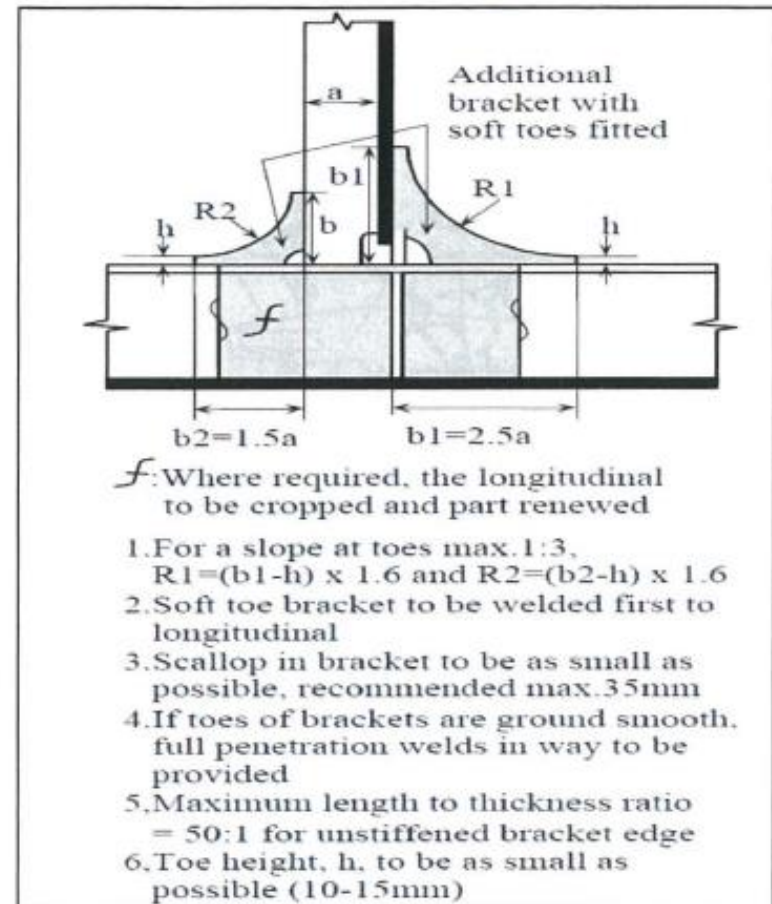


Topside Tank Structure

Sketch of damage

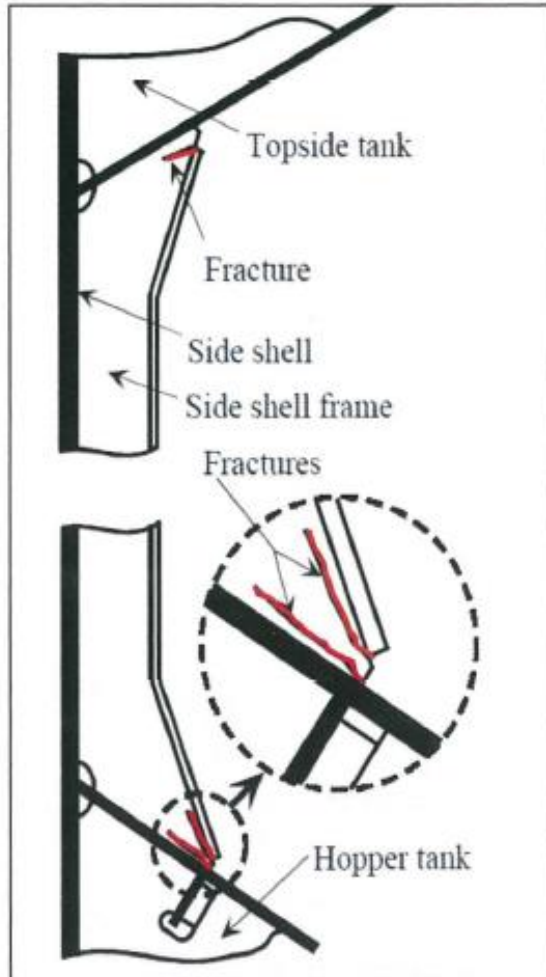


Sketch of repair

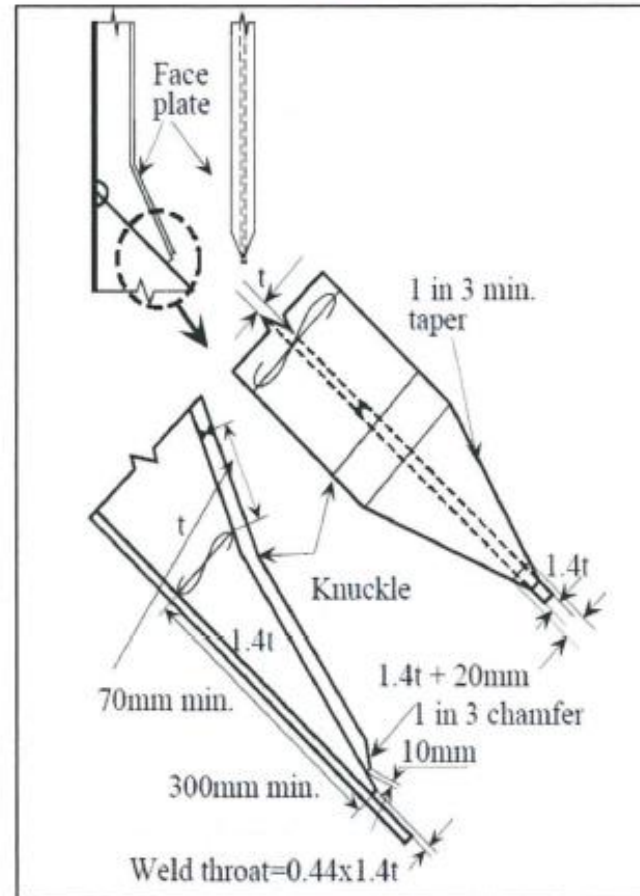


Cargo Hold Side Structure

Sketch of damage

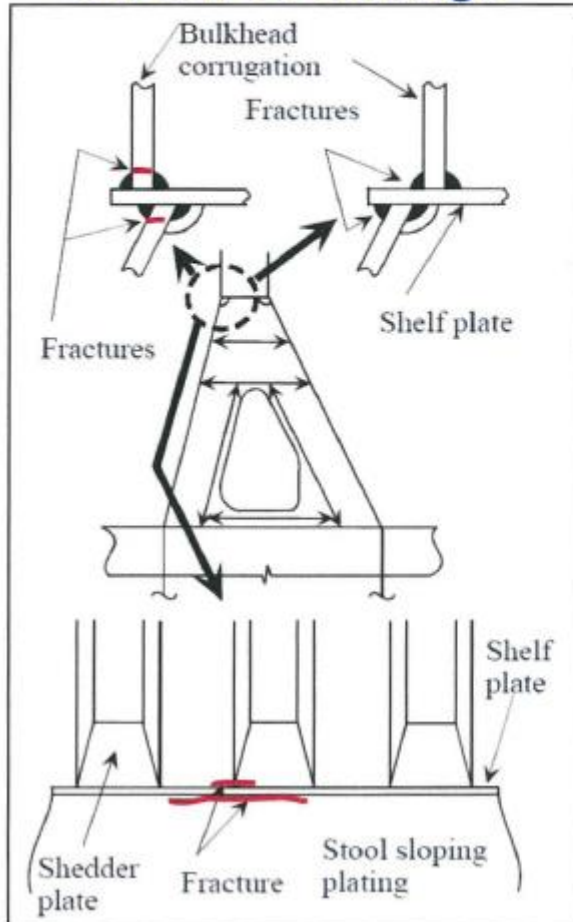


Sketch of repair

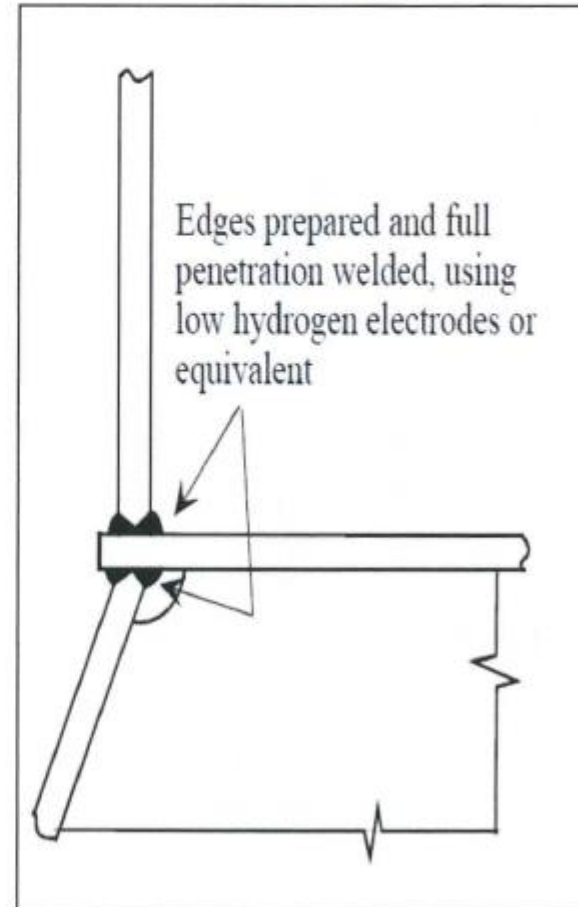


Transverse Bulkhead

Sketch of damage

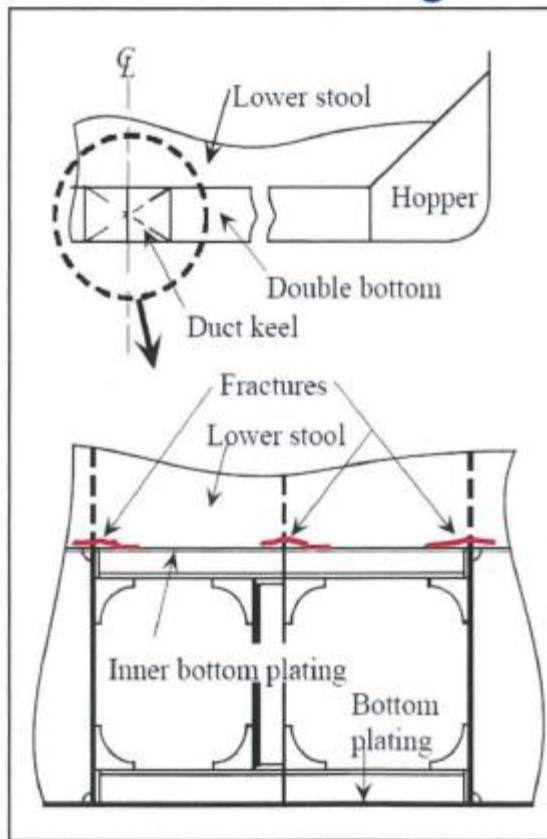


Sketch of repair

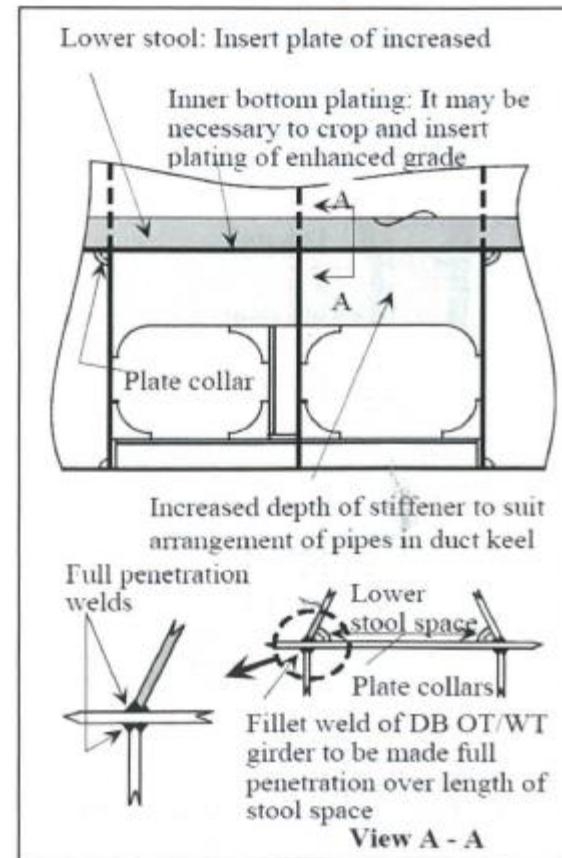


Transverse Bulkhead

Sketch of damage

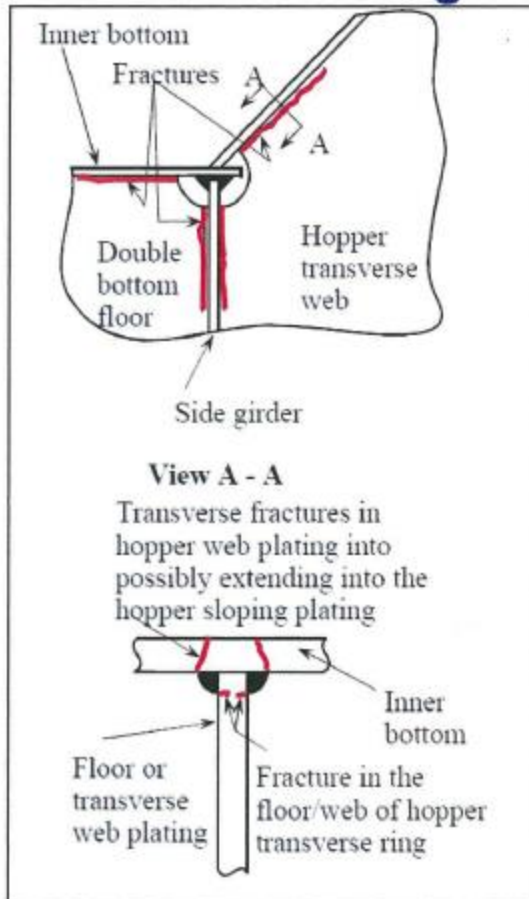


Sketch of repair

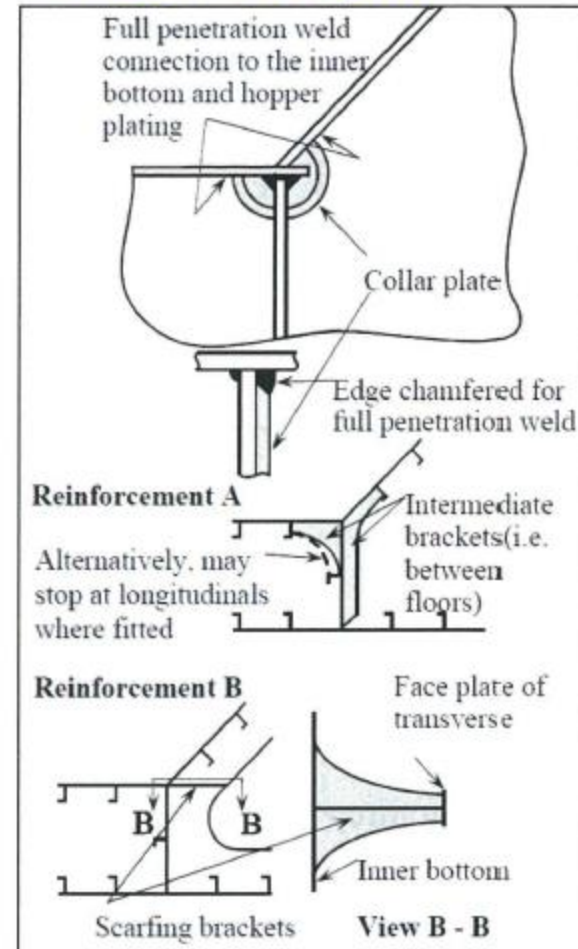


Double Bottom Tank

