NAVAL ARCHITECTURE PAPER - I
(Management Level)

Chief Mate-FG (Phase-1)

Notes by: Anupam Singh Rajput

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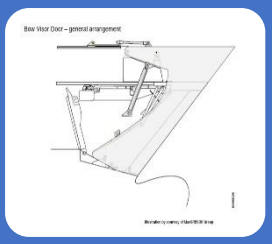
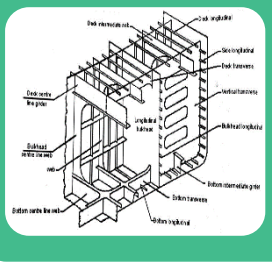


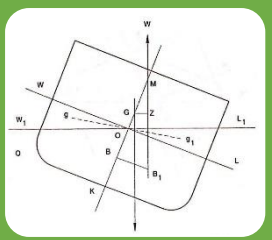
Q NO 4 (Page 12 to 32)

- SHIP CONSTRUCTION-SKETCH



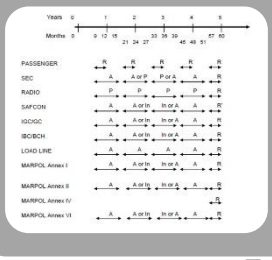
Q NO 6 (Page 12 to 32)

- SHIP CONTRUCTION-THEORY



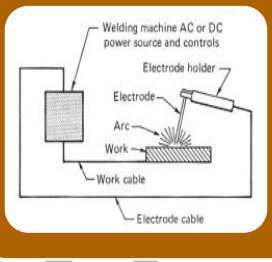
Q NO 5 (Page 34 to 47)

- SHIP STABLITY-THEORY



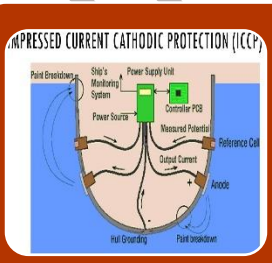
Q NO 7 (Page 49 to 64)

- SURVEYS AND CERTIFICATES



Q NO 8 (Page 66 to 78)

- WELDING



Q NO 9 (Page 80 to 93)

- CORROSION/PAINTING

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FIRST MATE OF A FOREIGN GOING SHIP (PHASE - I)

FUNCTION: CONTROLLING THE OPERATION OF THE SHIPS & CARE FOR PERSONS ON BOARD (Management Level)
PAPER: - NAVAL ARCHITECTURE PAPER – I

TIME: 3 HOURS **PASS MARKS: 120** **MAX.MARKS: 200**

NOTES:

1. All questions in Part A are compulsory. and carry 30 marks each
2. Attempt any four out of five from Part B. (Each question carry 20 marks)
3. Wherever applicable, sketches should be drawn to support the answer.

PART-A

Q.1. Ship Stability- Numerical (Application of Simpson's Rules, Grain Stability)

Q.2. Ship Stability- Numerical (Trim, Dry-docking, Grounding with fixed data)

Q.3. Ship Stability- Numerical based on Ship Stability Booklet (List, Trim, Dry-docking, Grounding, Intact stability requirements)

TOPICS TO COVER:

A) M.V HINDSHIP – LIST & TRIM
B) NORMAL VESSEL & BOX SHAPED VESSEL
C) SIMPSON'S RULE
D) DRY-DOCKING
E) GROUNDING
F) GZ CURVE

Q.4. Ship Construction- Sketch (Page 12 to 32)

(Construction of W/T bulkheads and its attachments to sides and tank top, How water tightness is maintained when bulkheads are pierced by longitudinal, beams or pipes, Arrangement of power operated sliding W/T door, Hinged W/T door and means of securing them, Ramp doors of Ro-Ro ships, Ship side doors)

4.1) Draw and label all parts of a transverse **plane watertight bulkhead** showing its attachment to sides and tank top. (6 times)

4.2) With respect to the **transverse watertight bulkheads** fitted on ships.
a) Sketch and label one such bulkhead showing its attachments to the sides, top and bottom.
b) Functions of transverse watertight bulkheads.
c) Regulations for the testing of such bulkheads.
(5 times)

4.3) Sketch and label a **collision bulkhead**. State requirements regarding positioning and piercing allowed of collision bulkhead as per SOLAS. (6 times)

(OR),

Sketch and describe a collision bulkhead. State its principal function and location in the ship. (2 times)

4.4) Sketch and label a diagram of **watertight corrugated transverse bulkhead** and discuss its construction and functional aspects. State the advantages of corrugation. (2 times)

(OR),

Sketch, label and describe a corrugated watertight bulkhead. Explain the function of bulkheads, and their number and location requirements. (2 times)

(OR),

With sketch of a corrugated bulkhead, show its connection with the shell Plating and deck. (2 times)

4.5) a) Draw the horizontal **sliding power operated watertight door** fitted on a ship.
b) Enumerate the SOLAS requirements for these doors on ships. } (11 times)
c) Describe their testing procedures as per SOLAS.

(OR),

Sketch and label a power-operated horizontal sliding watertight door. Describe its method of achieving water-tightness on passenger ships. (3 times)

(OR),

a) Sketch a power operated watertight door. **d)** Enlist the routine inspection requirements to ensure the trouble free operation of these doors. (4 times)

(OR),

b) List the SOLAS requirements for power operated watertight doors on passenger ships.

4.6.a) Sketch a **hinged type watertight door** showing securing arrangements to ensure water tightness.
b) What are the different categories of watertight doors?

4.7) Sketch and label **Bow door** (side opening) of a RORO Ferry. (2 times)

4.8) Draw and label the **ramp**/stern ramp of a Ro-Ro ship. (5 times)

(OR/AND),

Sketch and describe the arrangement of ramp doors of Ro-Ro ships and its effect on ships stability. (3 times)

4.9) Sketch and label the mid-ship section of a bulk carrier.

PART B

Q.6. Ship Construction- Theory (Page 12 to 32)

Ship Construction: Rules and Regulations for Bulkheads, Watertight doors, Condition Assessment Scheme and Condition Assessment Programme

6.1) a) Write short notes on: i) Water tight ii) Weather tight iii) Oil tight
b) Describe testing requirements of main W/T compartments on cargo ships. (5 times)

6.2) Describe the SOLAS requirements for a **transverse watertight bulkhead** of a cargo ship. (a) Minimum number (b) Location (c) Initial tests (5 times)

(OR),

State the SOLAS requirements regarding:
i) The minimum number of transverse watertight bulkheads on ships (5 times)
ii) location of the **collision bulkhead**. (3 times)

6.3) Compare the advantages and disadvantages of **plain and corrugated bulkheads.** (2 times)

6.4) What are the special strengthening arrangements provided for the bulkheads bounding the tanks for the carriage of oil? (2 times)

Q.6) a) Explain SOLAS regulations of piercing of Collison Bulkhead.
See Q. No 4.3
b) Sketch and label a transverse corrugated watertight bulkhead.
See Q. No 4.4
(2 times)

Q.6 a) What are the regulations for the positioning of the collision bulkhead? b) What are the special strengthening arrangements provided for the collision bulkhead compared to bulkheads fitted elsewhere? (3 times)

(OR),

a) Describe the rule applicable regarding location of collision bulkhead. b) Why and how is collision bulkhead specially strengthened. (2 times)

See Q. No 4.3

Q.6 a) Sketch and describe hydraulic closing Watertight door. b) List and explain SOLAS requirements of watertight doors of cargo ships. (2 times)

See Q. No 4.5

6.5) Explain the rules regarding number of openings in passenger ships and W/T door.

6.6) State the hazardous conditions for the ship when the watertight doors need to be closed.

6.7) Describe the systems for indication and monitoring of bow door operation on board Ro-Ro ships.

6.8) Describe with the aid of a simple sketch, securing and locking arrangements of bow doors on ships

6.9) What is cofferdam? Where it is fitted and what are its functions? (3 times)

Q.5. Ship Stability- Theory (Page 34 to 47)

Ship Stability: Effect of density on trim, Effect of beam, freeboard and length on GZ curves, Effect of shift of weight on GZ curves, Dry-docking

1) With reference to the International Code for the Carriage of Grain in bulk explain: a) Intact stability criteria as applicable to ships carrying grain in bulk. b) Volumetric heeling moments and its effect on stability. (12 times)

2) State the intact stability requirements for cargo vessels.

3) What are Cross Curves of Stability. How are they used in stability. Calculations by a Chief mate of a vessel. (2 times)

4) With the help of suitable diagram, explain how can initial GM be obtained from Curve of Statical Stability.

5) Draw and explain the Curve of Statical Stability for a listed ship and the ship at angle of loll. (2 times)

6) Explain what is Angle of Loll and its corrective actions.

Q.5 Draw a sketch of statical stability curve for a vessel which is at an angle of loll. Also suggest the remedial action to be taken explaining the reasons for same.

Write joint answers from Ques 5 & 6

7) Explain with neat sketches effect on GZ values because of a) Vertical shift b) Transverse shift of cargo on-board a ship

(OR),

Q.5 Discuss the effects of shift of cargo on the GZ values & GZ curve of a vessel.

8) Describe the effect of the following on GZ curve of a vessel. a) Increase of beam b) Increase of freeboard c) Vertical upward shift of vessels centre of gravity. (8 times)

(OR),

Discuss the effect of change in Beam and Freeboard on the GZ curve of the ship. (7 times)

9) Why and how does the trim of a vessel change when she goes from: (a) SW to FW (LCB > LCF) (b) FW to SW (LCF > LCB) (4 times)

(OR),

With neat sketches, discuss the effect of Change in Density of the water in which ship is floating on the Trim (3 times)

(OR),

Explain with suitable sketches the change in trim of the vessel when she goes from water of lesser density to water of higher density provided a) LCF > LCB b) LCF < LCB.

(OR),

How would the trim of a vessel change whose LCB = 73m & LCF = 74m change when she goes from FW to SW.

10) Discuss the effect of change in the Density of water in which a ship is floating on: i) Trim ii) GZ values iii) LCG (3 times)

11) Explain: a) Critical Period b) Critical Instant c) Declivity (3 times)

12) a) What are the reasons for desirability of dry docking with the small stern trim. **b)** What precautions will you take for dry docking a loaded ship. (3 times)

13) Explain why the values of trim and metacentric height in the freely afloat conditions are important when considering the suitability of a vessel for dry-docking. (3 times)

14) Explain how the values of following parameters change with change in vessel's draughts: i) KMT ii) LCB iii) MCTC iv) TPC v) LCF (3 times)

15) A vessel on her voyage has inclined unexpectedly by 5°. Discuss the various possibilities for this condition.

16) GM alone is not the adequate measure of the stability of the ship. Justify the above statement with sketches.

17) State and explain the condition necessary from the stability point of view, when carrying out routine drydocking of ship

Q.7 Surveys and Certificates (Page 49 to 64)

1) Write short notes on the following: a) Harmonized System of Survey and Certification. b) Condition Assessment Scheme. c) Enhanced Survey Programme. (4 times)

Q.6 Describe the objectives and main features of the harmonized system of surveys and certification, and list various certificates covered by this system.

Write answers from Ques 1.a

Q.7 a) List the advantages of the Harmonised System of Survey and Certification. (6 times)

Write answers from Ques 1.a

2) Enumerate various types of surveys and draw a diagrammatic arrangement of various surveys as required by harmonic system of surveys and certification. (2 times)

Q.7 a) State the main features of the HSSC? State the circumstances when you will call the surveyor for additional survey?

Write joint answers from Ques 1.a & 2

3.a) Explain the need for vessels to undergo CAP Survey. (3 times)

3.b) Discuss as to how the Condition Assessment Programme differs from Condition Assessment Scheme. (2 times)

(OR),

Compare between Condition Assessment Program and Condition Assessment scheme. (2 times)

(b) Write short notes on Condition Assessment Scheme (CAS). (4 times)

Write answers from Ques 3

4) For which type of ship is “The Enhanced system of survey” compulsory? Briefly describe the system. (3 times)

Q.7) Explain what is "Close up inspection" and "Critical areas" with reference to Enhanced Survey programs. **Describe the contents of "Documents File."** (4 times)

Write answers from Ques 4

Q.7 With respect to Enhanced Survey, explain the following: a. Critical Areas b. Suspect Areas c. Close-up inspection d. Substantial Corrosion.

Write answers from Ques 4

Q.7 a) Explain the Enhanced Survey Programme for ships? b) Describe: i) Substantial corrosion ii) Close up inspection and iii) Frequency of bottom survey / inspection as per Enhanced Survey Programme.

Write answers from Ques 4

Q.7 Explain how the “Enhanced Survey Programme” has been helpful in making the ships safer.

Write answers from Ques 4

Q.7 i) What is an Enhanced Survey Program (ESP)? ii) List the surveys carried under the HSSC and explain the scope of the Annual Survey?

Write joint answers from Ques 4 & 2

Q.7 a) What is enhanced of survey? To which ships does this system apply? b) What documentation is done on board with respect to enhanced system of survey?

Write joint answers from Ques 4 & 5

Q.7 Discuss the main features of ESP while explaining the requirements for inspection and surveys carried out on double hull oil tankers.

Write answers from Ques 4

5) How the flag states ensure that their rules and regulations are effectively enforced on the ships registered with them? (3 times)

6) State the objectives and features of ESP with reference to: a) Age of the vessel b) Access to the Surveyor c) Coating Condition d) Owner’s Responsibility.

7) Describe the procedure for preparing the vessel for (SAFCON) safety construction renewal survey. (5 times)

8) Explain process of preparing for Safety equipment survey of your ship

9) Under the Harmonized system of surveys & Certification explain how will you prepare you vessel for an annual Load Line survey? (2 times)

(OR),

Q.7 Briefly describe the scope of initial, annual, intermediate and renewal surveys for loadline certificate.

Q.7 a) Describe the frequency of class surveys? How would you prepare your ship for Load line survey? (2 times)

Write joint answers from Ques 2 & 9

10) List out the various items to be opened and examined in dry dock as part of classification society surveys.

11) How will you as Chief Officer, prepare the ship for special survey?

12.a) What are the survey requirements for an oil tanker undergoing 3rd special survey? **b)** What are the preparations to be carried out for the above vessel prior to the commencement of the survey? (2 times)

13) List the certificates required to be carried on board an oil tanker in addition to statutory & mandatory certification carried by cargo ships.

Q.8 Welding (Types, Faults, Tests) (Page 66 to 78)

1) List various types of welding. (2 times)

Explain manual metal arc welding, with precautions to take: *Ans from 1.1*

Describe the process of gas wielding, with the help of a neat diagrams (2 times): *Ans from 1.2*

Write short notes on: i) Submerged Arc welding: *Ans from 1.4* ii) T.I.G. welding: *Ans from 1.3* (2 times)

Write short notes on: a) Thermit welding: *Ans from 1.5* b) MIG Welding: *Ans from 1.2*
c) Importance of flux in welding: *Ans from Ques 2* } (3 times)

Compare the Submerged Arc Welding and Manual Metal Arc Welding processes. (2 times) : *Ans from 1.2 & 1.4*

Describe and compare the TIG and MIG welding processes : *Ans from 1.2 & 1.3*

2) What is flux? What is the purpose of flux in welding? (3 times)

3) Describe with sketches, the various types of weld 'Joints' (2 times)

Write brief note on butt, lap and fillet weld with help of suitable diagrams (2 times): *Ans from Ques 3*

4.a) Describe various types of defects that could be found in welded joints, with sketches as relevant. (3 times)
b) Also explain their causes and how they can be minimized by good welding practice.
(OR),
List & describe the main causes of faults in welding and show how they may be overcome by good welding practices. (3 times)
c) Describe the destructive and non-destructive methods of testing welds (3 times)

List the various defects in welding. Explain any one of them: *Ans from Ques 4.a*

Describe four types of welding defects and preventive measures: *Ans from Ques 4.a*

Write short notes on weld faults? (2 times) : *Ans from Ques 4.a*

List the causes and remedies for the following types of weld defects: i) Lack of fusion: *Ans from Ques 4.a*
ii) Incomplete penetration: *Ans from Ques 4.a* iii) Undercutting: *Ans from Ques 4.a* } (5 times)
iv)What is the purpose of flux in welding? : *Ans from Ques 2*

Describe with sketches various types of defects that could be found in welded joints and what are the remedies.
Write Same as Question 4

State how these defects can be minimized by good welding practices. (3 times): *Ans from Ques 4.b*

a) Describe submerged arc welding? : Ans from 1.4 b) Describe the various welding faults: *Ans from Ques 4.a*

Q.9 Describe the faults that can be found in welds and describe the methods of testing of these faults. **(11 times)**
Write joint answers from Ques 4.a & 4.c

Q.8 a) Describe three types of automatic welding process used in shipyards. b) Describe three types of welding defects and preventive measures. (2 times)
Write joint answers from Ques 1 & 4.a

5) With the help of sketches, write short notes on: a) Edge preparation of plates for welding b) Tack welding
c) Measures adopted in minimum distortion d) Back-run

6) How effective weld penetration is achieved while welding thick steel plates? (2 times)

Q.9 Corrosion/ Painting (Page 80 to 93)

Q.9 (a) Sketch and describe Impressed Current Cathodic Protection system used on ships. (b) Compare the merits and demerits of Cathodic protection system by sacrificial anodes and ICCP system. +7

Q.8 a) Explain corrosion cell with regards to galvanic corrosion. b) Sketch and describe an Impressed Current Cathodic Protection System (ICCP). +4

Q.8 Describe the principle of cathodic protection system against corrosion. Explain various methods used on board merchant vessels. +1

Q.9 What is galvanic cell in terms of corrosion? Describe SACP or ICCP methods of corrosion prevention. +3

Q.9 ii) With the help of a neat diagram, explain the ICCP method of corrosion prevention on board ships. +1

Q.9 a) Describe different types of corrosion taking place on board ships. b) Compare sacrificial anode protection to Impressed Current cathodic protection ICCP. +1

Q.9 i) What is the objective of surface preparation prior to painting? List the methods of surface preparation? +2

Q.9 Describe a typical paint scheme for: a) Main deck including fittings b) Superstructure c) DB tanks internal d) Forepeak tank

Q.9 a) Describe the components of marine paint and their importance. +1 b) How will you calculate the wetted surface area for painting.

Q.9 Describe how corrosion is controlled on board the ship under following headings: a) Protective Coating b) Cathodic Protection +1

Q.9 a) Explain the structure of paint and purpose of each of its constituent. b) What is the importance of Material data Safety Sheets?

Q.8 Good understanding of the Galvanic series of metals is vital for protection against corrosion. Discuss its application in context of shipboard measures employed in preventing corrosion of ship's hull.

Q.9 a) Describe the methodology of selecting a suitable protective coating for different areas of ship in order to minimize the effects of marine corrosion. b) Describe the painting scheme for weather decks. +1

Q.9 a) How improved design of a ship and its various structures can help reducing corrosion? Describe with suitable examples.

Q.9 a) Differentiate between corrosion and erosion. Enlist different types of corrosion on board ships. b) How does the cathodic protection help reduce shipboard corrosion? +2

Q.9 What are the various methods of controlling corrosion on board? +1

Describe with a neat sketch, the Impressed Current Cathodic Protection method of corrosion control with its advantages and disadvantages.

Q.9 Write notes on: i) Power tool cleaning ii) Sacrificial anode system of corrosion control iii) Corrosion cell

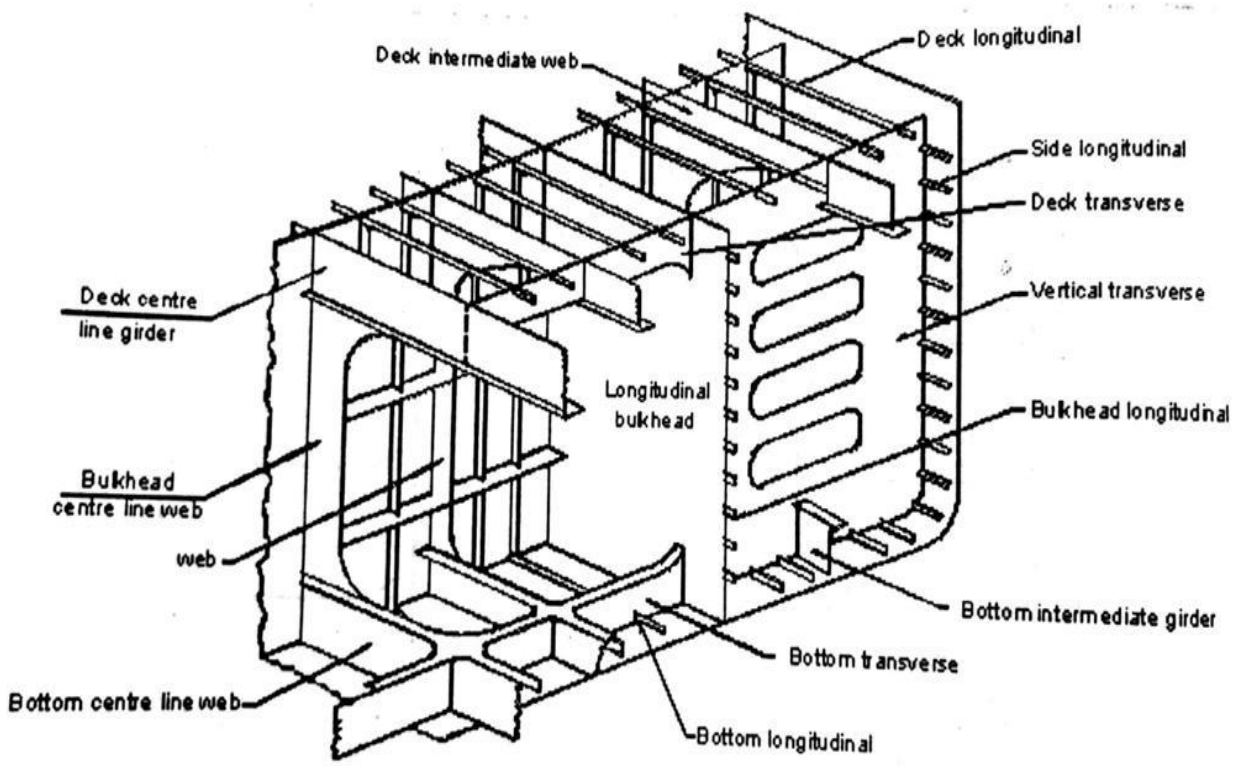
Q.9 Describe a typical paint scheme for: a) Underwater areas and flat bottom b) boot-top area c) top side area d) ballast tank interior

Q.9 a) Why corrosion prevention non ship's structure is very important to ensure safety of life and marine environment? b) What are the different means of corrosion prevention adopted for the ship's structure? +1

Q.9 Write short notes on the following: a) Sacrificial anode b) Cavitations c) Corrosion d) Safety precautions when using paints

Q.4 & 6 Ship Construction- Sketch & Theory

(Page No 12 to 32)



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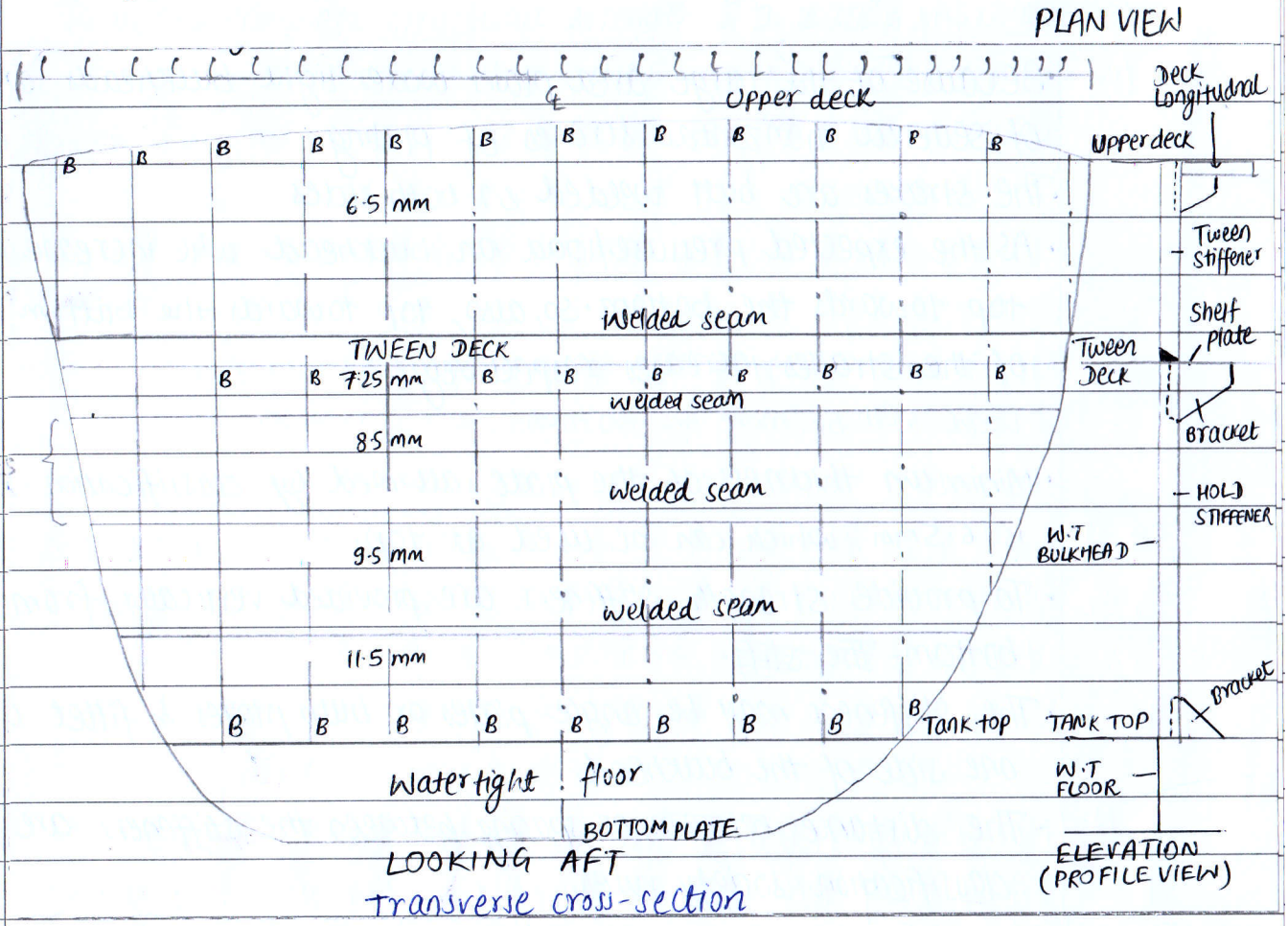
Q.4. Ship construction - Sketch , and,

Q.6. Ship construction - Theory

PLAIN WATERTIGHT BULKHEAD

4.1) Draw and Label all parts of a transverse plain watertight bulkhead showing its attachment to sides and tank top (6 times)

Ans:-



6.1.a) Write short notes on:

(i) Water tight

- Water tight means having no openings to allow the passage of water.
- Used for sub division of ship to provide stability in case of damage.
- Designed to withstand maximum hydrostatic pressure in case the compartment is fully flooded
- Watertight fitting shall withstand water pressure from both sides.