Sketch of damage

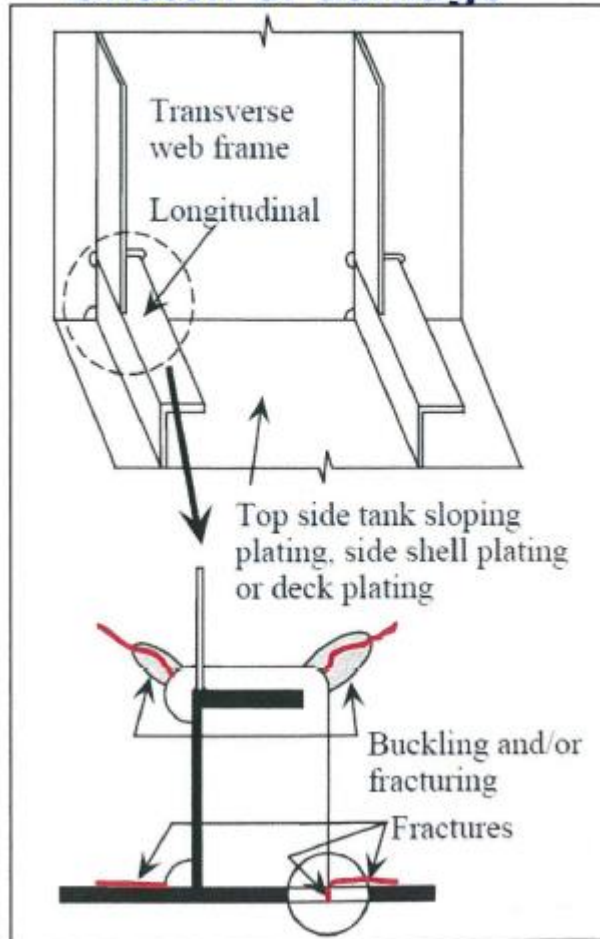


Sketch of repair

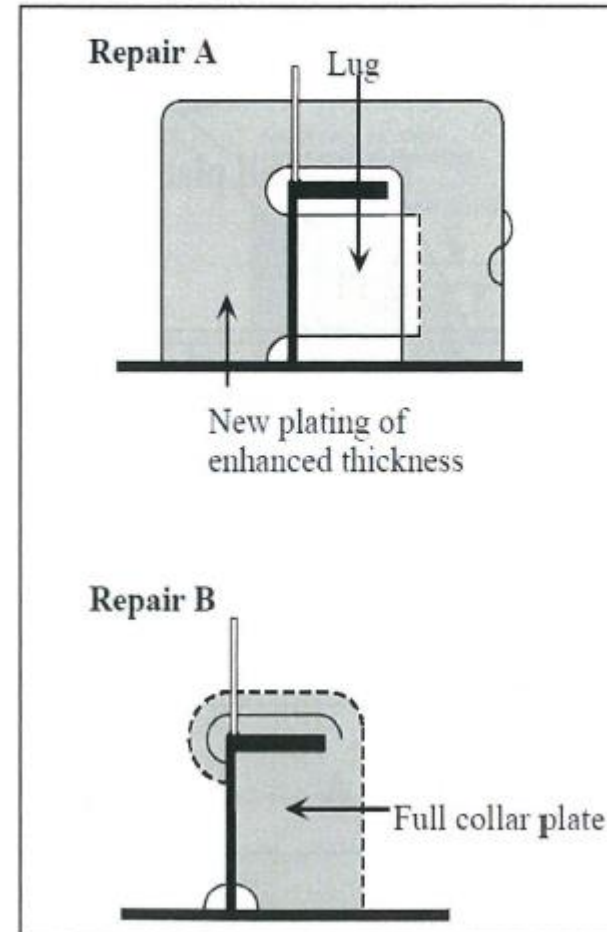


Double Bottom Tank

Sketch of damage

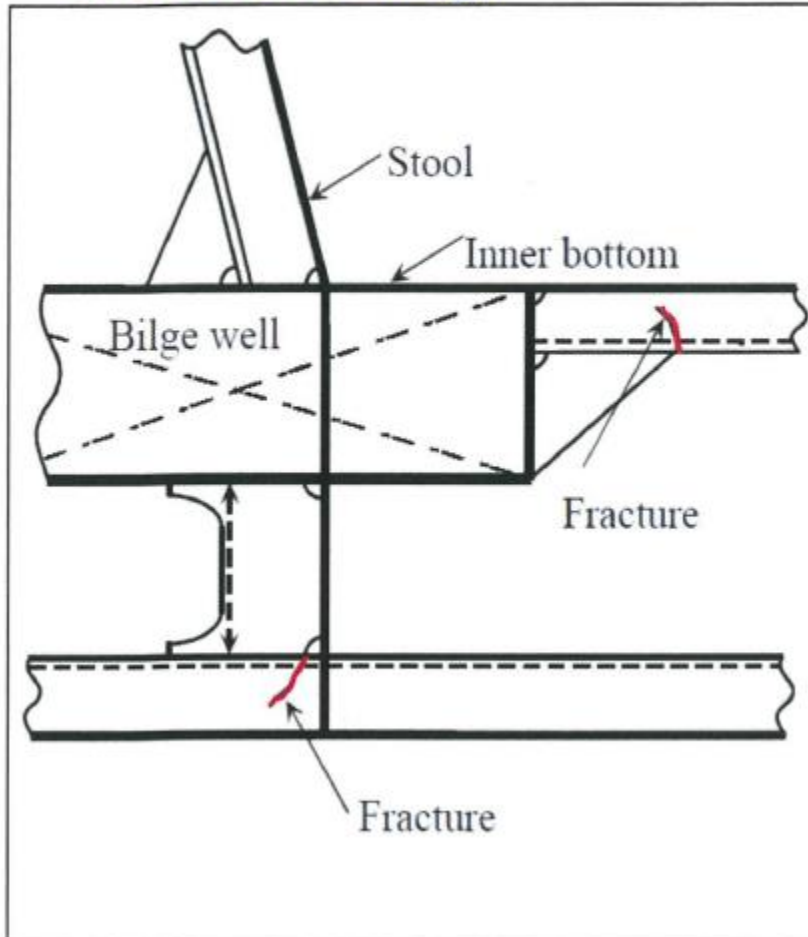


Sketch of repair

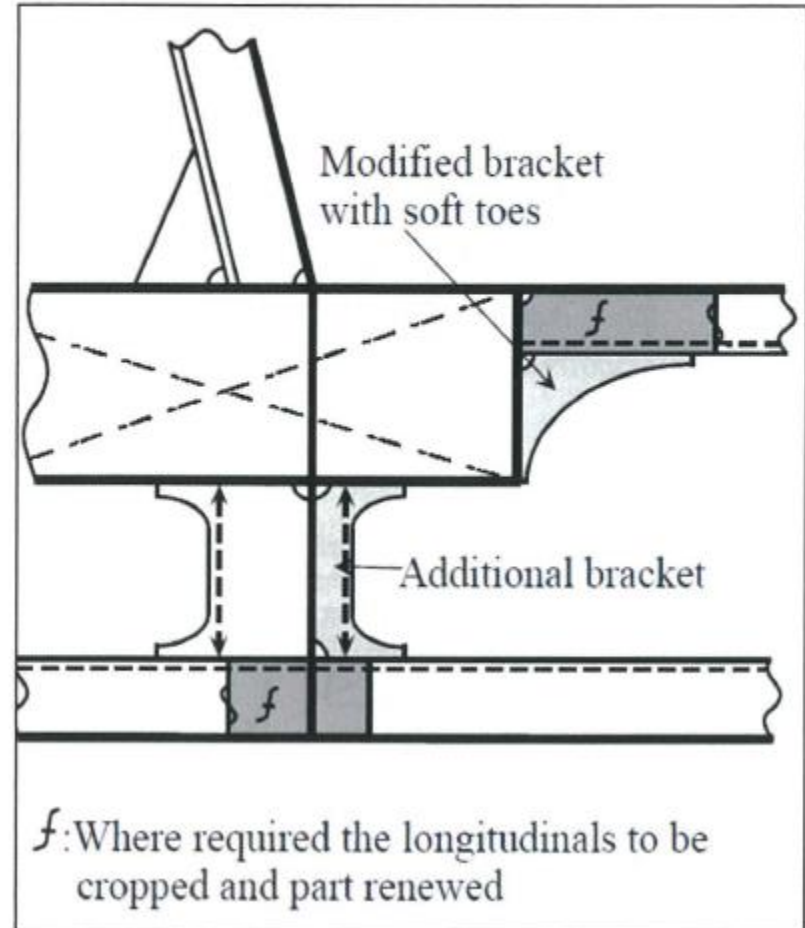


Double Bottom Tank

Sketch of damage

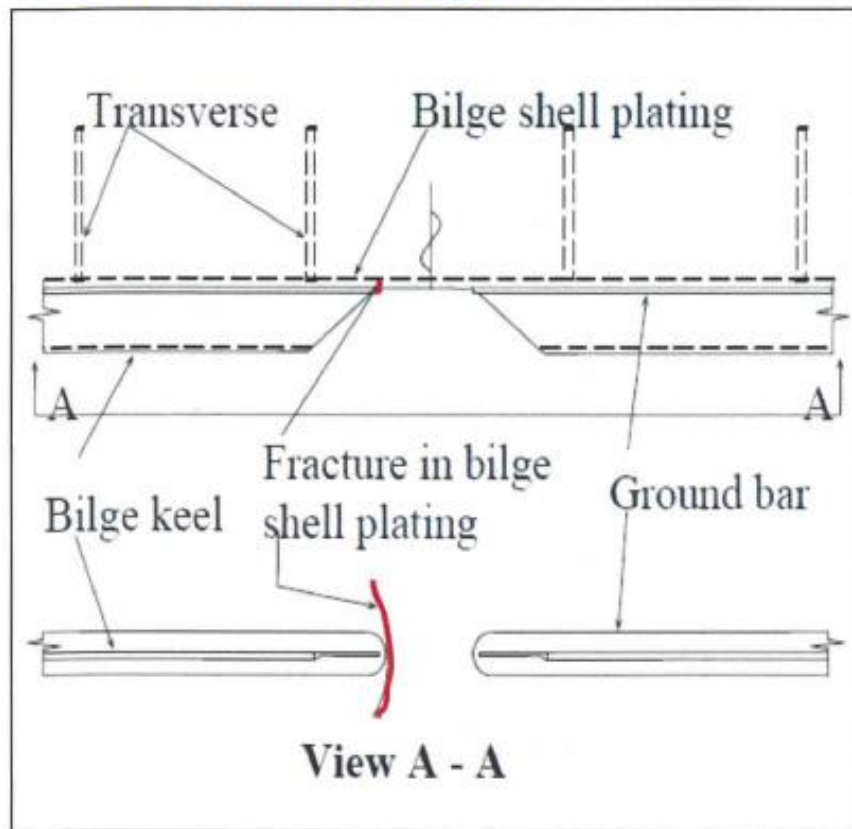


Sketch of repair

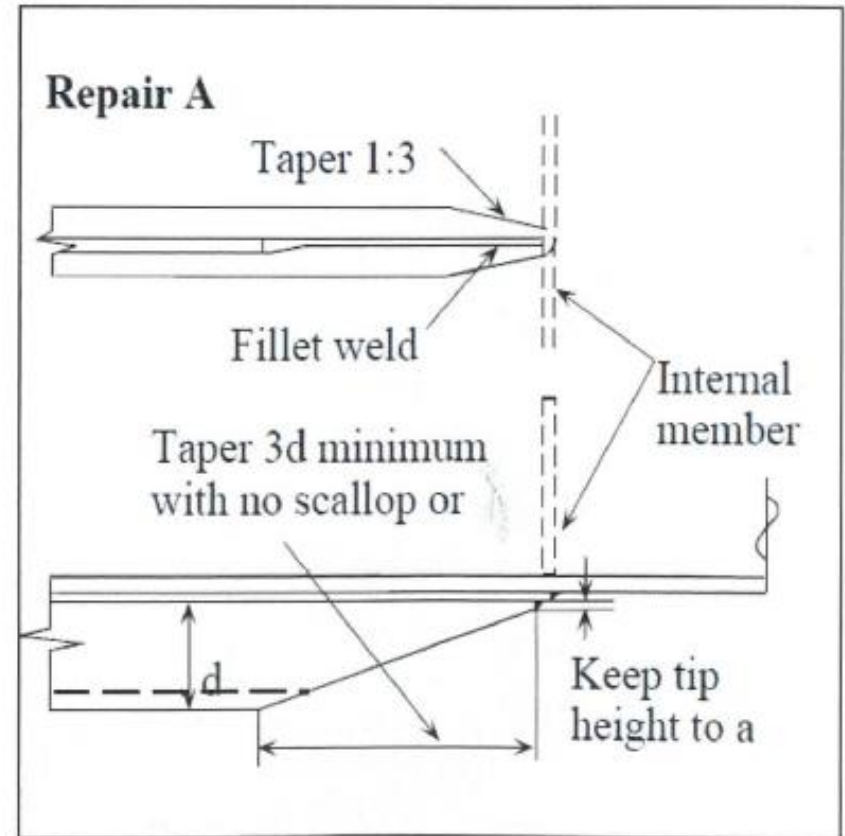


Bottom Shell Plate

Sketch of damages



Sketch of repair

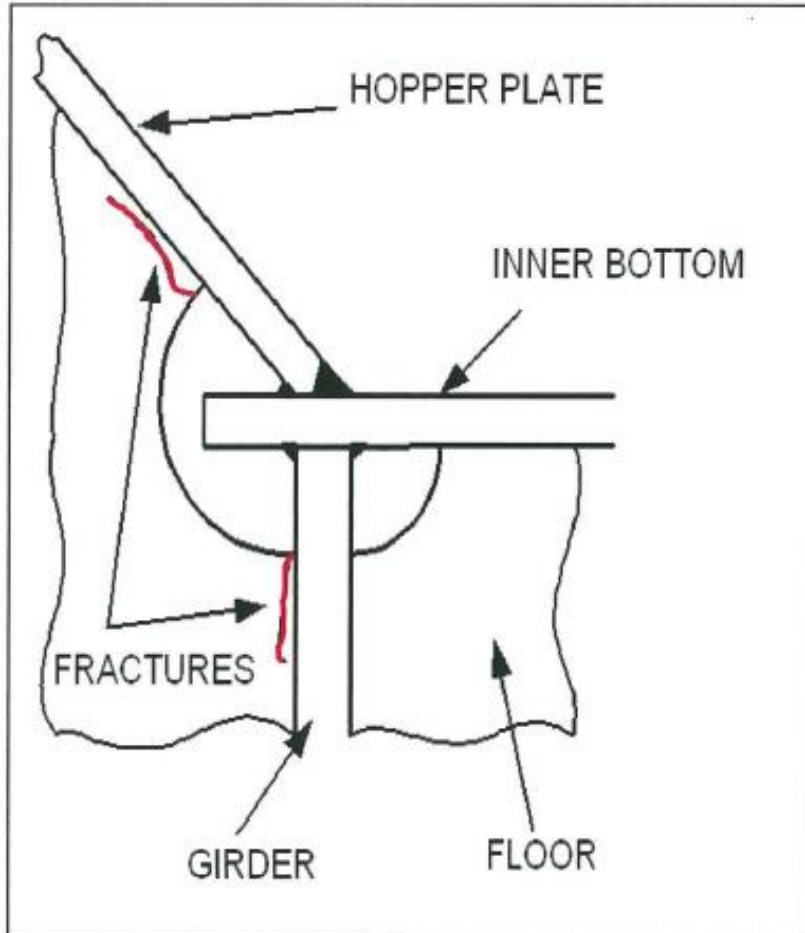


IACS Guidelines for Surveys, Assessment and Repair of Hull Structures Recommendation No.96 – Double Hull Oil Carrier