(ii) Weather tight

- Weather tight means that in any condition water will not penetrate into the ship.
- Weather tight fitting shall have a strength atleast equal to the bulkhead or deck in which it is fitted.
- Weather tight fitting shall withstand water pressure from the outside.

(iii) Oil tight

- Oil tight means partition of plating capable of preventing the flow of oil under pressure from one compartment to another.
- Used for the boundaries of tank which are designated for use of liquid cargo and fuel oil.
- It has more stringent test than water tight bulkhead.

TRANSVERSE WATERTIGHT BULKHEAD

4.2) With respect to the transverse watertight bulkhead fitted on ships:

a) Sketch and label one such bulkhead showing its attachments to the sides, top and bottom. (5 times)

Ans:- Same as Ques 4.1

b) Function of transverse watertight bulkheads (5 times)

Ans:- Function of transverse watertight bulkheads are as follows:

- Provide structural strength specially against shearing force
- Sub-division of ship into water-tight compartment.
- To provide for survival in case of damage
- Designed to withstand maximum hydrostatic pressure in case the compartment is fully flooded.
- Shall withstand water pressure from both sides.
- Operation requirements i.e. cargo & machinery spaces, bunker tanks, ballast tanks etc.
- Commercial requirements: based on type of cargo and trade of the ship.

c) Regulation for the testing of such bulkheads (5 times)

Ans:- SOLAS II-1/11

All water-tight bulkheads must be tested initially & periodically upto bulkhead deck on passenger ship and freeboard deck on cargo ship.

Two types of test are required by classification societies:-

(aa) Structural test

To verify complete structural strength of a water tight compartment.

Example: Hydrostatic test & Hydropneumatic test

(i) Hydrostatic test

- Should be carried out with liquid of the appropriate density based on the required service of the tanks.
- Sea water should be used for all cargo & ballast tank and fresh water can be used for fuel & lube oil tank.
- The tank should be filled with water upto a level which is greater of the following: top of overflow pipe
  2.4m above the top of tank
  Upto the bulkhead deck/ freeboard deck.
- If the tank is designed for cargo density greater than seawater, the height for the test should be increased to generate the same pressure.
- This test is used for all ballast tanks, fuel tanks where liquid is carried under atmospheric pressure.

(ii) Hydropneumatic test

- It is required for all tanks designed to carry oil as per MARPOL Annex I or chemical as per IBC code.
- The tank is filled with SW upto the maximum level possible and then pressurized with air to simulate the actual loading condition with the expected vapour pressure.
- For oil tanker, this test is required to be carried out during special surveys.

bb) Leak test

It is required to verify the tightness of boundaries & welded joints.

Example: Hose test, Air test, Ultrasonic test and Dye-penetrant test.

(i) Hose test
- If the compartment cannot be filled with water for testing, hose test may be carried out on welded joints.
- For hose test, the nozzle should have atleast 12mm diameter & should be at perpendicular distance less than 1.5m.
- The minimum pressure required in hose is 2 bars.

(ii) Ultra sonic test
- Used when flooding/hose test are not feasible (like in accomodation spaces, electrical spaces)
- A transmitter placed on one side emits high-frequency sound waves.
- A reciever on the opposite side detects any leakage through weak spots.

6.2) Describe the SOLAS requirements for a transverse watertight bulkhead of a cargo ship

a) Minimum number (10 times)

Ans:- (i) Collision bulkhead at forward end of the ship
(ii) Aft peak bulkhead at aft end of the ship.
(iii) Transverse bulkhead fwd & aft of machinery space to seperate from accomodation & cargo spaces.
Note: If design permits, the aft peak bulkhead may be combine with aft bulkhead of machinery space.
(iv) Sufficient number of transverse watertight bulkhead required to sub-divide the ship into watertight compartment such that the flooding of any one compartment will not endanger the ship's buoyancy and stability

b) Location of collision bulkhead (8 times)

Ans:- Same as Ques 4.3

c) Initial test (5 times)

Ans:- Same as Ques 4.2.c

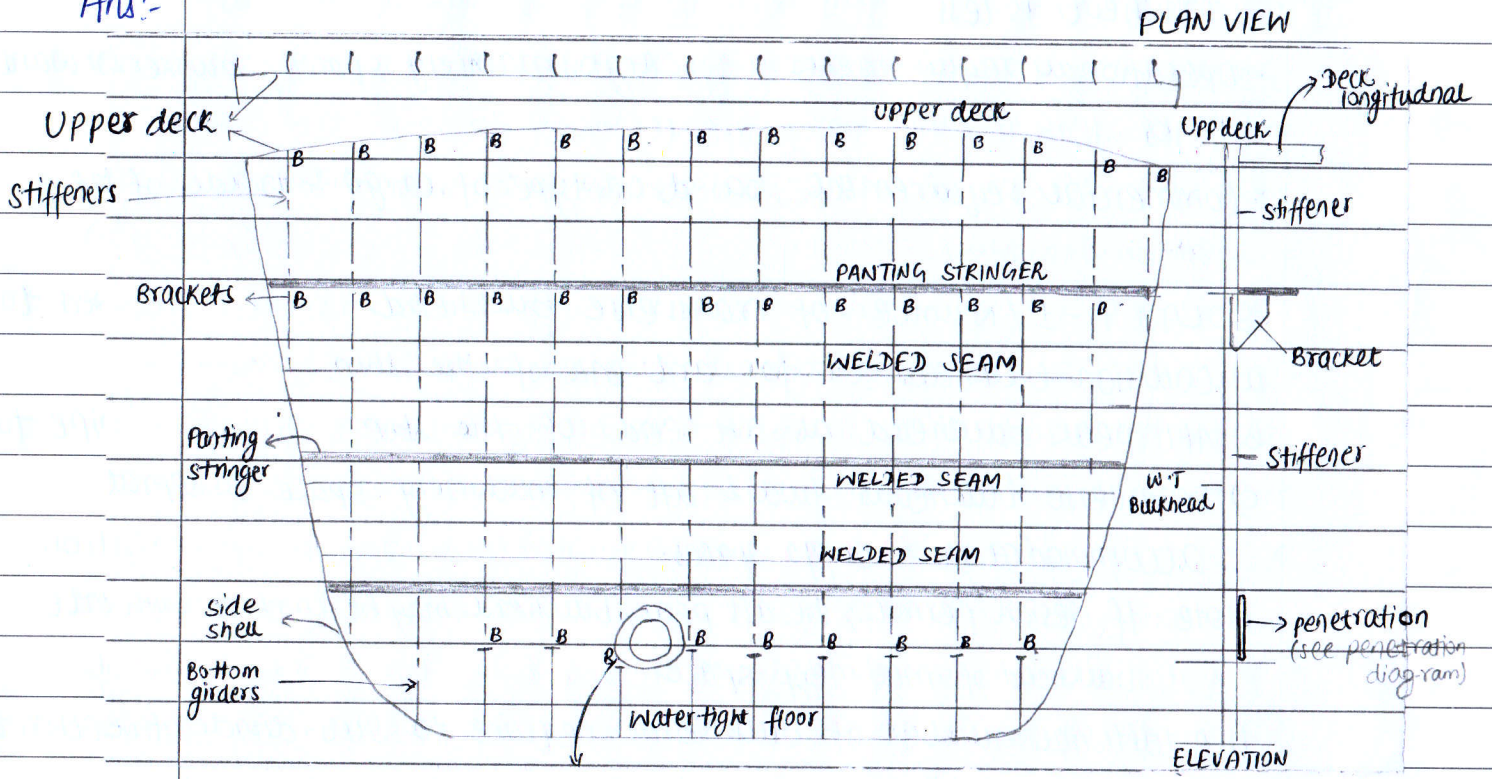
COLLISION BULKHEAD

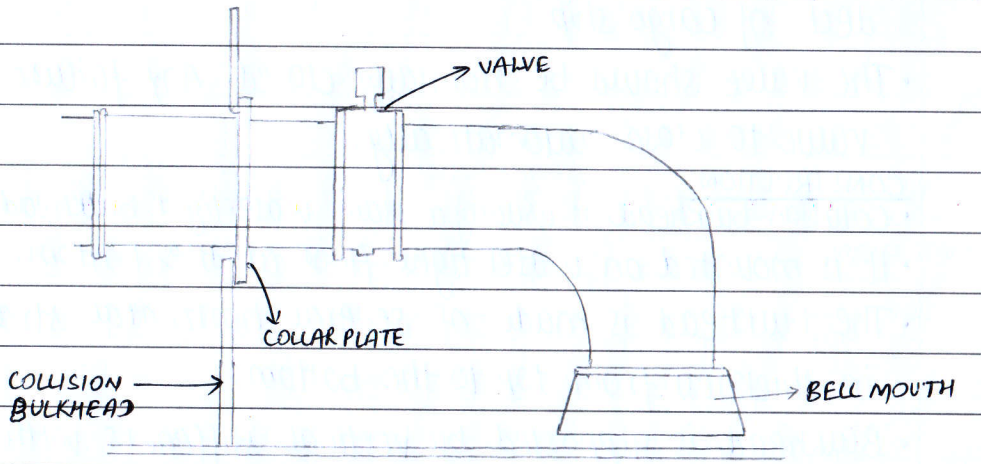
4.3) Sketch and label a collision bulkhead. State requirements regarding positioning and piercing allowed of collision bulkhead as per SOLAS (6 times)

(OR),

Sketch and describe a collision bulkhead. State its principle function and location in the ship (2 times)

Ans:-





Solas requirement for collision bulkhead :-

SOLAS II-1/12

COLLISION BULKHEAD

- Every ship shall be fitted with a collision bulkhead at the forward end

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- Collision bulkhead shall be watertight upto the bulkhead deck on passenger ship.
- Collision bulkhead shall be watertight upto the free-board deck on cargo ship.
- The bulkhead shall be located:
  - → not less than 5% of the length or 10m from the forward perpendicular whichever is less.
  - → not more than 8% of the length or 5% of length + 3m from the forward perpendicular, whichever is greater.
- The ship should be able to survive any damage forward of the collision bulkhead.
- No doors, manholes, access opening or ventilation ducts are allowed to be fitted on collision bulkhead.
- The collision bulkhead may be pierced by not more than one pipe to deal with liquid in forepeak tank.
- NO flanges are allowed at the collision bulkhead & the penetration piece should be welded to the collision bulkhead with a collar plate.
- A valve should be provided which should be able to be remotely operated from above the bulkhead deck of passenger ship and freeboard deck of cargo ship.
- The valve should be normally closed. Any failure will make the valve to close automatically.

CONSTRUCTION:

- Collision bulkhead is usually a plain watertight bulkhead
- It is mounted on water tight floor at the bottom.
- The bulkhead is made of several horizontal strakes or plating increasing in thickness from top to the bottom.
- Bulkhead is supported by vertical stiffeners with reduced spacing to increase the strength.
- Several horizontal stringer plates are used at equal distances to counter panting.
- The stiffeners are brackated to the stringers and deck plate.
- The penetration for the forepeak tank ballast line is made watertight by using a collar plate.

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CORRUGATED WATERTIGHT BULKHEAD

4.4) Sketch and label a diagram of watertight corrugated transverse bulkhead and discuss its construction and functional aspects. State the advantages of corrugation. (2 times)

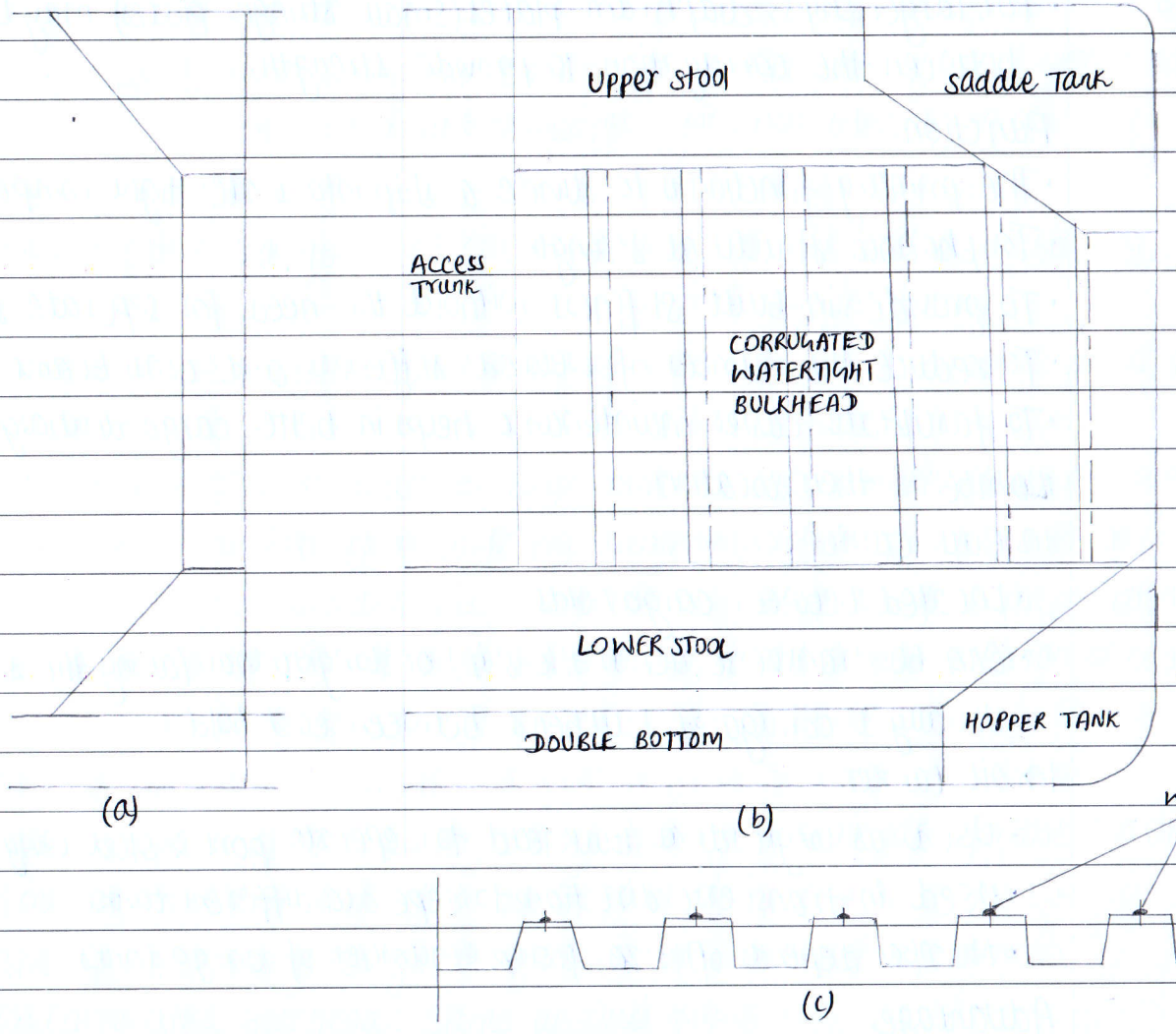
(OR),

Sketch, label and describe a corrugated watertight bulkhead. Explain the function of bulkhead, and their number and location requirements. (2 times)

(OR),

With sketch of corrugated bulkhead, show its connection with the shell plating and deck (2 times)

Ans:- Corrugated water tight bulkhead



(a) Section through corrugation
(b) Elevation of bulkhead
(c) Plan view of corrugation

Construction

- Corrugation (or swedges) are used to eliminate the need for stiffeners & stringer.
- A corrugated plate will be stronger along the direction of corrugation.
- For this reason, vertical corrugation are preferred for transverse wates tight bulkhead.
- Angle of corrugation is usualy around 45 degrees.
- For small ships, bulkhead may be directly mounted on tanktop plating and underside of the upper deck.
- On large ship, bulkhead is usualy mounted between upper and lower stool spaces.
- For larger ships, diaphram plates (small stringer plates) may be used between the corrugation to provide strength.

Function:

- The primary function is to divide a ship into water-tight compartment
- To enhance structural strength
- To provide in-built stiffness without the need for seperate stiffeners.
- To reduce the number of welded stiffeners and cross beams.
- To fascilitate easier maintenance helps in better cargo discharge & washing.

Number & their location.

In Bulk carrier

- Located between cargo holds.
- Can be transverse (across the ship) or longitudnal (along the ship)
- Usualy 1 corrugated bulkhead between each hold.

In oil tanker

- Used as longitudnal bulkhead to seperate port & stbd wing tanks
- Used in transverse direction to seperate different tank
- Number depends on size of ship & number of cargo tanks.

Advantage

- No need for additional stiffeners.
- Easier to clean and inspect
- More strength with less material.
- Better space usage in cargo tanks or holds.

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6.3) Compare the advantage and disadvantage of plain and corrugated bulkheads (2 times)

Ans:-

Item	Plain	Corrugated
Strength	To increase the strength, plate thickness should be increased & stiffener spacing should be reduced	Strength comes from corrugation shape itself.
Weight	Heavier due to stiffeners and more steel	Lighter as no stiffeners are required.
Construction	More complex - need fitting and welding of stiffeners.	Simpler and faster to fabricate.
Cost	High due to extra material & labour.	Marginal difference, if stool spaces are used at top & bottom.
Cargo capacity	Maximum grain capacity is available including multiple point for lashing	Reduced by stool spaces and so not used by VLCCs.
Cargo operation	Likelyhood of cargo residue	Faster loading, discharging, cleaning and gas freeing.
Inspection & cleaning	Difficult due to multiple corners	Easy - no hidden corners, smooth surfaces.
Maintenance	Due to multiple abrupt corners, difficulty in surface preparation. Localized stress concentration is higher and so less retention of coating.	Due to their flush & smooth surface and the absence of abrupt corner, surface preparation is easier and retention of coating is longer.

6.4) What are the special strengthening arrangement provided for the bulkhead bounding the tanks for the carriage of oil? (2 times)

Ans:- The special strengthening arrangement provided are as follows:

(a) Corrugated bulkhead: Same as Ques 4.4

(b) Web frames & girders: Provided on deck & bottom sides to support bulkhead plating

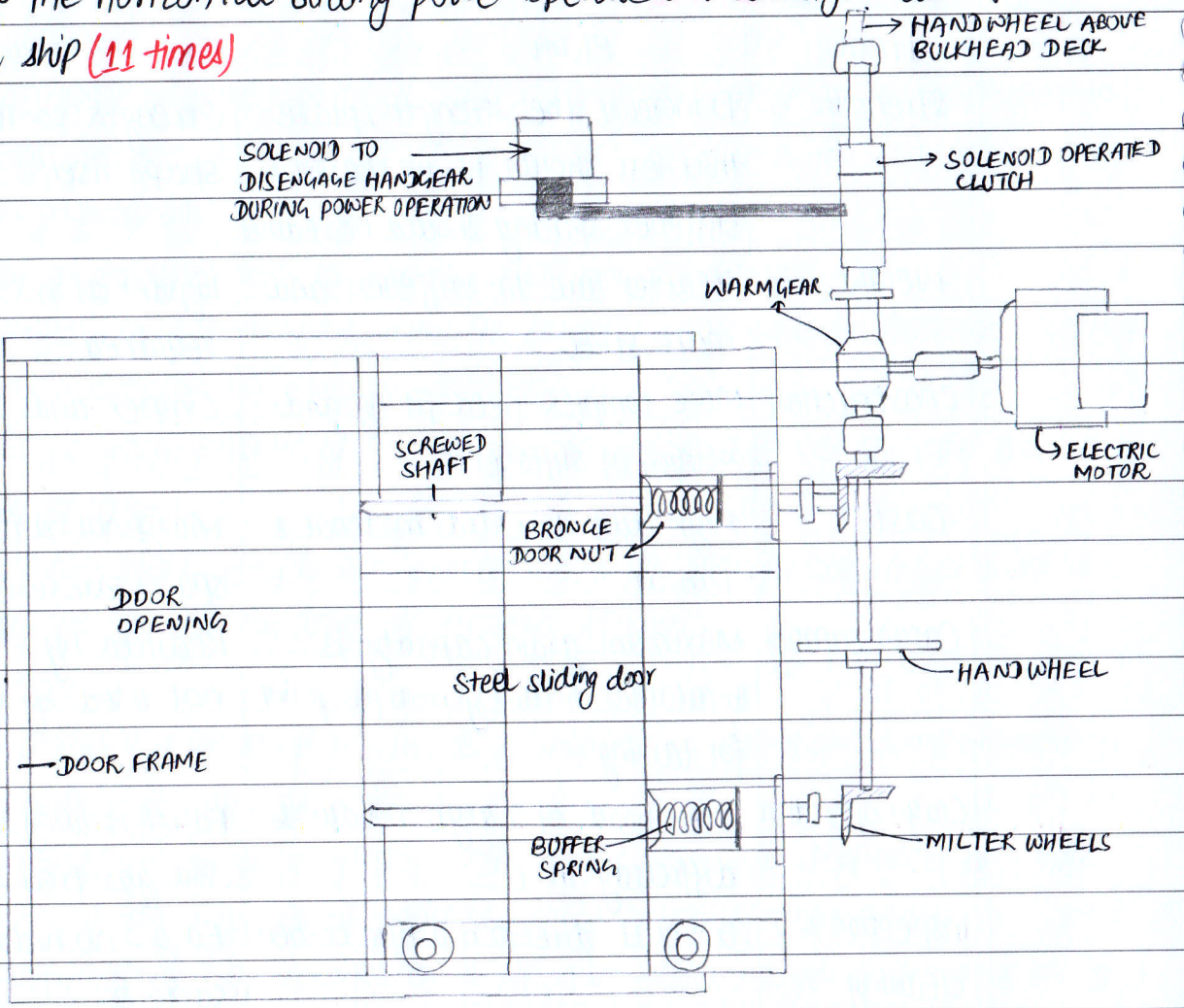
(c) Brackets: Brackets are fitted at the corners where bulkhead meet tank top or ship side

(d) Anti-corrosion coating: Inner surface of oil tank bulkhead are coated with epoxy-based oil resistant paint.

Power operated sliding watertight door.

4.5.a) Draw the horizontal sliding power operated watertight door fitted on a ship (11 times)

Ans:-



b) Enumerate the SOLAS requirement for these doors on ships (11 times)

Ans:- SOLAS II-1/Reg 13

- Every opening in watertight bulkhead below the bulkhead of passenger ship should be provided with means of closing.
- All watertight doors provided as means of closing should be of power operated sliding type (POS).
- Each POS W/T door shall have a vertical or horizontal motion.
- All POS W/T door shall be capable of being closed
  - → locally and manually.
  - → Remotely by manual arrangement from above the bulkhead deck
  - → All door simultaneously from the remote & central operating console located on the Navigation bridge.

- All POS W/T doors shall be capable of being closed simultaneously from the navigating bridge in not more than 60 seconds with ship upright.
- The means of closing watertight door should be operational with ship listed 15° eitherway and with the water flowing through the door at static head of 1m.
- The local controls for watertight door shall be located close to the door but such that the likelyhood of damage in case of flooding will be minimized.
- The watertight doors & controls must be located greater than $\frac{1}{5}^{th}$ or 20% of the breadth of the ship from ship side.
- The maximum clear opening of POS type WT door should be limited to 1.2mtr.
- It should be possible to close these doors from either side locally & manually in not more than 90 seconds with ship upright.
- An indicator console with audio/visual alarm should be fitted locally as well as on navigation bridge.
- The indicator should provide following:
  - → Power supply and power failure
  - → Door open or closed indication
  - → Common master control switch on bridge to close all door simultaneously.
  - → Earth failure/Grounding alarm (short circuit)
- Each door shall be fitted on audio/visual alarm locally which will sound & flash when the door is being operated remotely.
- The power supply should be sufficient to operate all the doors atleast 3 times with adverse list of 15° (close, open & close)
- A single failure in electrical or mechanical system should not cause the door to open or operation of other doors.

c) Describe their testing procedure as per SOLAS (11 times)

Ans:- Method of testing watertightness of POS WT door are:-

(i) Chalk test

- Apply a continuos layer of chalk along the rubber gasket or metal contact surface of the door.
- Close the door completely and apply pressure by locking it.

- Open the door after a few minutes.
- Inspect the chalk pattern
  → If the chalk is uniformly removed, the door has good contact.
  → If chalk is intact in some areas, it indicates leak

(ii) Hose test
Same as 4.2.c

(iii) Ultrasonic test
Same as 4.2.c

d) Enlist the routine inspection requirements to ensure the trouble free operation of these doors (4 times)

Ans:- Inspection requirement to ensure the trouble free operation of these doors are as follows:-

- Drills for the operating of water-tight doors, valves and closing mechanism shall take place weekly.
- In ship, in which the voyage exceeds one week, a complete set of operational test drill shall be held before leaving port, and thereafter once a week during voyage.
- All watertight doors, both hinged and power operated, in watertight bulkheads, in use at sea, shall be operated daily.
- The watertight doors, its mechanisms, indicators, all valves (closing of which is necessary to make compartment watertight), all valves (operation of which is necessary for damage control cross connection) shall be periodically inspected at sea atleast once a week.
- A record of operational test drill and inspection required by the regulation shall be recorded in the log book with record of defect, if observed any.