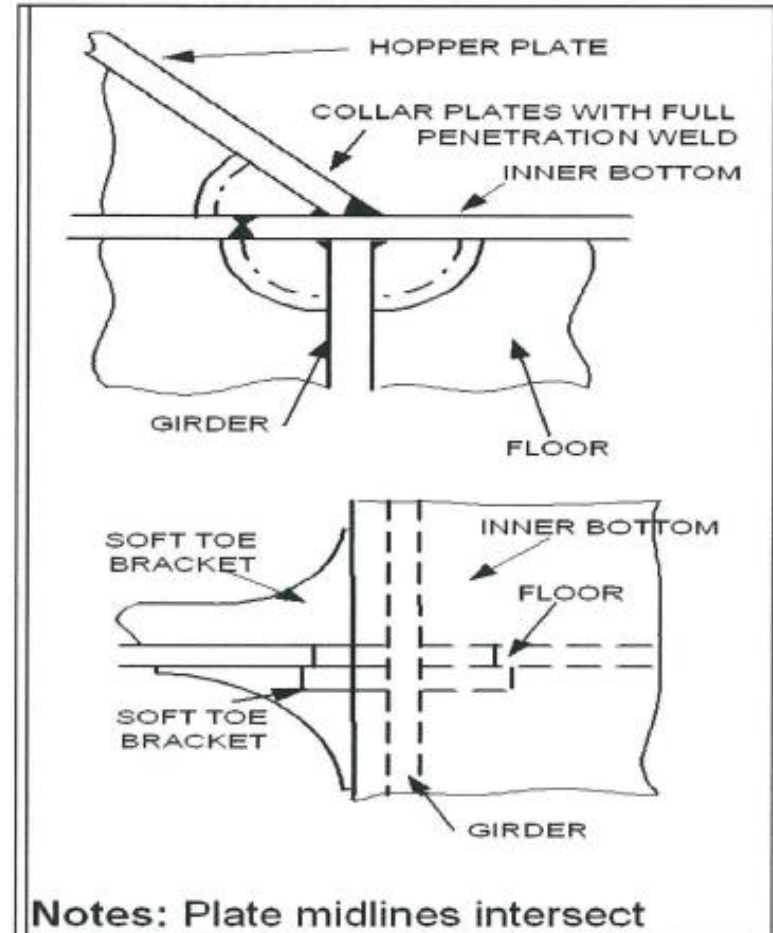


Hopper and Double Bottom Ballast Tank

Sketch of damage

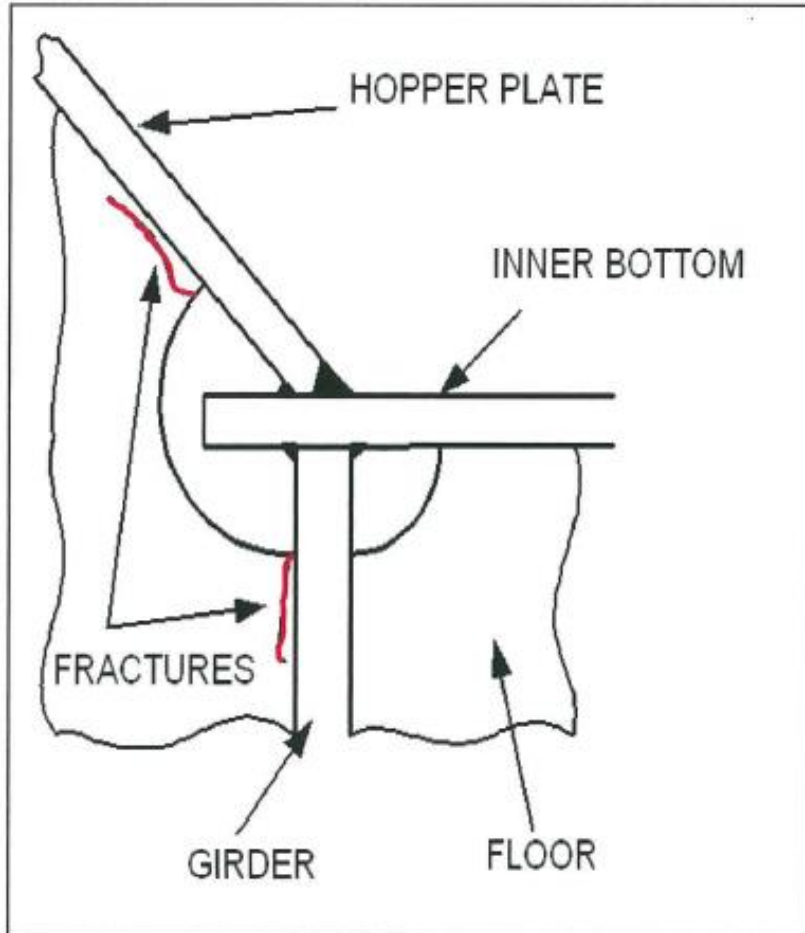


Sketch of repair

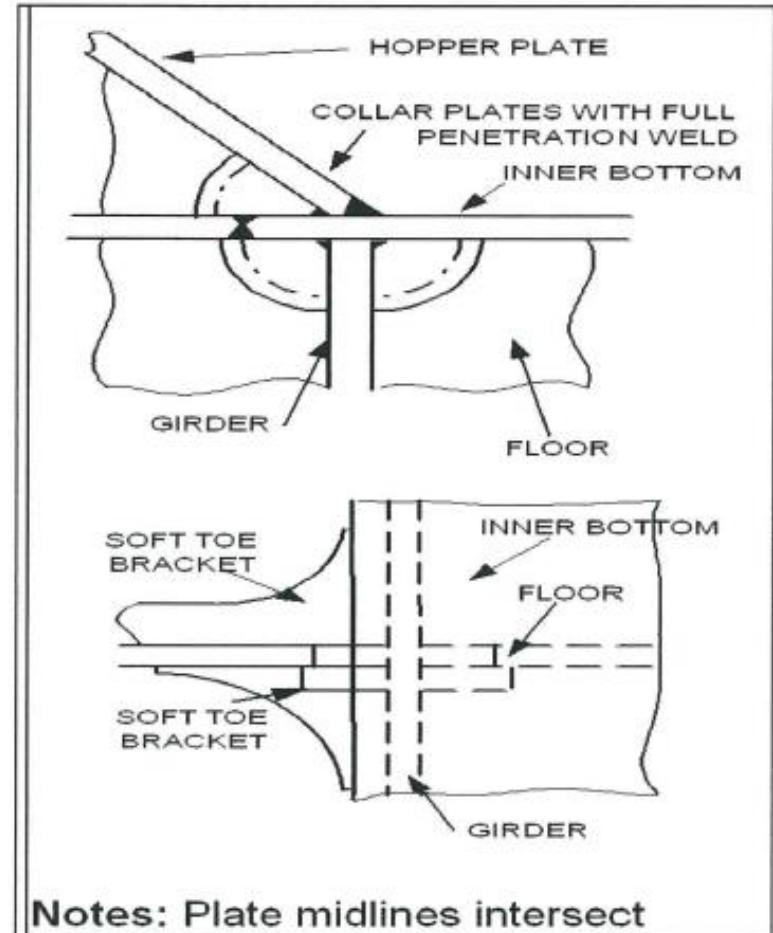


Hopper and Double Bottom Ballast Tank

Sketch of damage

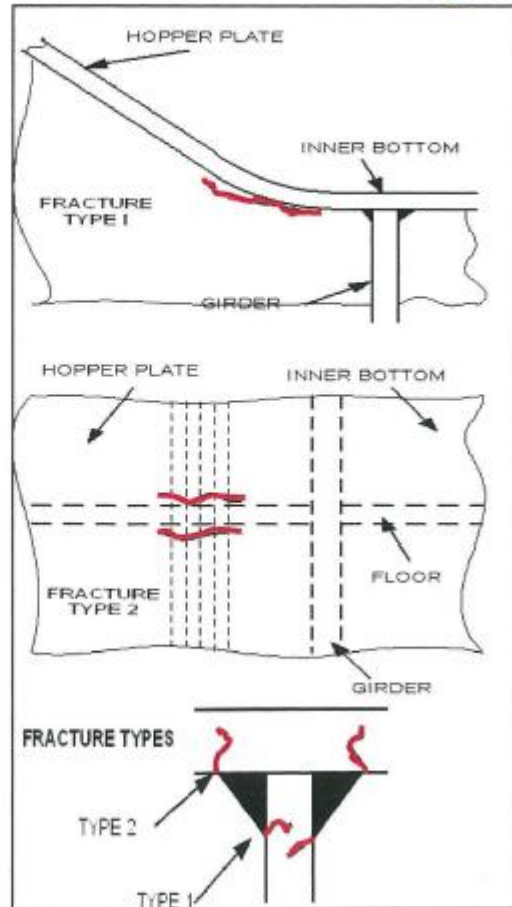


Sketch of repair

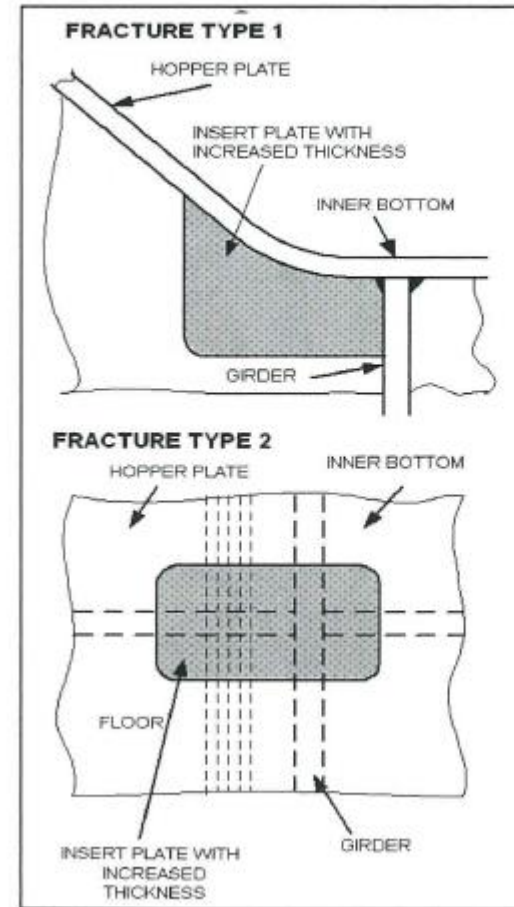


Example of Hopper and Double Bottom Ballast Tank

Sketch of damages

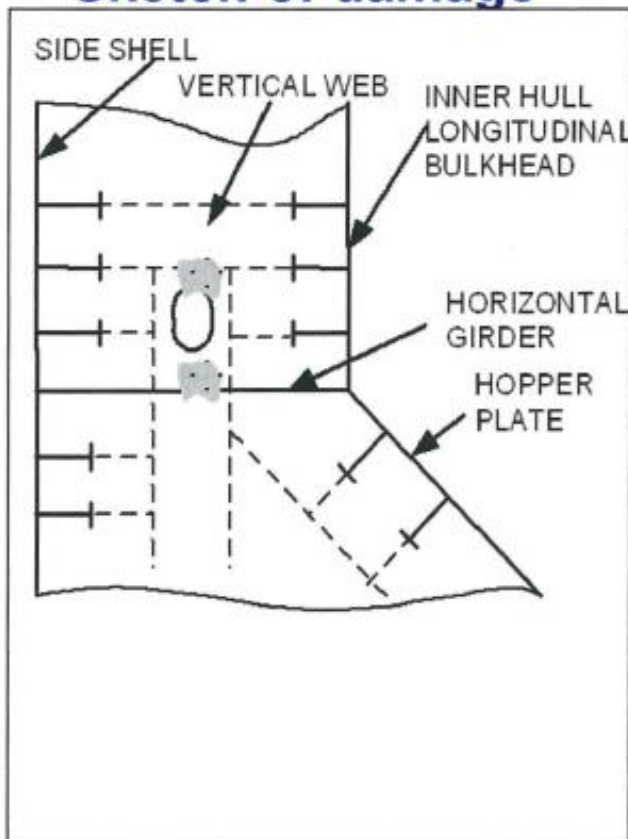


Sketch of repair

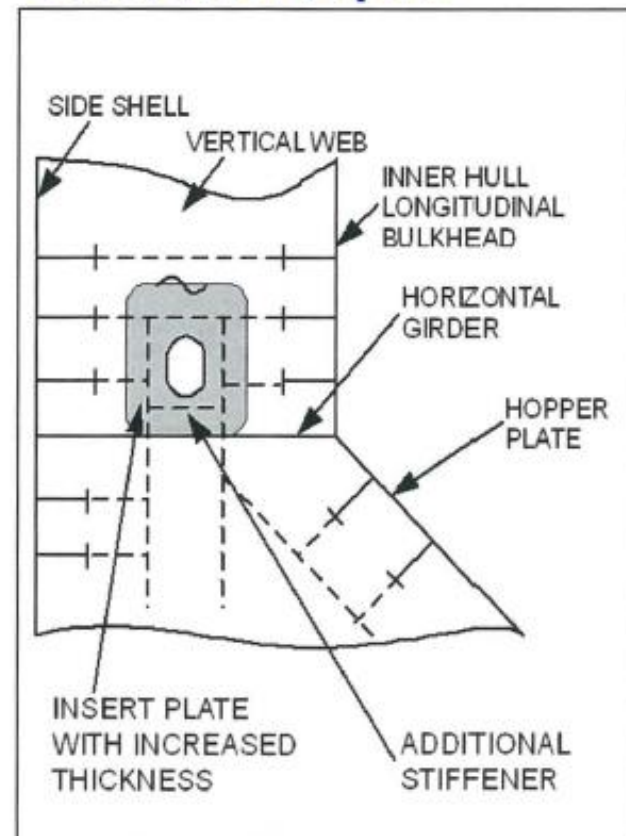


Wing Ballast Tank

Sketch of damage

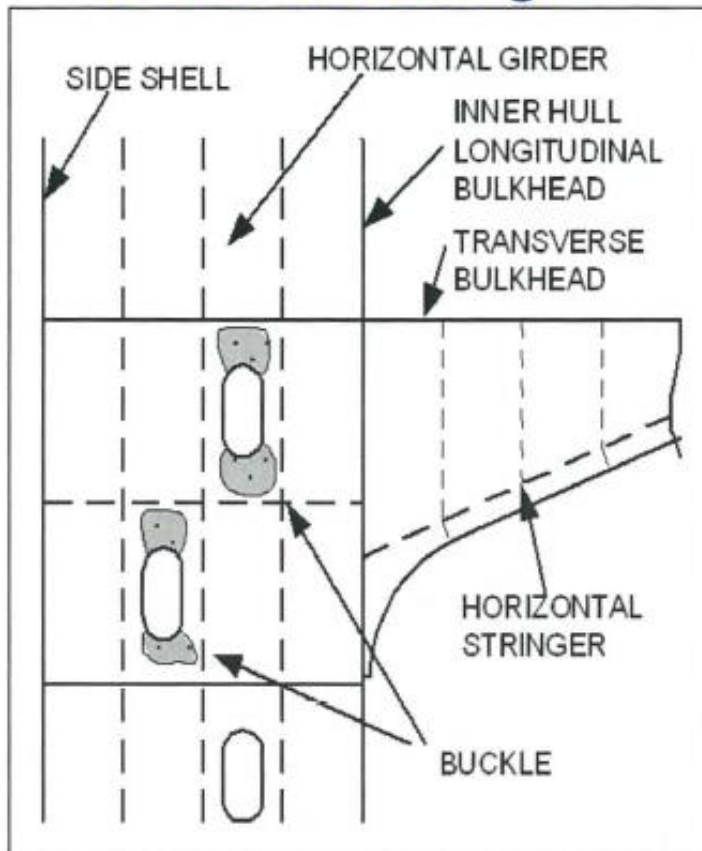