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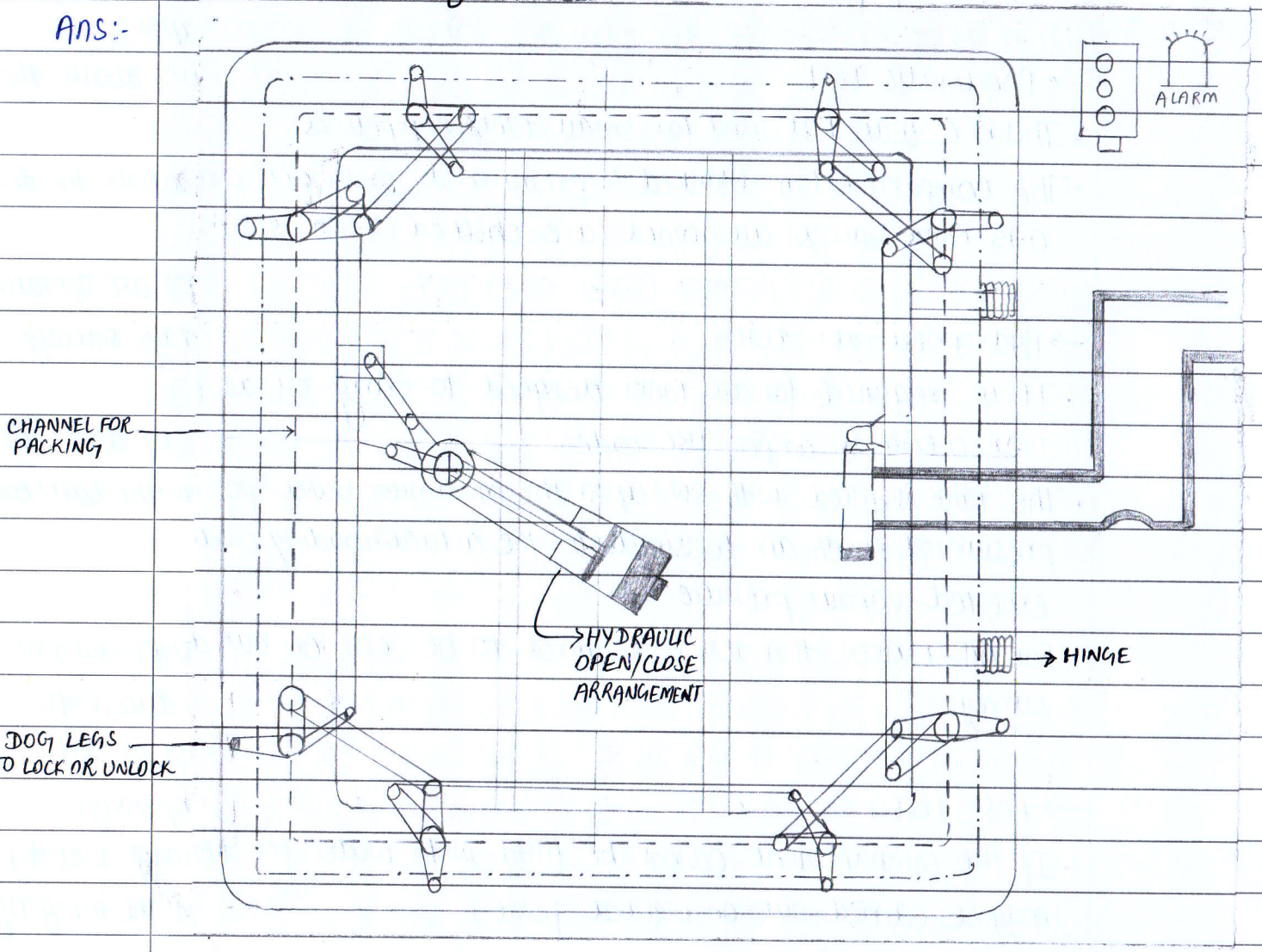
Hinged type watertight door

4.6.a) Sketch a hinged type watertight door showing securing arrangement to ensure water tightness.

Ans:-



4.6.b) What are different categories of watertight doors?

Ans:- Different type of watertight doors on ships:-

Type A : This type of doors may be left open and are to be closed only during an emergency.

Type B : This type of doors should be closed and are made to remain open only when personnel are working in adjacent compartment.

Type C : This type of doors is to be kept closed all the time. It may be opened only for sufficient time when personnel are passing thrugh the door compartment.

Type D : This type of door is not SOLAS compliant. These doors shall be

closed before the voyage commences and shall be kept closed during navigation. These doors cannot be upgraded to another category.

Watertight doors are further classified into the following types:

Hinged type: This type of door are operated by rotation motion about the hinged axis located on the side or on the top.
Hinged type door are permitted minimum 2 meters above the deck which is above the deepest subdivision loadline.

Sliding type (operated by hand gear only): These type of door are operated by opening/closing in linear motion either horizontally sideways or vertically up and down.

Sliding type (operated by power and by hand gear): These type of doors are currently permitted for use on passenger ship below the bulkhead deck.

6.5) Explain the rules regarding number of opening in passenger ships & WT door.

Ans:-

- The number of openings in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the ship, satisfactory means shall be provided for closing these openings.
- Where pipes, scuppers, electrical cables etc. are carried through watertight bulkheads, arrangement shall be made to ensure the watertight integrity of the bulkheads.
- Valves not forming part of a piping system shall not be permitted in watertight bulkheads.
- No doors, manholes, or access openings are permitted in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space.
- Not more than one door, apart from the doors to shaft tunnels, may be fitted in each watertight bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the need of propulsion.

6·6) State the hazardous conditions for the ship when the watertight doors need to be closed.

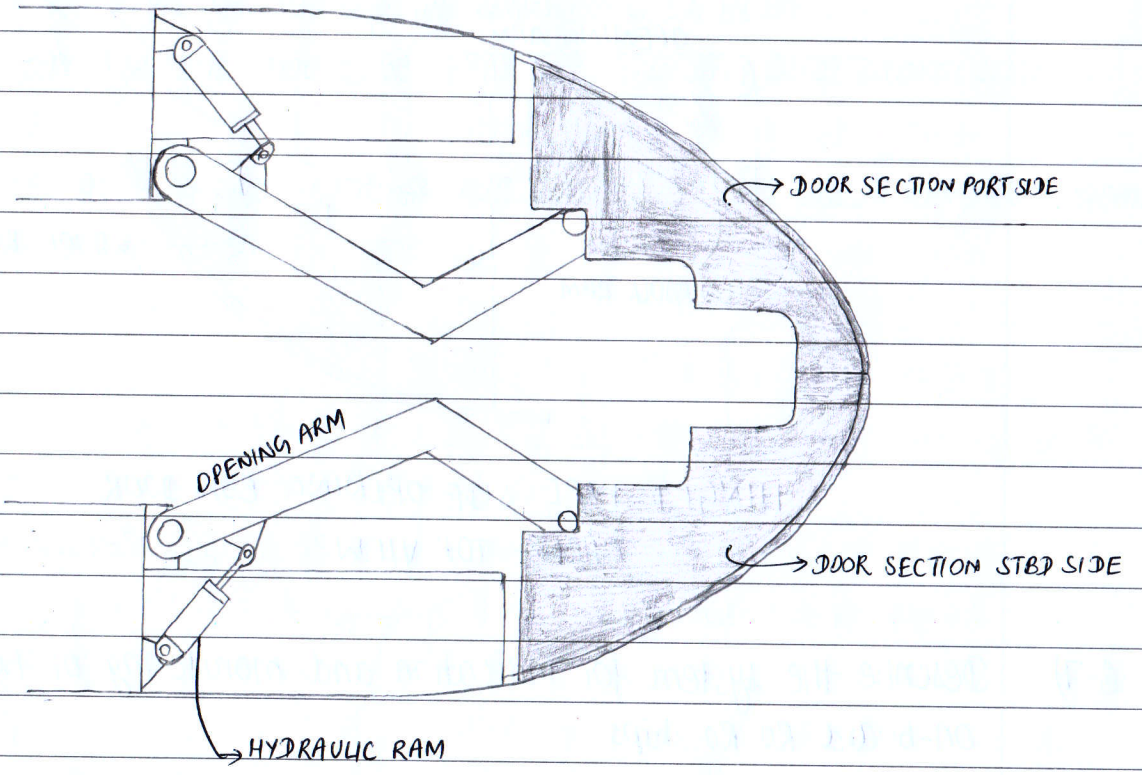
Ans:- The hazardous condition for the ship when the watertight doors need to be closed are as follows:-

(i) When there is restricted visiblity.
(ii) In ports where the port limits off compulsory pilotage limits.
(iii) When the depth of water is less than 3 times the draught.
(iv) High traffic density.
(v) Other factors when the master feels that the condition is dangerous.

BOW DOOR

4·7) Sketch and label Bow door (side opening) of a RORO Ferry (2 times)

Ans:-



HINGED TYPE BOW OPENING SIDE DOOR
CLOSED - TOP VIEW

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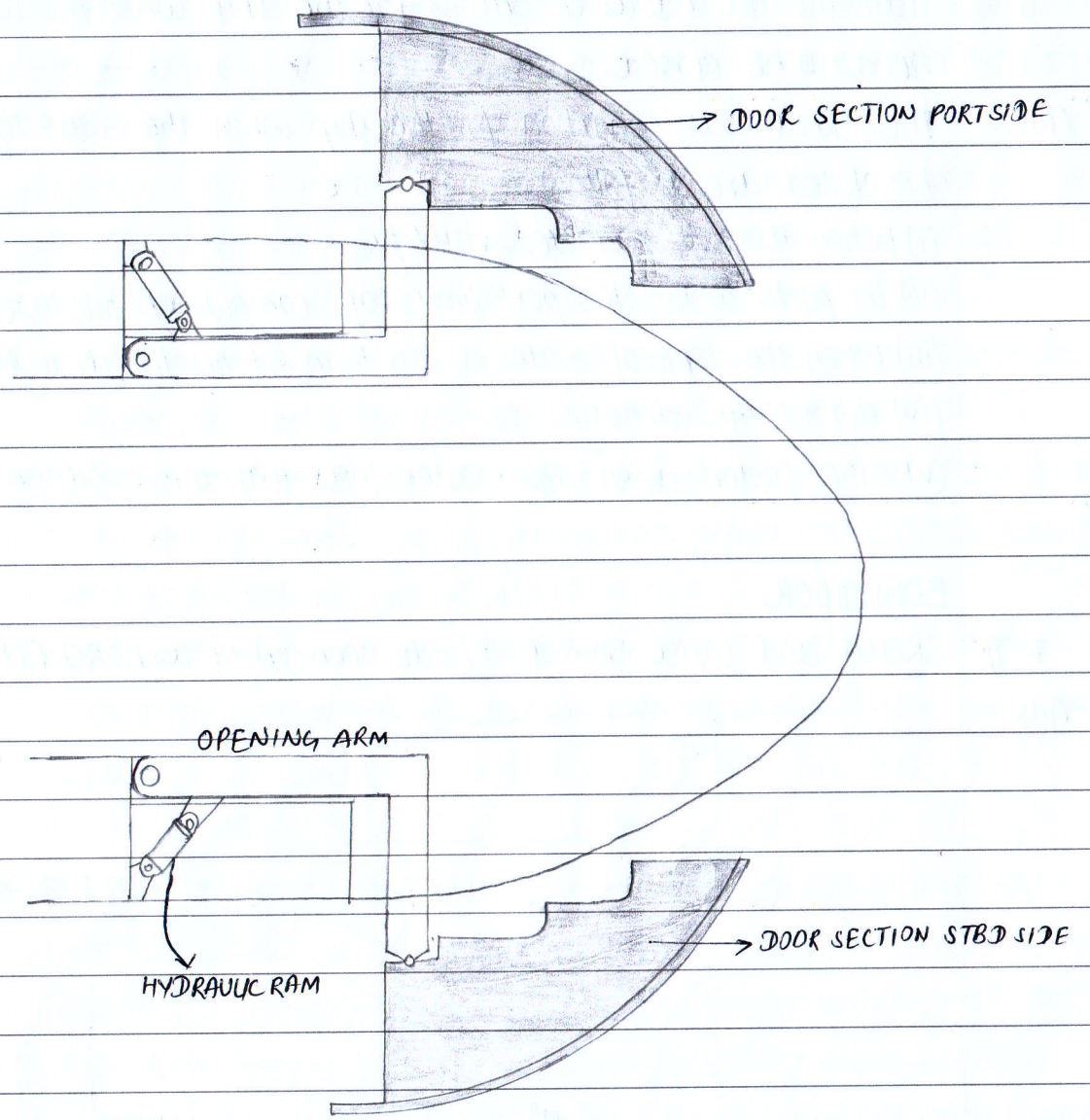

HINGED TYPE SIDE OPENING BOW DOOR
OPEN - TOP VIEW

6.7) Describe the system for indication and monitoring of bow door operation on-board RO-RO ships.

Ans:- SOLAS II-1

- Bow door must be located above the freeboard deck.
- Bow door must be weathertight
- A seperate inner door is to be provided.
- A inner door should also be weathertight.
- The inner door should be located close to the location of collision bulkhead.
- If design permits, the inner door may form part of the vehicle ramp.

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7 • Both the doors must be provided with the following indicators & alarms :-
(i) Power failure alarm
(ii) Earth failure alarm
(iii) Lamp test
(iv) Seperate indication for door closed, door locked, door not closed and door not locked.

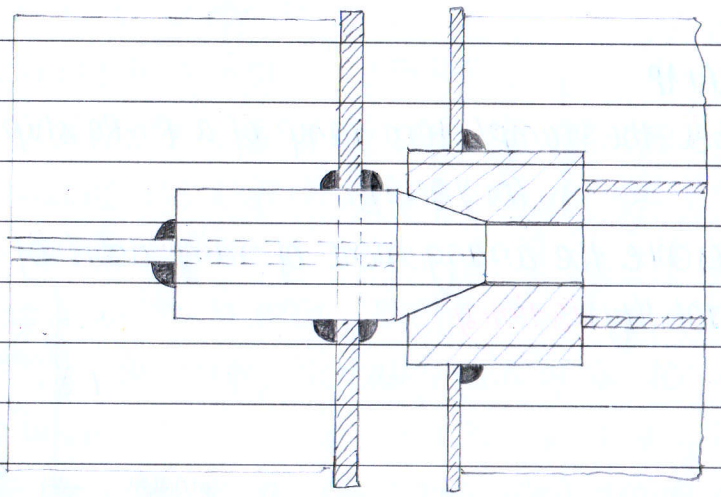
8 • Indication panel on the navigation bridge should have a mode selector function (Harbour/sea passage).

9 • The panel on the navigation bridge must give an audio/visual alarm, if the ship proceeds to sea with the bow door or inner door not closed or not locked.

10 • A water leakage detection system with CCTV arrangement should be provided with monitors fitted on navigation bridge & ECR.
The arrangement should be fitted with audio/visual alarm system.

6·8) Describe with the aid of a simple sketch, securing and locking arrangements of bow doors on ships.

Ans :-



• Securing devices are to be simple to operate and easily accessible.
• Securing devices are to be equipped with mechanical locking arrangement or be of gravity type.
• The opening and closing system as well as securing and locking devices are to be interlocked in such a way that they can only be operate in proper sequence.

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- Where hydraulic securing devices are provided, the system is to be mechanically lockable in closed position, so that in the event of loss of the hydraulic fluid, the securing devices remains locked.
- The hydraulic system for securing and locking device is to be isolated from other hydraulic circuit when in closed position.
- Indication of every securing and locking device is to be provided at the remote control station.
- Seperate indicator light and audible alarms are to be provided on the navigation bridge and on the operating panel to show that securing and locking devices are properly positioned.
- The indicator system should show visual alarm if the door is not fully closed and not fully locked and by audible alarm if securing device become open or locking device become unsecured.
- A notice plate, giving instruction that "all securing device are to be closed and locked before leaving harbour" is to be placed at each operating panel.
- A CCTV arrangement is to be provided to monitor the position of doors and sufficient number of their securing device.

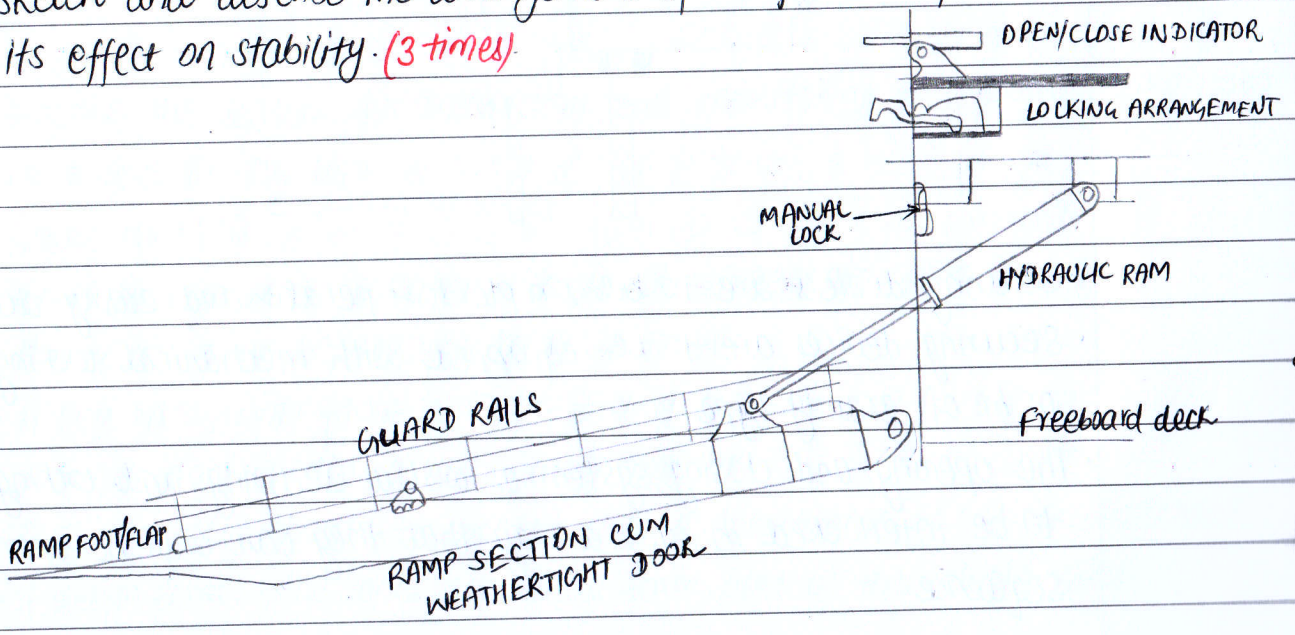
RAMP/STERN RAMP

4.8) Draw and label the ramp/stern ramp of a RO-RO ship (5 times)

(OR/AND),

Sketch and describe the arrangement of ramp doors of RO-RO ships and its effect on stability. (3 times)

Ans:-



- For Bow doors, the ramp is provided separately.
- For Bow doors, the ramp may form the inner weathertight door if design permits.
- For side doors & stern doors, the weathertightness may be provided by the ramp or by seperate weathertight door.
- The ramps are usually of folding type & fitted in sections.
- The ramps may be operated by hydraulic cylinders or in the case of large stern ramps by wire purchase winch & pulley systems.
- The end section of ramp is called flap or foot which will rest on jetty.
- All ramp should be provided by bulwarks or guard rails whereever the ramp passed over the sea.
- Side and stern ramps may be able to rotate within a few degree of adjustment.
- In all cases, the ramp should be stored with positive locking arrangement for sea passage.
- For all inner doors, remote indication of their position should be provided i.e. open or closed.

Impact on stability:-

(i) Watertight integrity.

When ramps are open, they create large openings in the hull, potentially compromising the ship's watertight integrity.

(ii) Freeboard

Ramps are often located close to waterline. If the ship lists or heels, these ramps can submerge, increasing risk of water ingress.

(iii) Flooding

Inadequate subdivision of the hull with transverse bulkhead can lead to rapid flooding and capsizing, if water enters through open or damaged ramps.

(iv) Dynamic load during operation.

While loading/discharging heavy cargo via ramp can lead to heel or trim change.

(v) Ramp design and operation.

The design and operation of the ramp themselves can pose risk. For example: a hinged ramp can fail unexpectedly due to seal or hydraulic issue.

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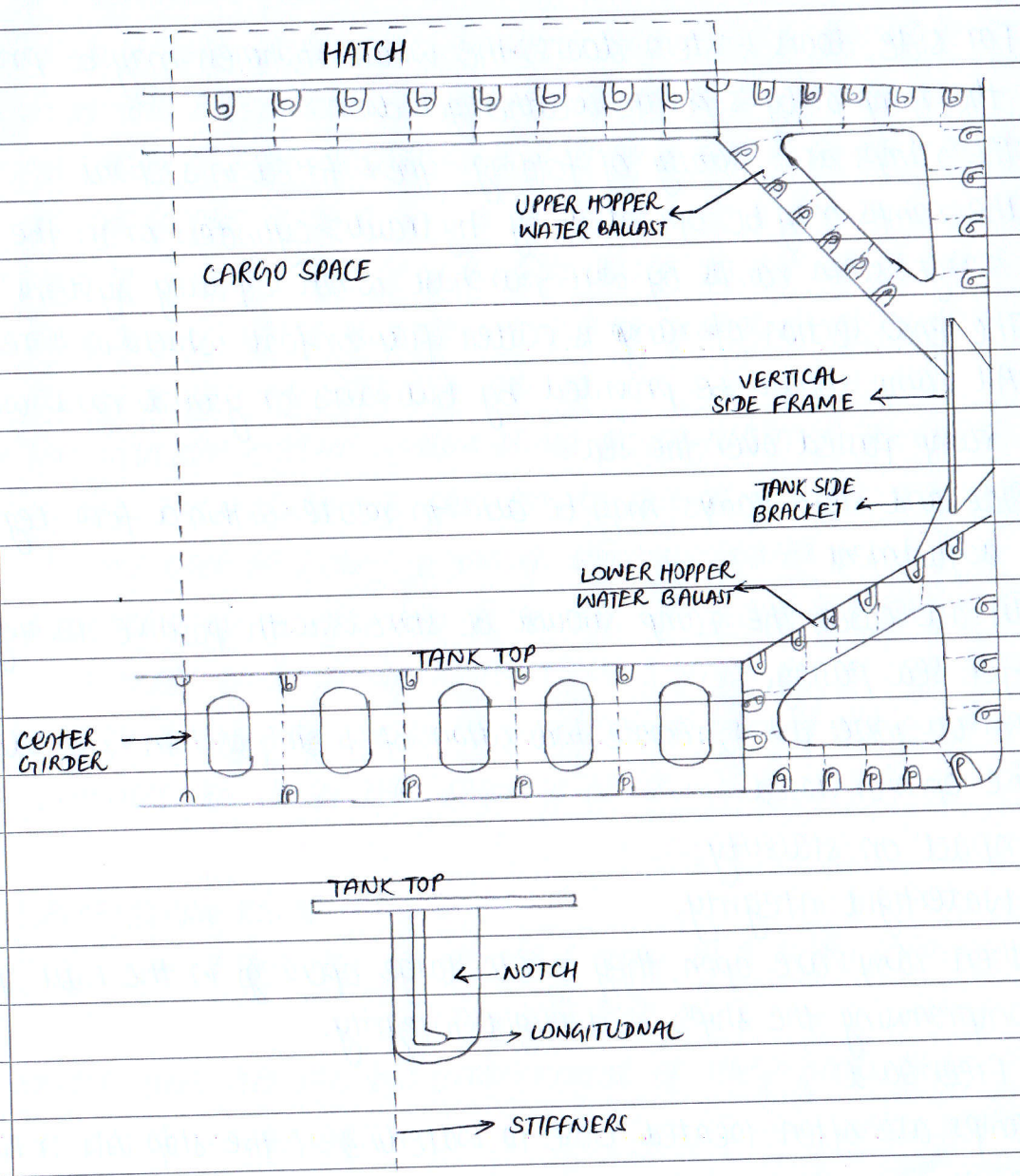
OTHERS

4.9) Sketch and label the mid-ship section of a bulk carrier.

Ans:-



6.9) What is cofferdam? Where it is fitted and what are its function? (3 times)

Ans:- A cofferdam is a narrow, empty(void) space between two bulkheads or decks, designed to prevent the mixing or leakage between two adjacent tanks or compartments on a ship.

It act as a safety barrier to protect cargo, structure or personnel from leakage of hazardous or incompatible substances.

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It is generaly fitted between:

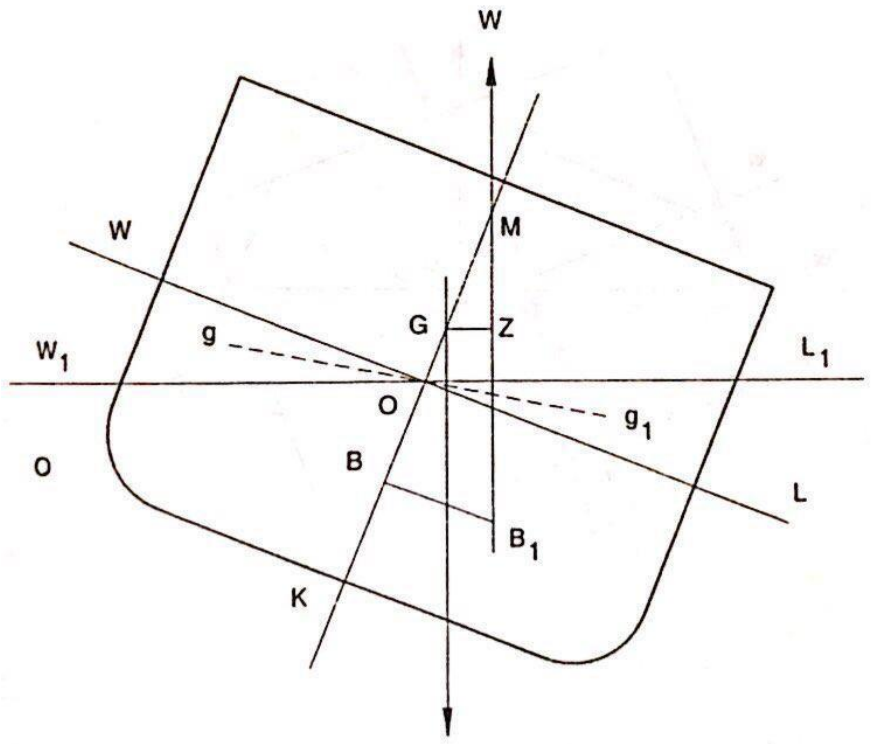
- Cargo tanks and pump rooms.
- Cargo tanks and machinery spaces.
- Cargo tanks and accommodation spaces.
- Fuel oil tanks and fresh water tanks.
- Adjacent tanks carrying incompatible substance

Functions of cofferdam are:-

- Prevent cross-contamination or leakage between adjacent tank containing different substances.
- Reduces risk of explosions by preventing vapours from reaching ignition sources.
- Allow access to adjacent tank boundaries for inspection, cleaning and repairs.
- Being empty and ventilated, cofferdam provide space to monitor the structural integrity of surrounding bulkheads.
- Protect sensitive spaces like accomodation and engine room from the pressure or chemical action of tank contents.