Sketch of repair

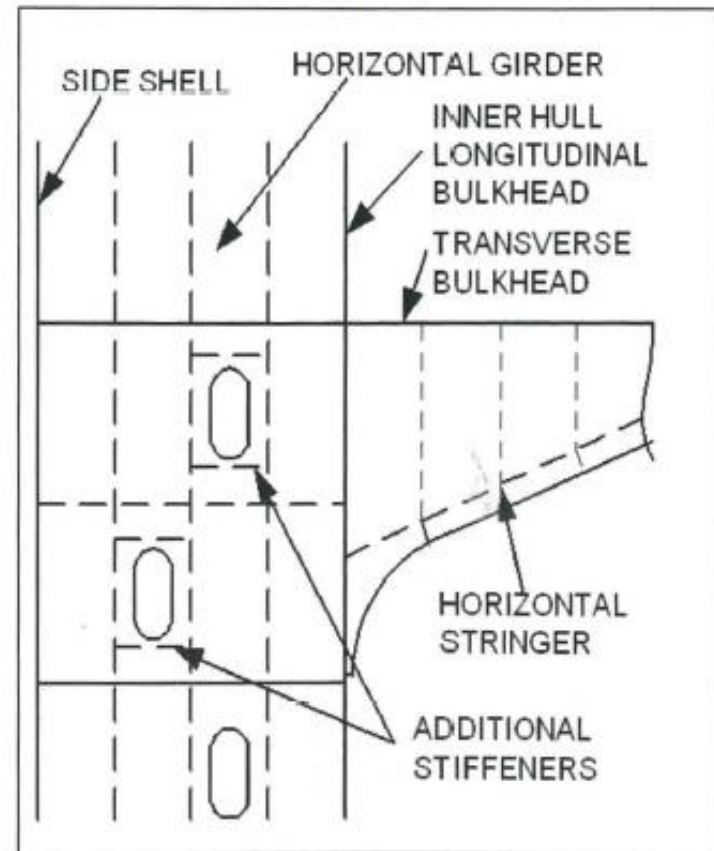


Wing Ballast Tank

Sketch of damage

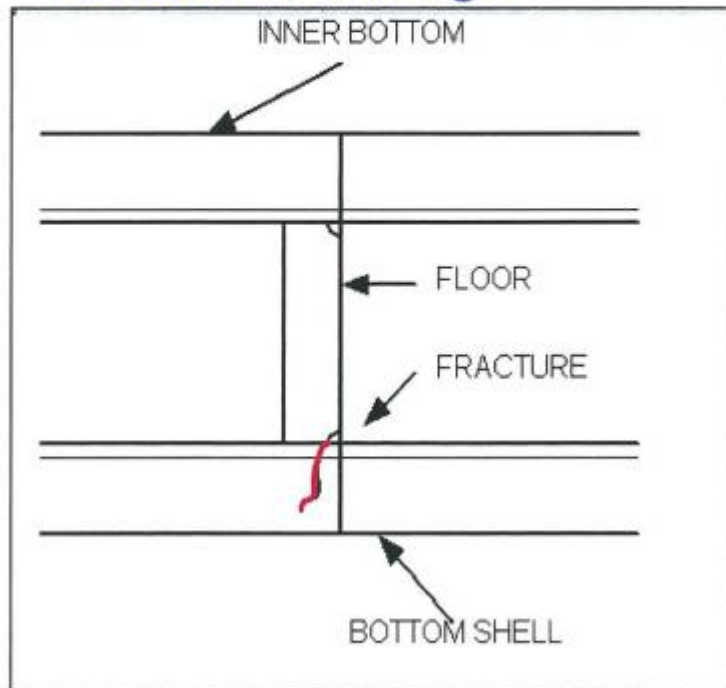


Sketch of repair

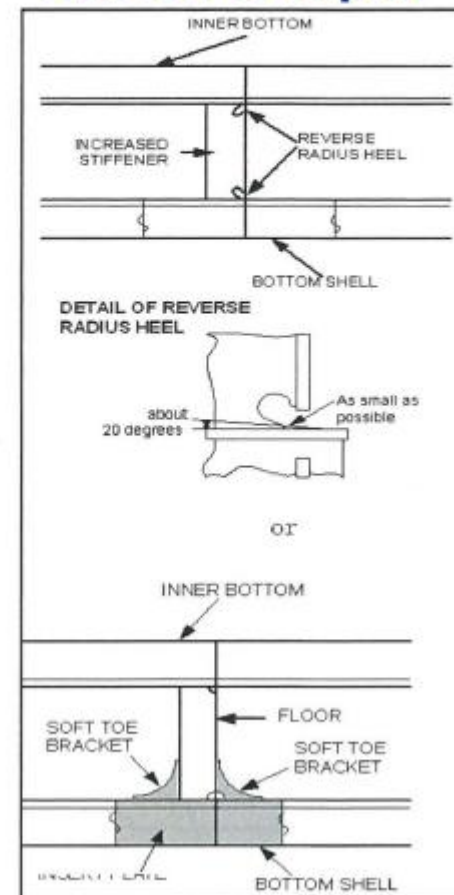


Bottom Ballast Tank

Sketch of damage

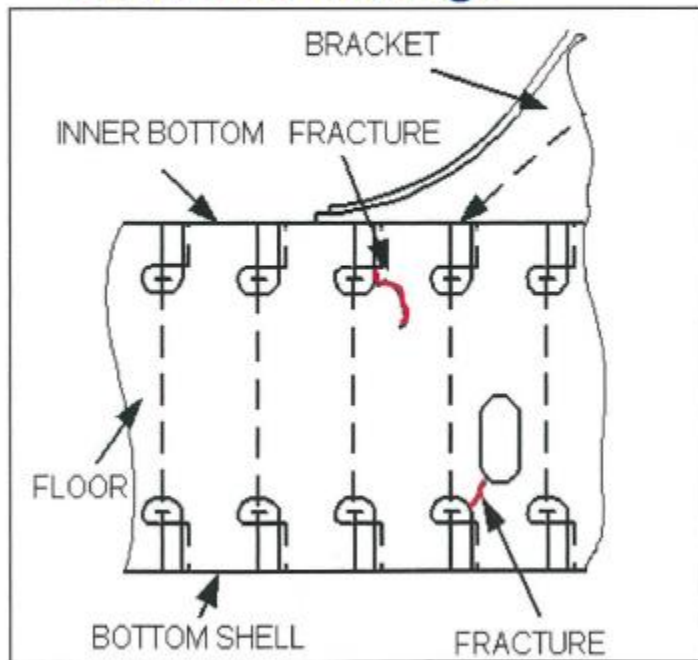


Sketch of repair

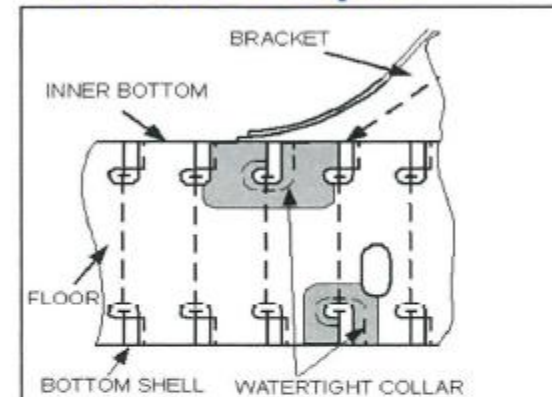


Bottom Ballast Tank

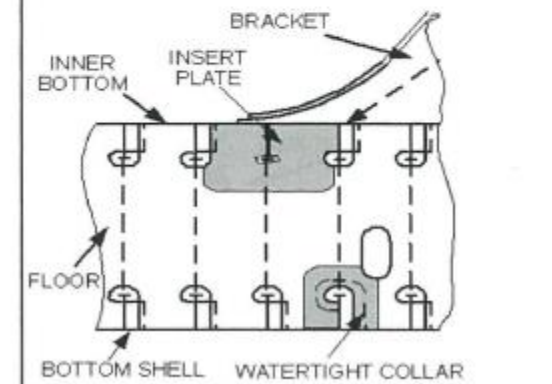
Sketch of damage



Sketch of repair



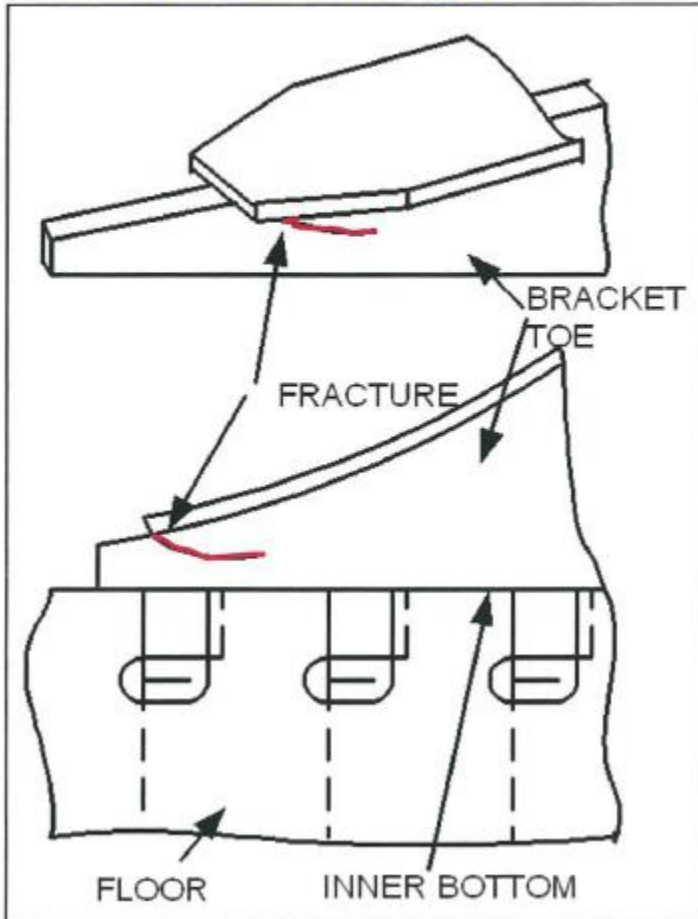
Above for relatively small fractures.



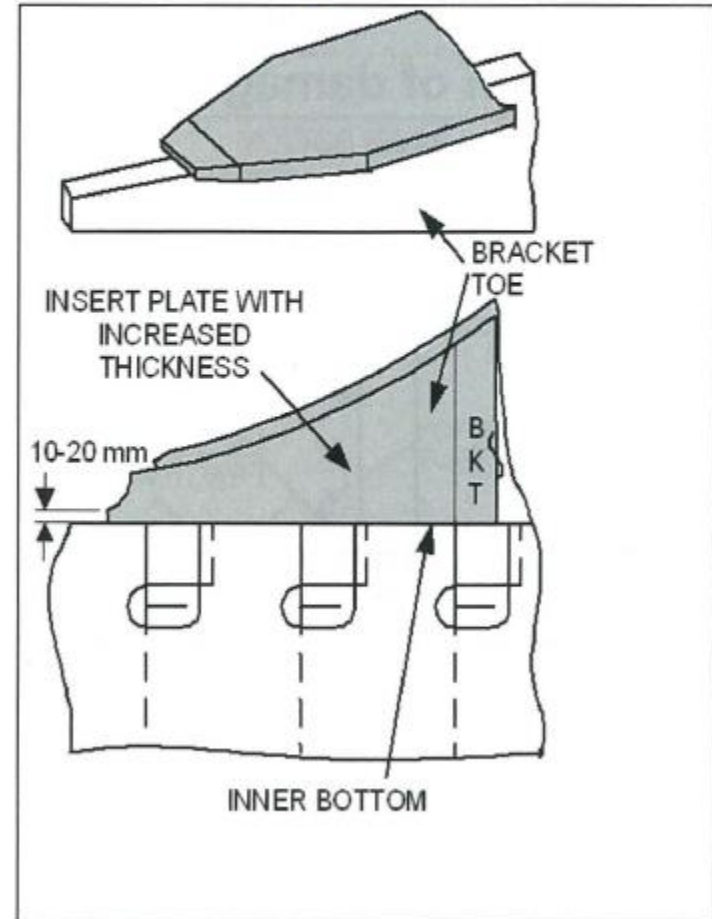
Above method for larger fractures.