Q.5 Ship Stability - Theory

(Page No 34 to 47)



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Q.5. Ship Stability - Theory

Ques 1) With reference to the International Code for the carriage of grain in bulk, explain (12 times)

a) Intact stability criteria as applicable to ships carrying grain in bulk

Ans:- Same as cargo notes Page-143

b) Volumetric heeling moments and its effect on stability.

Ans:-
- Volumetric heeling moment is the heeling moment caused by the transverse shift of grain within the cargo hold due to movement of the ship
- This occurs because grain cargo has tendancy to shift to the lower side when a ship heels or rolls, especially if the grain is not properly secured or trimmed.
- It is expressed in m^4.
- The volumetric heeling moment is taken into account in Grain stability calculations to ensure the vessel maintain adequate positive stability.
- The IMO grain code provided methods for calculating VHM based on:
  - → Type of grain
  - → Hold dimensions.
  - → Stowage method (filled, party filled, trimmed/untrimmed)

Effect on stability:

(i) Reduced GM

The lateral grain shift causes a temperory shift in G, reducing GM and causing the ship to heel

(ii) Danger of capsizing

In case of heavy seas or improper loading, excessive grain ship can cause permanent list or even capsizing.

(iii) Reduced Righting arm (GZ)

The ship's ability to return to upright after heeling is compromised due to the decreased GZ curve area

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Ques 2) State the intact stability requirements for cargo vessels.

Ans:- Same as Page-5 of M.V. Hindship particular.

Ques 3) What are cross curves of stability. How are they used in stability. Show calculations by a Chief mate of a vessel (2 times)

Ans:-
- Cross curves of stability are a set of curves used to determine the righting arm (GZ) of a vessel at various angle of heel and displacement.
- The x-axis represents displacement and the y-axis represents the value of KN
- The purpose of the cross curve .....

Same as Page 22 of M.V Hindship particular.

Ques 4) With the help of suitable diagram, explain how can initial GM be obtained from curve of statical stability.

Ans:- DIAGRAM SAME AS P-22 OF M.V HINDSHIP PARTICULAR

To find intial GM:-
- Draw a tanget to statical stability curve at 0° angle of heel.
- Draw a vertical line from angle of heel of 57.3°.
- Where this line meets the tangent, it is the initial GM measured on the GZ scale

Ques 5) Draw and explain the curve of statical stablity for a listed ship and the ship at angle of loll (2 times)

Ans:- Listed ship
- The GZ (righting arm) curve does not starts from zero at 0° angle of heel, indicating the ship is already listed.
- Maximum GZ will be lower than the maximum GZ of the upright ship (which curve starts at zero angle of heel).
- The ship has positive GM even when listed.
- Of a listed ship, the GZ value will be negative at zero degree angle of heel.
- The curve will eventually reach zero GZ, indicating the angle at which

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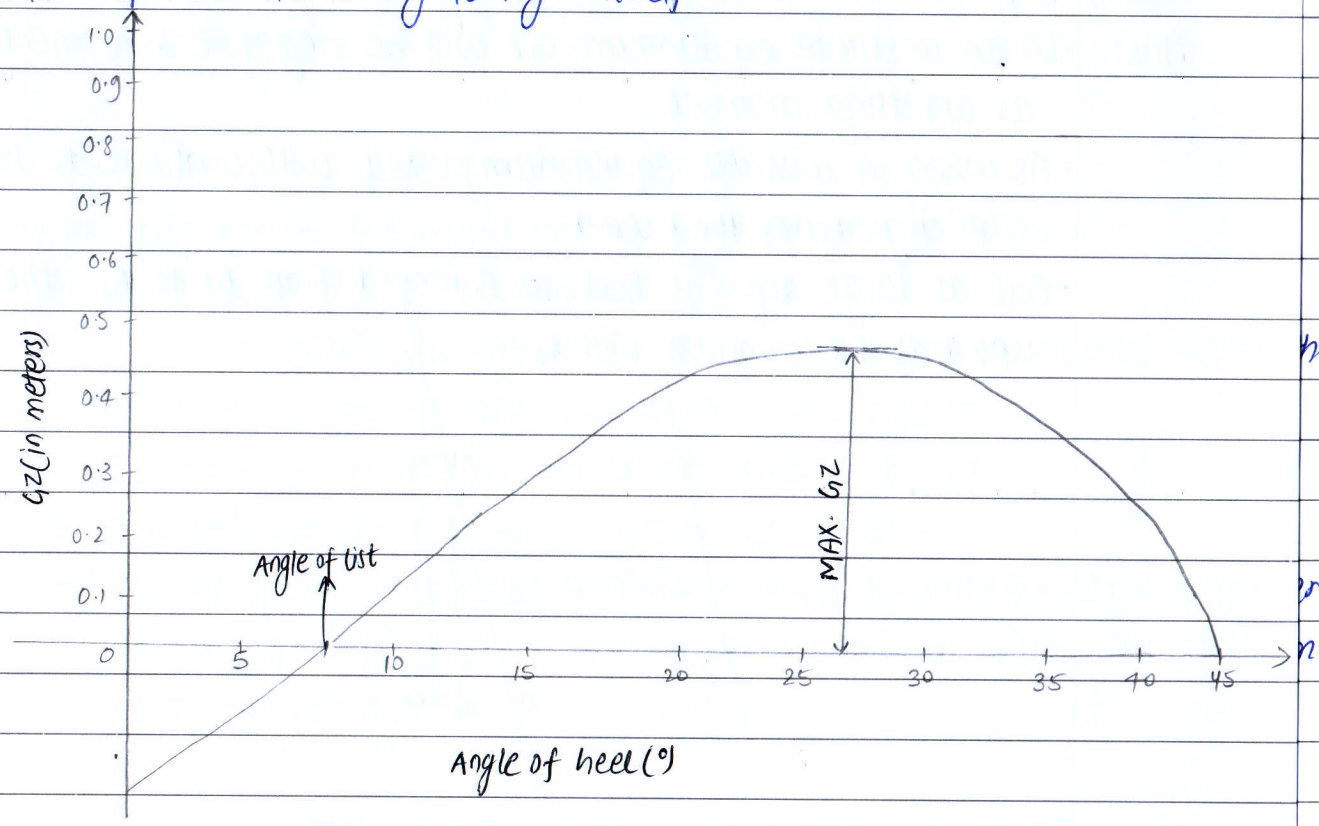
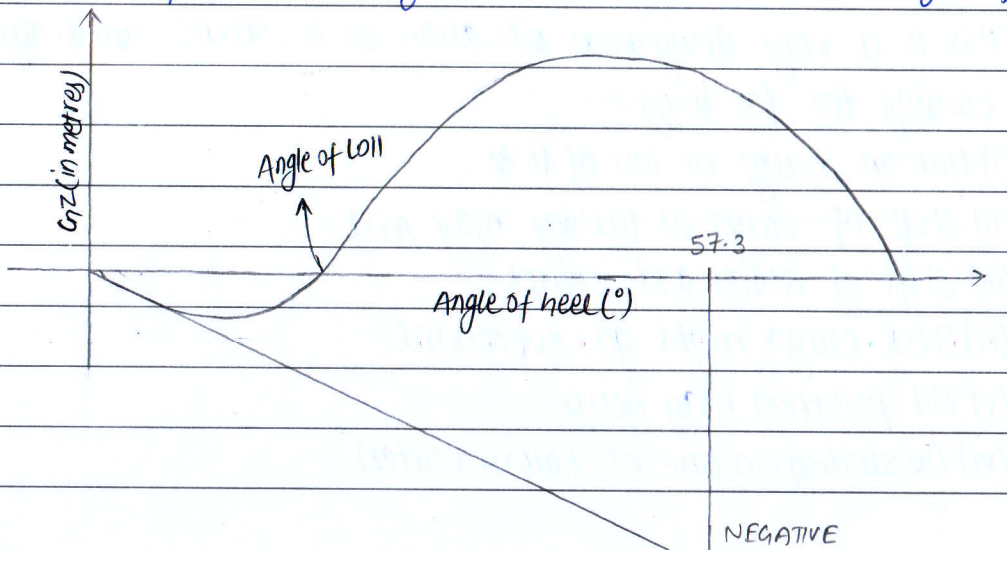
the ship loses its ability to right itself.



AT ANGLE OF LOLL

- As we know, at angle of loll, GZ is zero
- The GZ (righting arm) curve starts below the horizontal axis, indicating a negative intial metacentric height (GM) when vessel is upright (i.e at 0° angle of heel)
- The value of GZ will be zero at 0° angle of heel.
- The curve crosses the horizontal axis (GZ = 0) at the angle of loll
- After the angle of loll, the curve becomes positive, showing that ship can resist further heeling and will return to the angle of loll.



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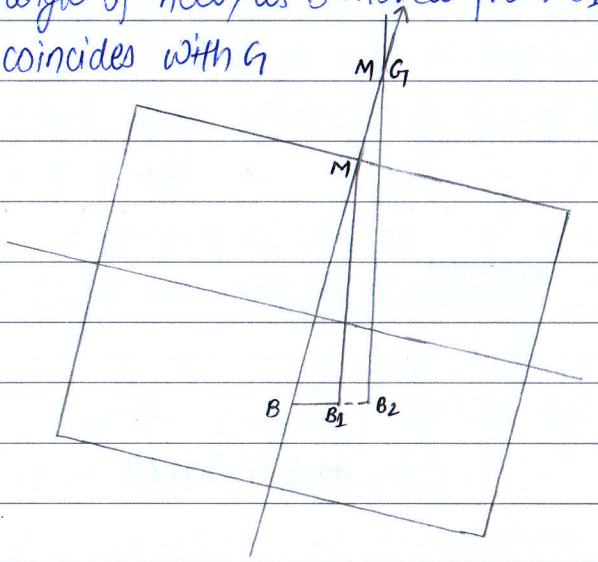
Ques 6) Explain what is Angle of Loll and its corrective actions.

Ans:-
- In an unstable equilibrium, GZ will be negative & moment is known as upsetting moment.
- As when in unstable equilibrium, vessel will continue to heel due to capsizing or upsetting lever.
- But at large angle of heel, as B moved from B_1 to B_2, the M moved upwards till coincides with G



At angle of loll, GM is negative (GM is not zero)
GZ is zero

- At this point, the GZ is zero & there is no tendancy of vessel to either heel more or become upright.
- Since the GM is negative and BM is positive, the vessel will never capsize but shall tend to remain in a state of oscillation, that is, to and fro.
- The angle of inclination at which above condition occurs is known as Angle of Loll.

This is a very dangerous situation as it occurs suddenly & voicently causing the following :-

(i) Human injury or loss of lives.
(ii) Shift of cargo as lashing may part.
(iii) Shift of stores and spares.
(iv) Deck cargo might go overboard.
(v) Oil pollution may occur.
(vi) Grounding (in case of shallow water)

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Corrective action

→ lower the 'G_1'

This can be done as follows (lower the G_1):

(i) Reduce FSC by emptying or pressing up slack tank.

(ii) Take ballast in DB tank on heeled side.

(iii) Never take ballast on other side bcz listing moment created make the vessel to flop over to other side & may even capsize.

(iv) Transfer liquid from upper to lower position.

(v) Deballast top side tank from opposite side of heel.

(vi) If shore crane is available, G can be lowered by loading cargo at lower position, discharging cargo from upper position or shifting cargo from upper to lower position.

Ques 7) Explain with neat sketches, effect on GZ values because of

a) Vertical shift

b) Transverse shift of cargo on-board a ship

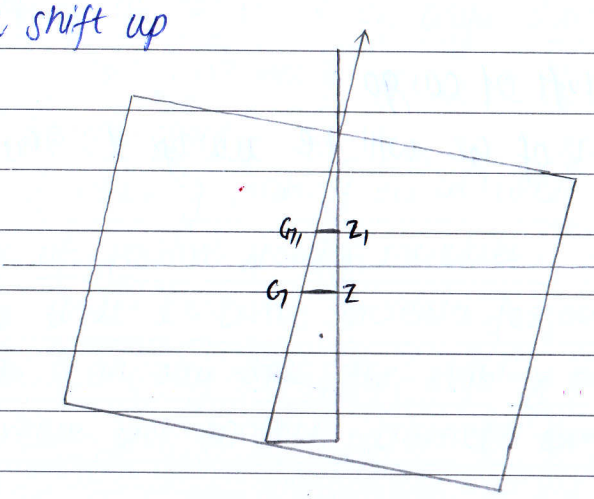
(OR),

Discuss the effects of shift of cargo on the GZ values & GZ curve of a vessel.