Web Frames in Cargo Tank

Sketch of damages

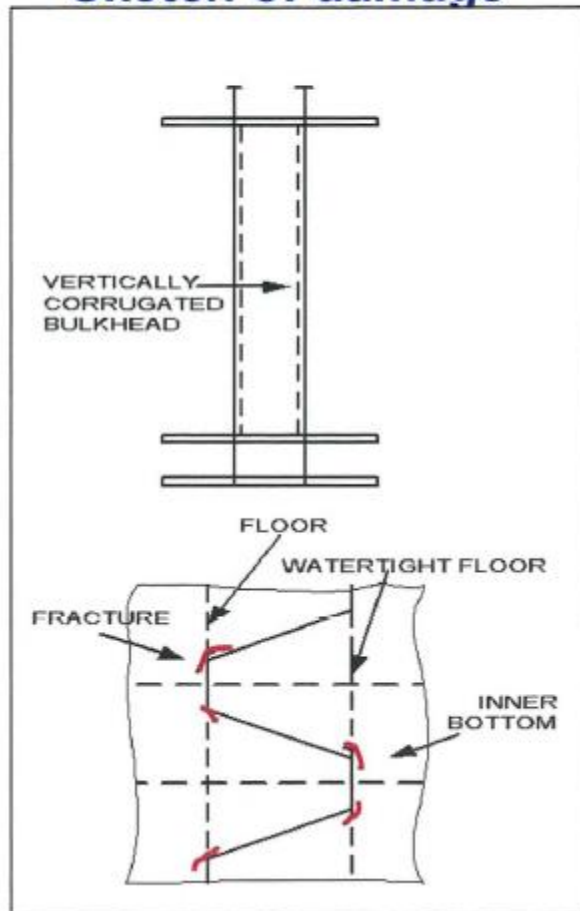


Sketch of repair

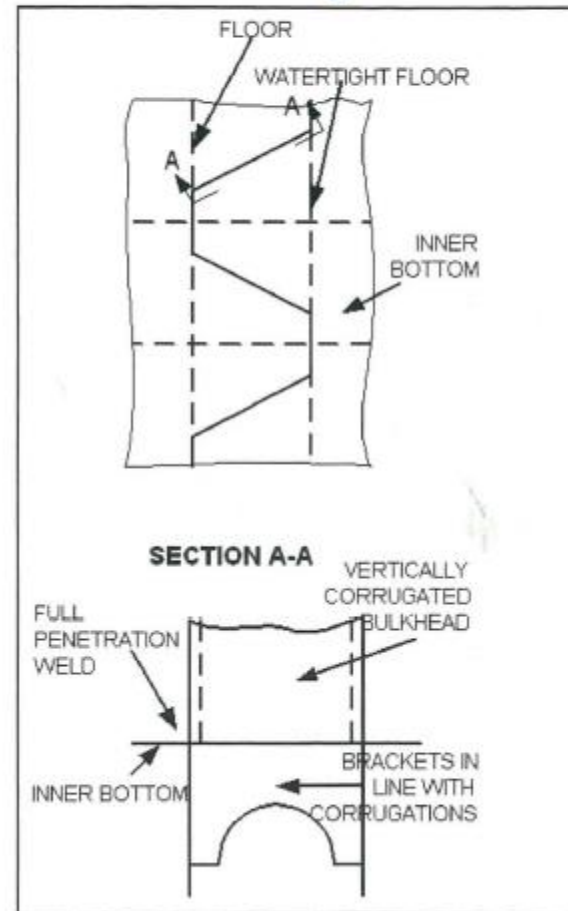


Transverse Bulkhead

Sketch of damage

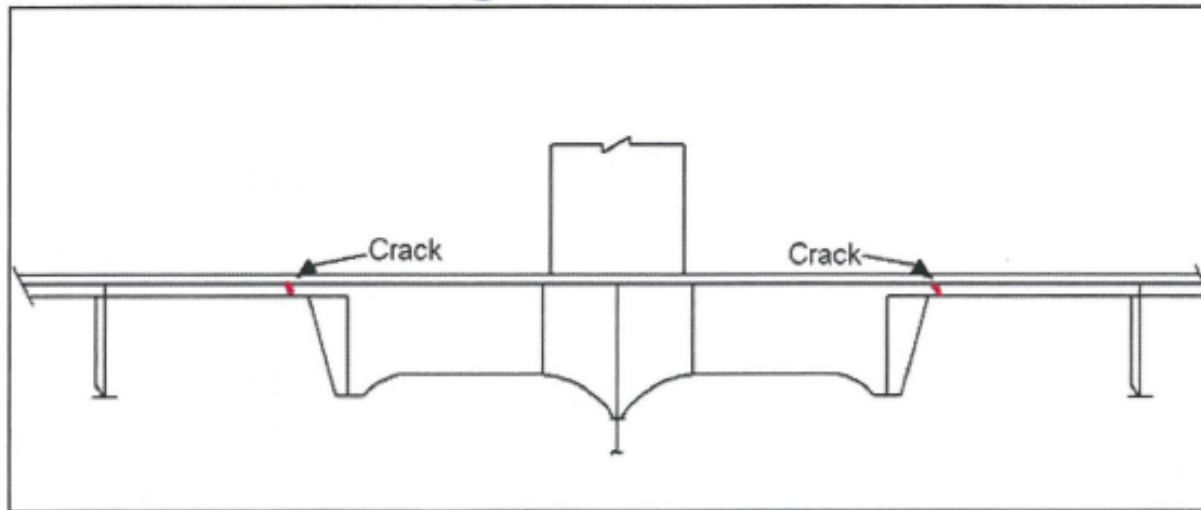


Sketch of repair

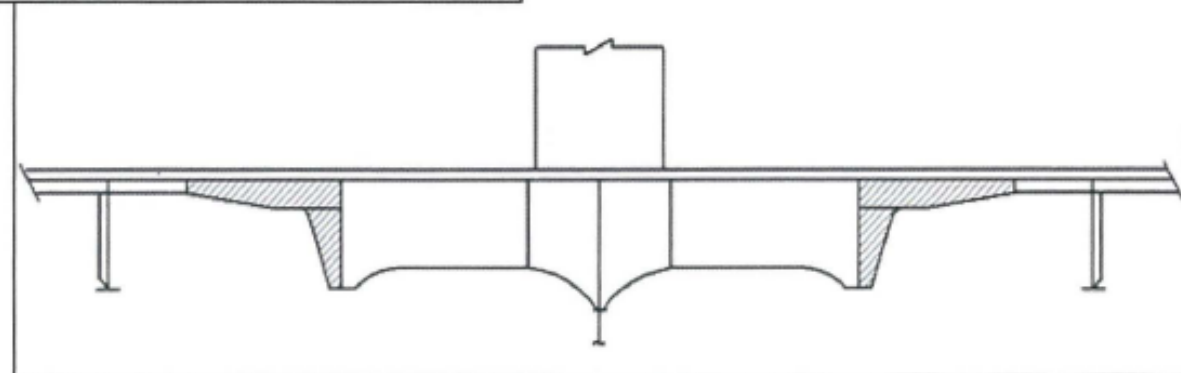


Deck Plating on the Crane Pedestal Support

Sketch of damage

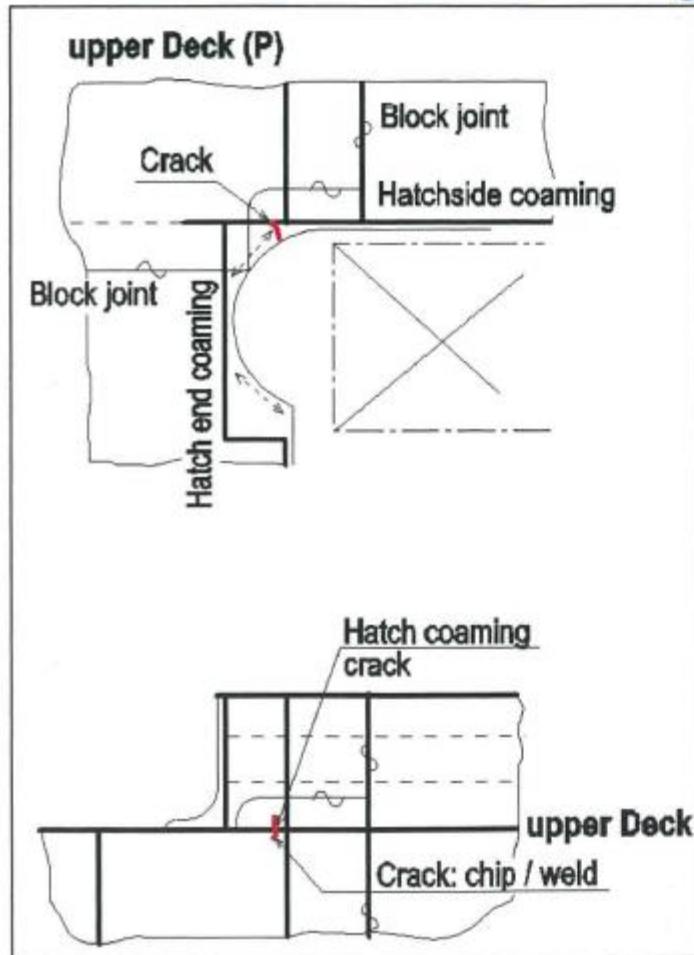


Sketch of repair

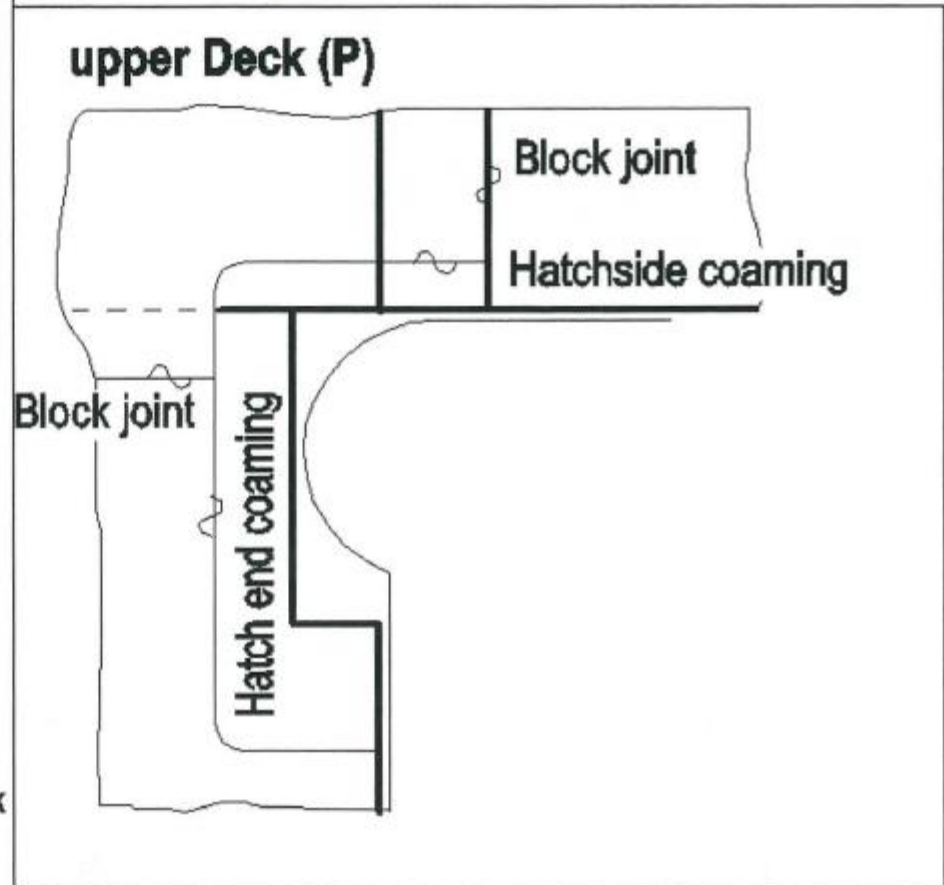


Upper Deck

Sketch of damage

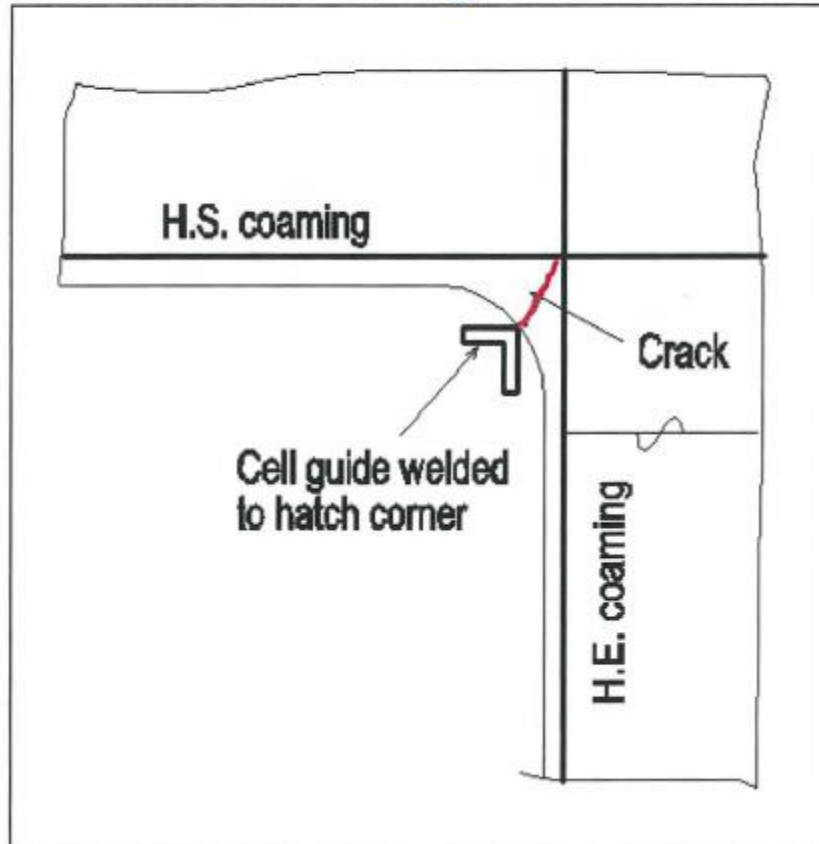


Sketch of repair

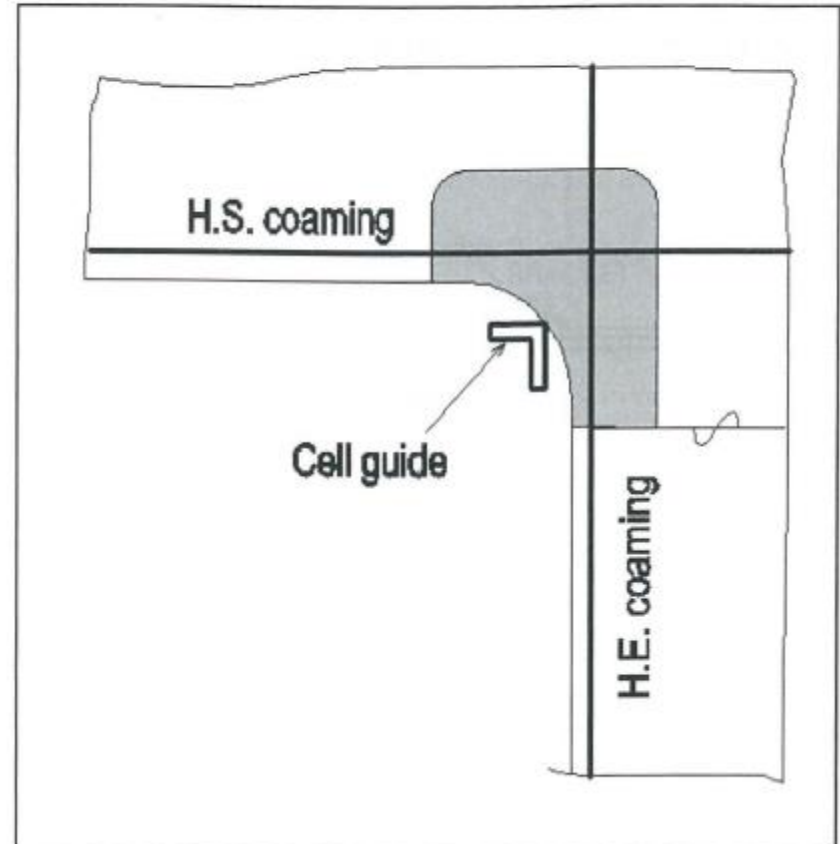


Upper Deck

Sketch of damage

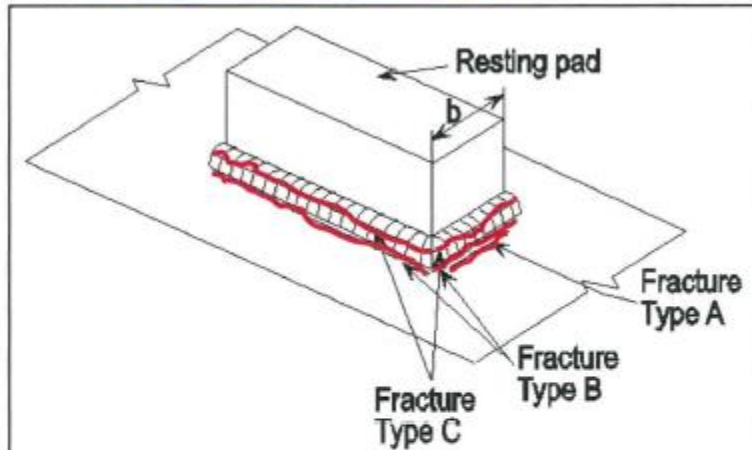


Sketch of repair



Upper Deck

Sketch of damage



Fracture Type A:

Starting in way of the undercut or HAZ of the transverse fillet weld and propagating in the top plating.

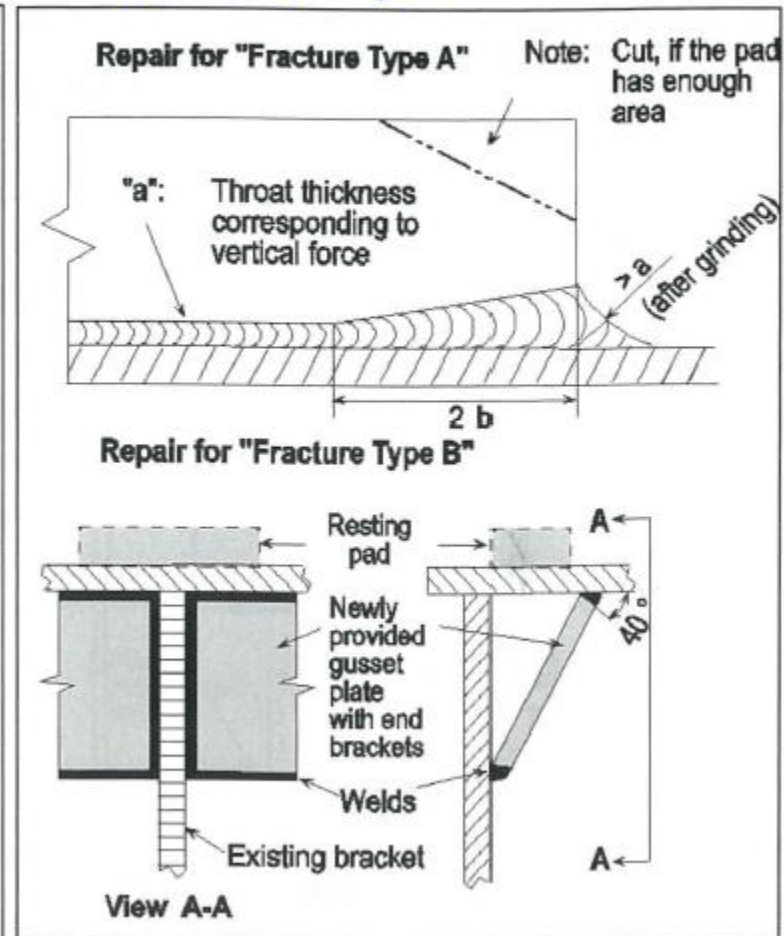
Fracture Type B:

Starting in way of the undercut or HAZ of the longitudinal fillet weld and propagating in the top plating.

Fracture Type C:

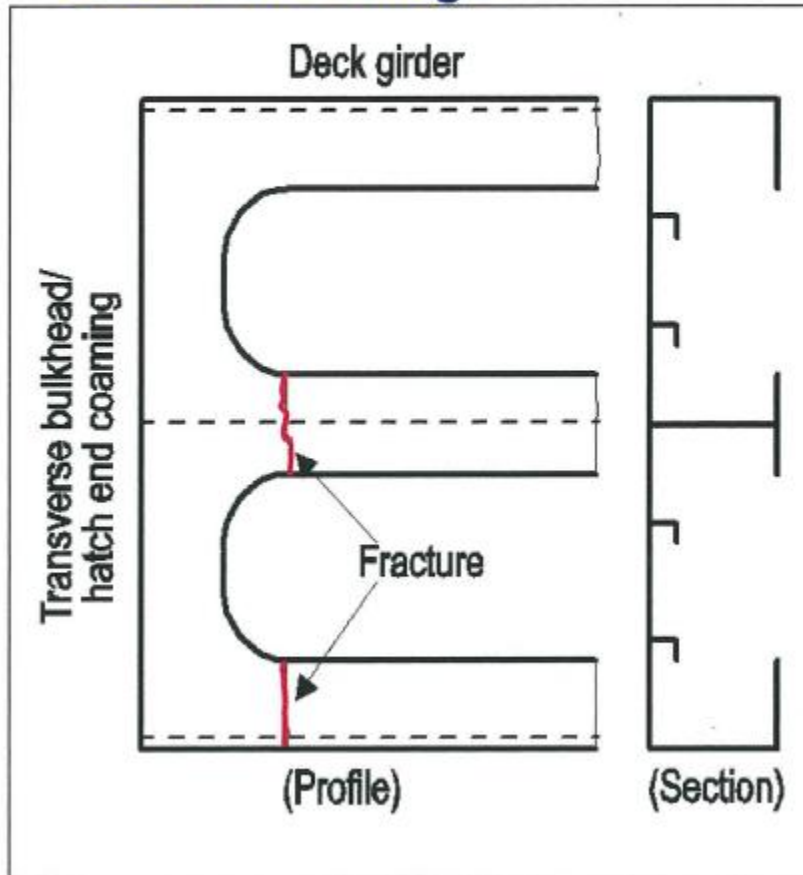
Starting and propagating in fillet weld

Sketch of repair

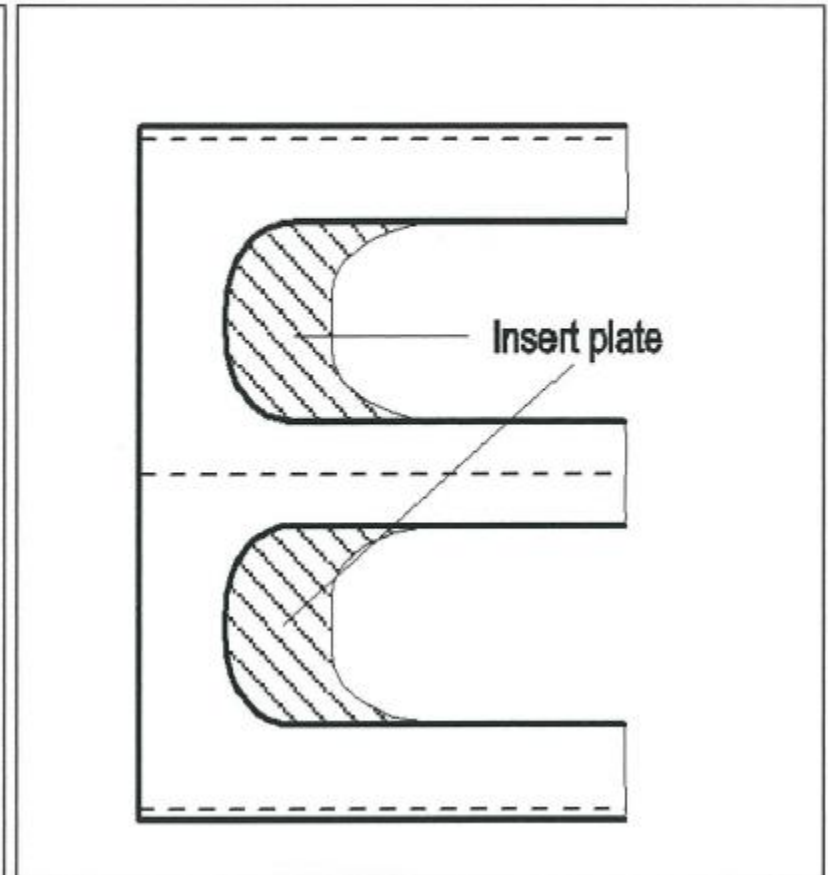


Upper Deck

Sketch of damage

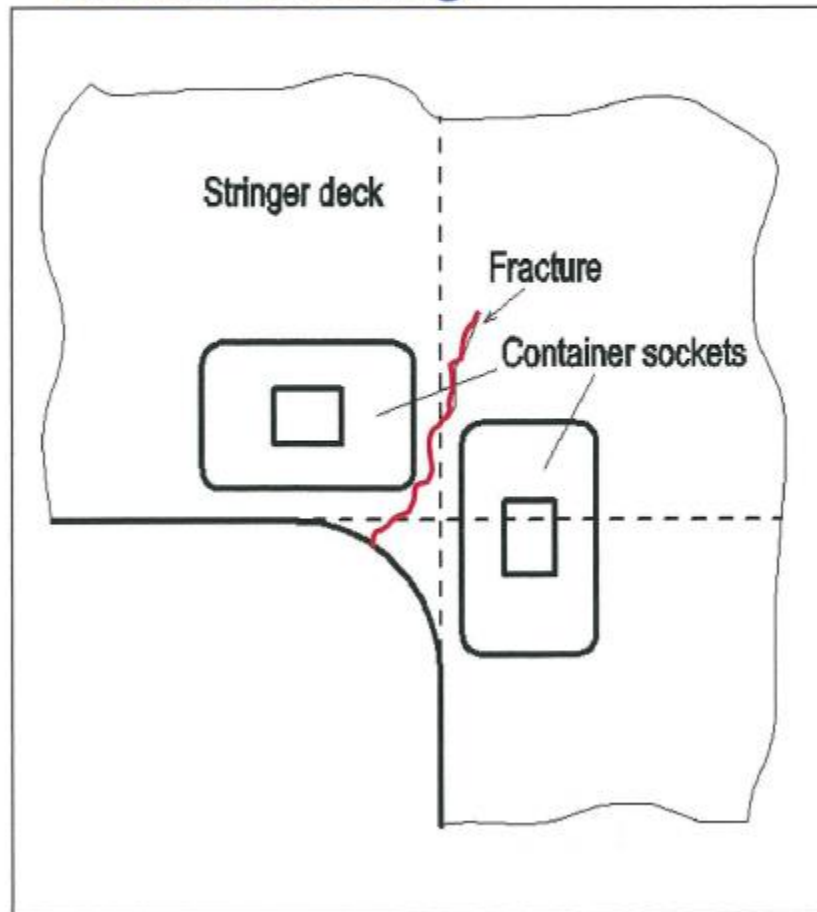


Sketch of repair

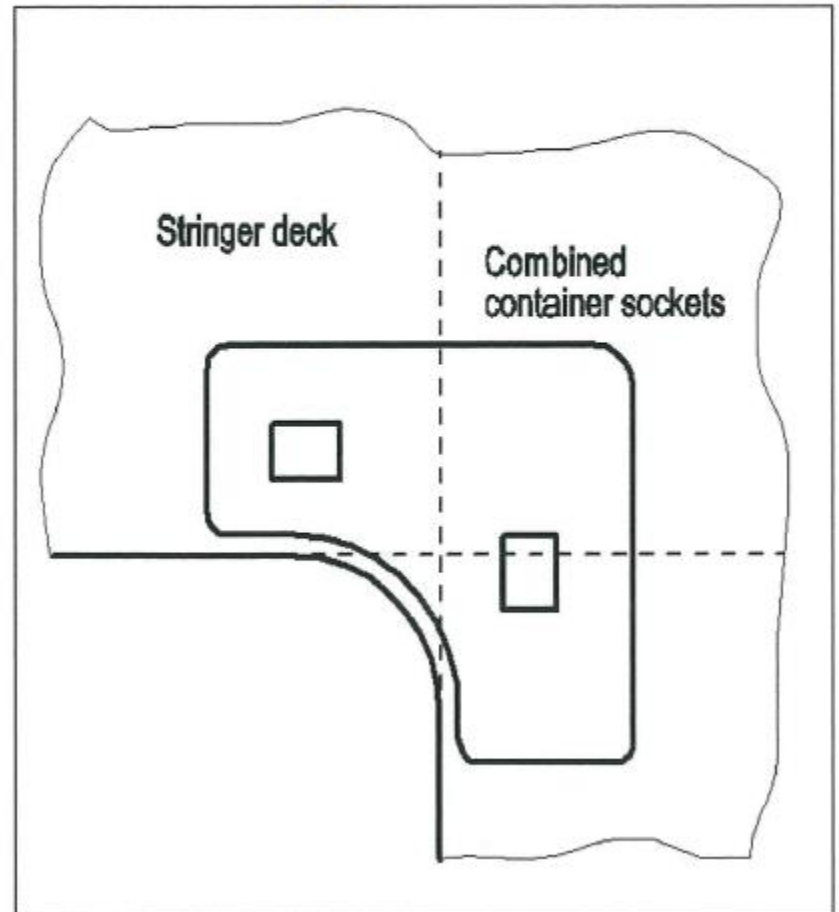


Upper Deck

Sketch of damage

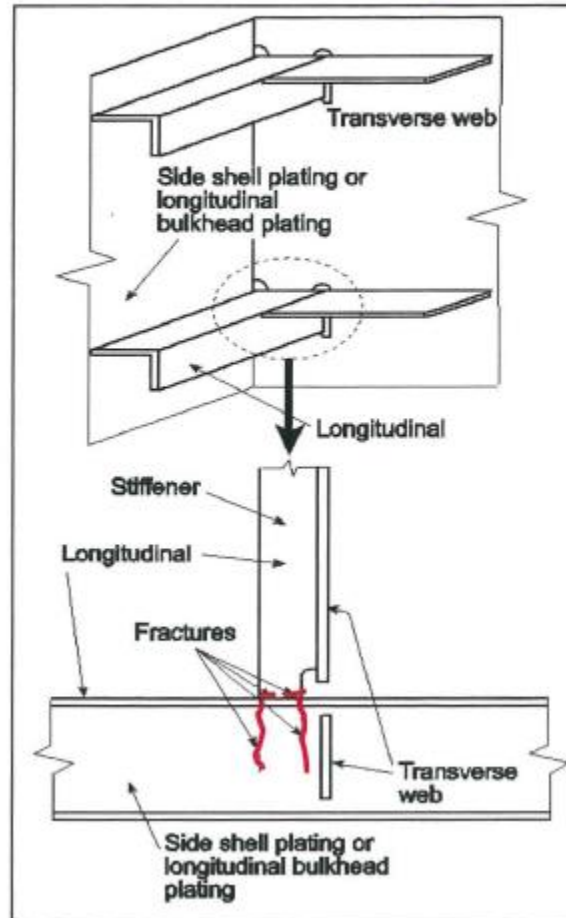


Sketch of repair

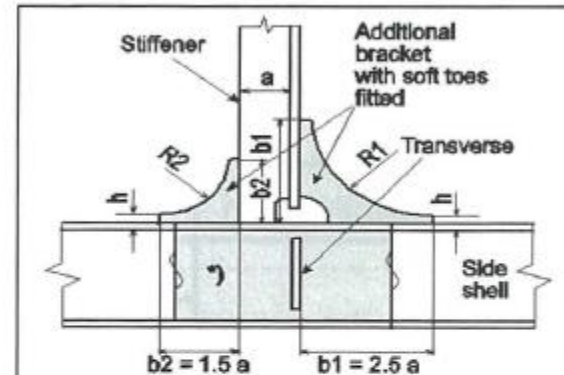


Example of Side Structure

Sketch of damages



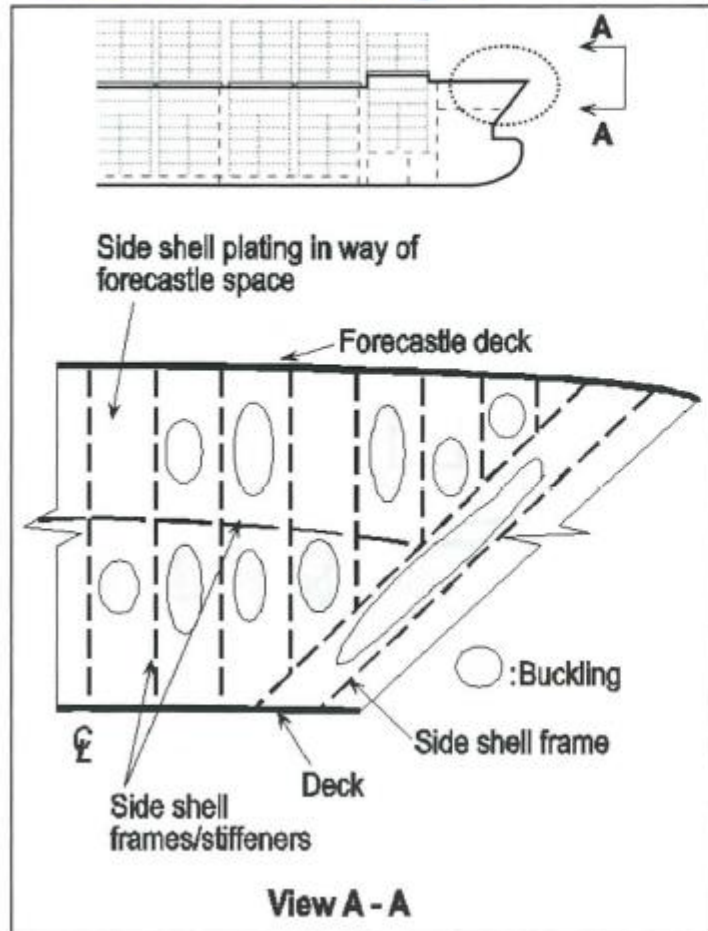
Sketch of repair



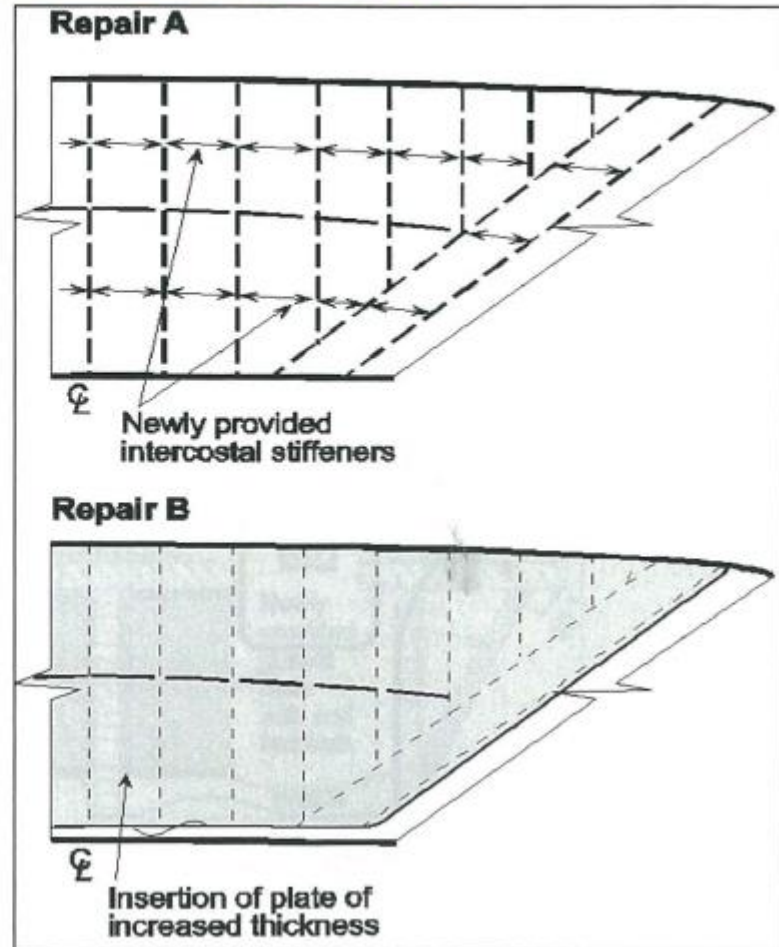
- *) Where required, the longitudinal to be cropped and part renewed
1. For a slope at toes max. 1:3, $R1 = (b1 - h) \times 1.6$ and $R2 = (b2 - h) \times 1.6$
 2. Soft toe bracket to be welded first to longitudinal
 3. Scallop in bracket to be as small as possible recommended max. 35 mm
 4. If toes of brackets are ground smooth, full penetration welds in way to be provided
 5. Maximum length to thickness ratio = 50:1 for unstiffened bracket edge
 6. Toe height, h, to be as small as possible (10-15 mm)

Example of Fore End Structure

Sketch of damages

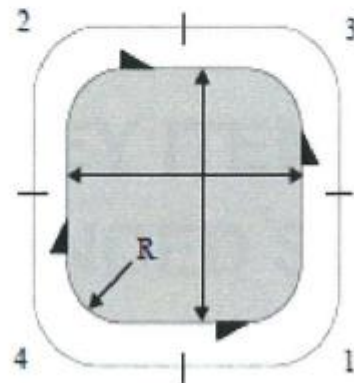


Sketch of damages

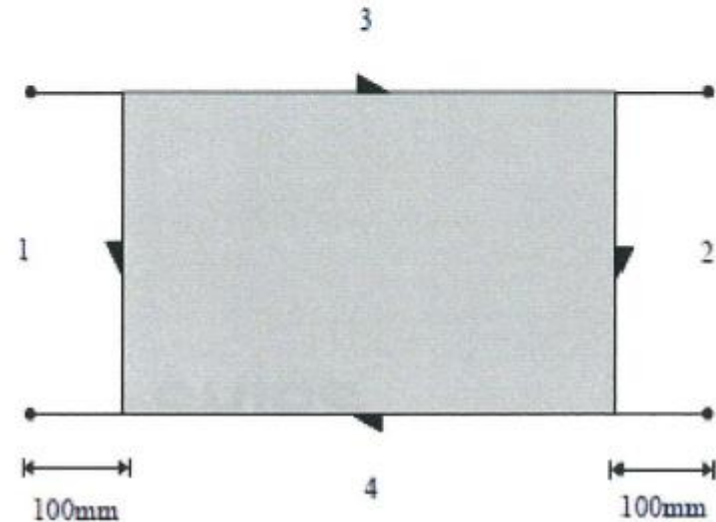


Renewal of Plates

- Size insert: Min. 300 x 300 mm
- Welding sequence:

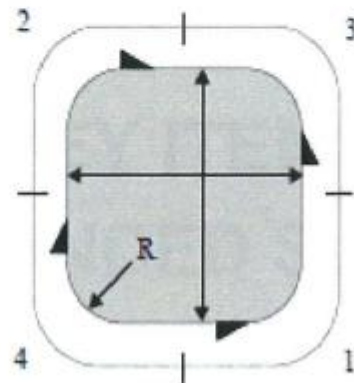


$R = 5 \times \text{plate thickness}$
min. 100mm

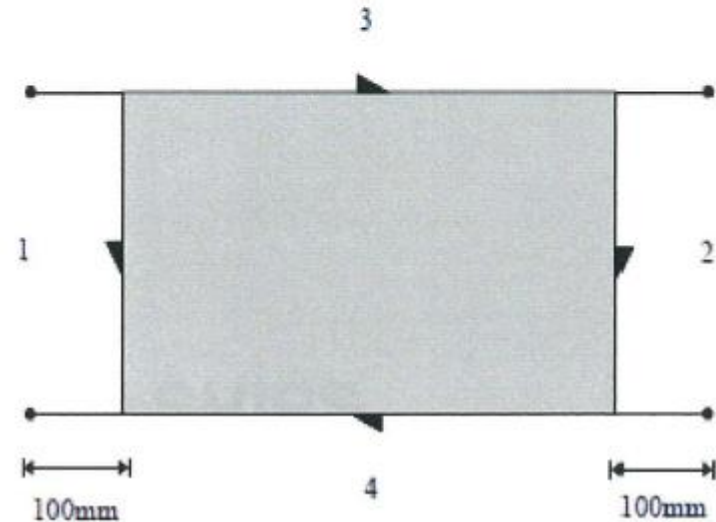


Renewal of Plates

- Size insert: Min. 300 x 300 mm
- Welding sequence:



$R = 5 \times \text{plate thickness}$
min. 100mm





END

2A: Hull Structure

In compliance with the IMO resolution MSC.349(92) and MEPC.237(65), RO Code, Appendix 2.

Rev.1



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