Ans:- a) Vertical shift of cargo

The effect of shift of cargo in vertical direction can be considered in two ways:-

(i) Vertical shift up



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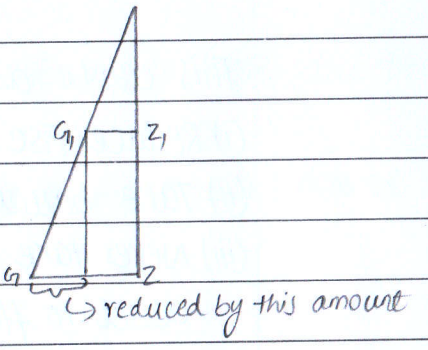
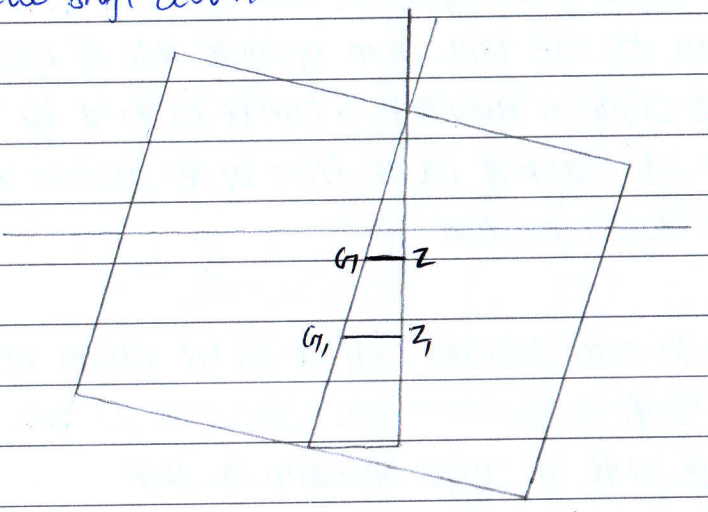
When there is a vertical shift of cargo upwards GG_1 (↑) will be calculated as $\frac{w \times d}{W}$

Thus, GZ is reduced by amount $GG_1 \sin\theta$

correction = (−) $GG_1 \sin\theta$



(ii) vertical shift down



When there is a vertical shift of cargo downwards GG_1 (↓) will be calculated as $\frac{w \times d}{W}$

Thus, GZ will increase by amount $GG_1 \sin\theta$

correction: (+) $GG_1 \sin\theta$

b) Horizontal shift of cargo.

The correction of GZ will be always (−) $GG_1 \cos\theta$

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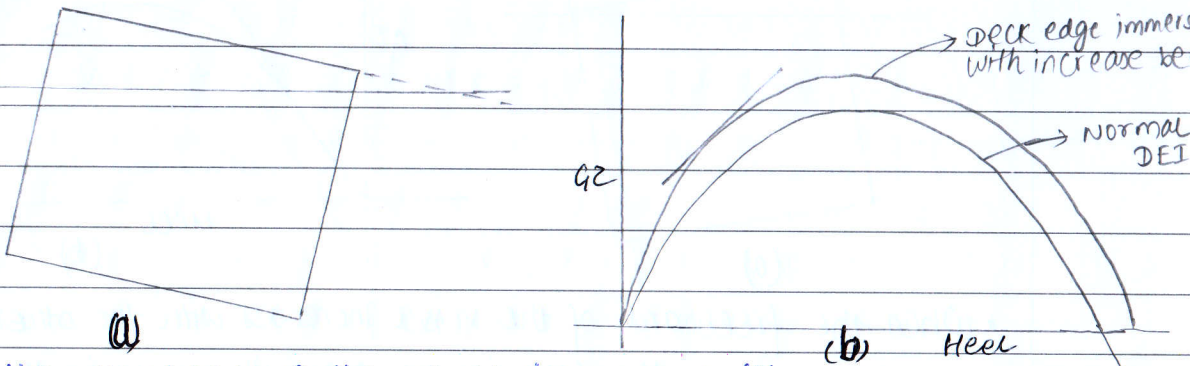
Ques 8) Describe the effect of following on stability of ship/GZ curve of a vessel
i) Increase of beam ii) Increase of freeboard (15 times)

Ans:- i) Increase of beam



- When the beam of the vessel increases with other parameters unchanged, the stability of the vessel is affected as follows:-

(i) Ref. to Fig (a) when the beam is increased, the deck edge immersion occured earlier

(ii) We know, $GZ = GM \sin\theta$

$GM = KM - KG$

$KM = KB + BM$

$BM = \frac{lb^3}{12V} = \frac{b^2}{12D}$

(iii) Thus as the beam increases, the BM increases, resulting in increase of KM & therefore the GM.

(iv) Thus the value of GZ increases at an angle of heel.

- Therefore, we can state the following
  (i) Deck edge immersion occurs earlier
  (ii) GZ value increases for all angle of heel
  (iii) value of GM increases
  (iv) Max^m GZ increases
  (v) Angle of vanishing stability occurs later
  (vi) Range of positive stability increases.
  (vii) Area under GZ curve increases for an angle of heel.
- Therefore we can say that, the stability of vessel improves as the beam increase will another parameter unchanged.

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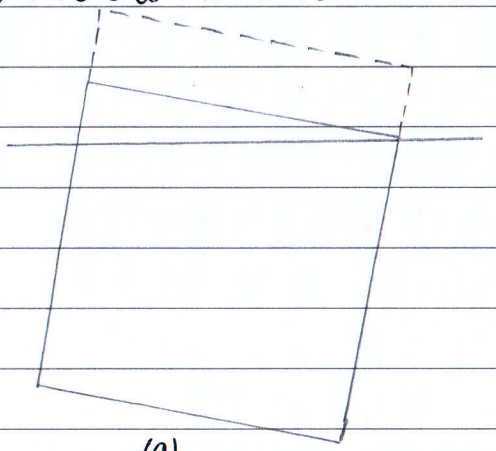
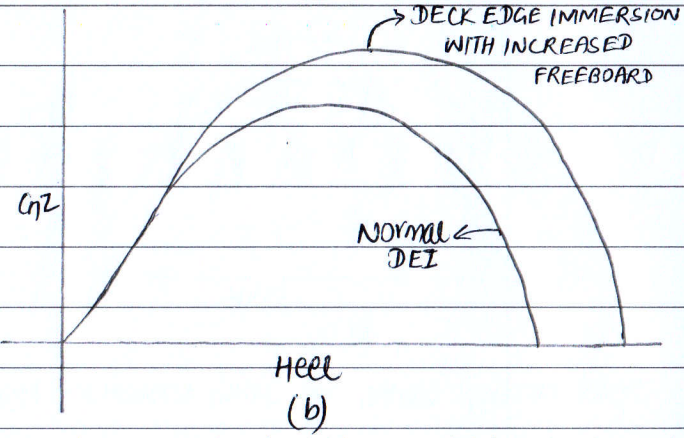
(ii) Increase in Freeboard



(a)



(b)

- When the freeboard of the vessel increases with the other parameters remaining same, the following changes will occur in the stability of the ship :-

(i) Ref to Fig (a), we see that the deck edge immersion occurs later when the freeboard of the vessel increases.

(ii) This will result in following changes of the vessel :-

a) Initial GM will remain the same.

b) There is no change in GZ curve till the original deck edge immersion.

c) Thereafter, the GZ value increases for all angle of heel that result in following :-

→ Max^m GZ occur later & increases.

→ Area under the curve increases for all angle of heel after the original deck edge immersion.

→ The angle of vanishing stability occurs later.

→ The range of stability increases.

- Thus, we can say, stability of the vessel improves when the freeboard is increased.

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Ques 9) Why and how does the trim of a vessel change when she goes from:
(a) SW to FW (LCB > LCF) (b) FW to SW (LCF > LCB) (4 times)

(OR),

With neat sketches, discuss the effect of change in density of the water in which ship is floating on the trim (3 times)

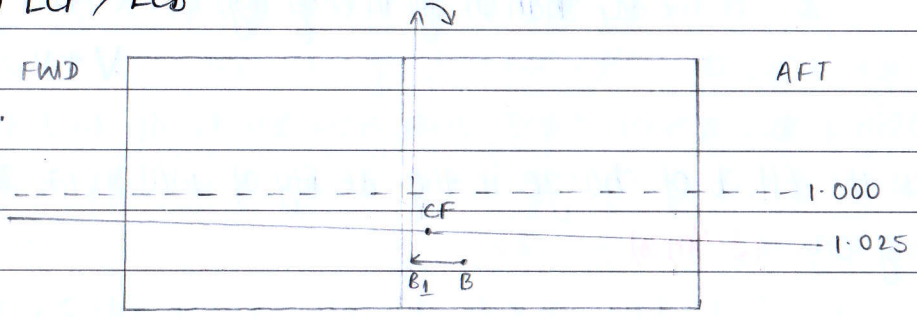
Ans:- (a) SW to FW

1.025 to 1.000

high to less

- When a vessel goes from water of higher density to water of lower density, she will experience a bodily sinkage.
- Further due to change of density, she will do experience change of trim.

I) LCF > LCB



Since LCF is greater than LCB, the COB of added volume will be forward of LCB. Therefore, B will move forward to B_1.
The upthrust due to buoyancy, thus move forward, will result in vessel trim by stern.

II) LCB > LCF

If, LCB is greater than LCF, the B will move aft.
The upthrust due to buoyancy move aft, will result in vessel trim by head

(b) FW to SW

1.000 to 1.025

less to high

- When a vessel goes from water of lower density to water of higher density, she will experience a bodily rise.
- Further due to change of density, she will do experience change of trim.

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I) LCF > LCB

The upthrust due to buoyancy move aft, will result in vessel trim by head

II) LCB > LCF

The upthrust due to buoyancy move fwd, will result in vessel trim by stern.

Formula for change in trim

$$\text{Trim} = \frac{TM}{MCTC \times 100}$$

where, $TM = BB_1 \times W$

and, BB_1 (change in buoyancy) $= \frac{v \times (LCF - LCB)}{V + v}$

Ques 10) Discuss the effect of change in the density of water in which a ship is floating on: (3 times)

(i) Trim

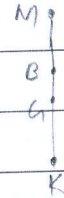
Ans:- Same as Q.9

(ii) GZ values.

When the density of water changes, the buoyancy force and draft changes, which in turn effect the GZ values.

(a) SW to FW

- Ship experience a bodily sinkage
- The upthrust due to buoyancy cause B to shift to B_1, thus affecting the BM.



- KM (depends on draft) may increase slightly, thus reducing GM
- Since $GZ = GM \cdot \sin\theta$

  So, when GM reduces, the GZ value also reduces at an angle of heel.
- Maximum GZ value is reduces.
- Area under the GZ curve decreases.

(b) FW to SW

- Ship experiences a bodily rise.
- The upthrust due to buoyancy cause B to shift to B_1, thus affecting the BM
- GM increases.
- GZ value improves

(iii) LCG

- LCG is the longitudinal position of the ship's center of gravity, measured from a reference point.
- It depends only on the distribution of weight (cargo, fuel, ballast etc.) within the ship, not on the external environment
- Change in water density does not affect LCG directly.
- If the weight inside the ship remain in the same place, LCG remains unchanged.

DRYDOCKING

Ques 11) Explain: a) Critical Period b) Critical Instant c) Declivity (3 times)

Ans:-

a) Critical Period

- When the stern touches the blocks & water level drops further, there is a virtual loss of GM i.e. equal to $\frac{P \times KG(Initial)}{W - P}$ or $\frac{P \times KM(Final)}{W(Initial)}$
- Therefore, the vessel is in critical situation because if the GM is not sufficient, she may have negative GM & may even flip over.
- Once the vessel sits on block overall, she is in safe position.
- Therefore critical period starts when stern first touches the block and ends when the ship sits on block overall.

b) Critical Instant

- It is the instant just before she sits on block overall.
- At this point the danger is maximum bcz the virtual loss of GM will be maximum & vessel has not yet sat overall on blocks.
- A moment after the critical instant, she sits on the block overall and she will be out on danger.

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c) Decivity.

- It is a small slop of drydock which aids in drainage of water.
- When decivity is given, the final trim of vessel is same as decivity.
- Therefore, T_c (on sitting overall) = Initial trim − decivity
- Example: Decivity = 20cm/100m, Initial trim = 1.0m
  Length of vessel = 150m
  So, final decivity = 30cm = 0.3m
  ↓
  i.e. Final trim after sitting overall

Hence, $T_c = 1.0 - 0.3$
$= 0.7m$

Ques 12.a) What are the reasons for desirability of dry docking with small stern trim (3 times)

Ans:-1 • When the vessel enters the drydock & make contact with the block, there is a transfer of weight from the ship to the blocks.

2 • This will put a lot of pressure at a point of contact.

3 • Thus, point of contact must be the stern frame i.e. the strongest structural member of ship

4 • Hence, a vessel must enter the drydock with stern trim, so that stern frame make contact with the blocks first.

5 • When the ship makes contact with the blocks & WL drops further, part of the weight of the ship is transferred to the block which is known as upthrust P.
It is equal to weight being discharged by way of stern frame.

$$T_c = \frac{\text{Trimming moment}}{MCTC \times 100}$$

where $TM = P \times LCF$

$$\text{Thus, } T_c = \frac{P \times LCF}{MCTC \times 100}$$

6 • If the trim is large, the upthrust P is also large resulting in greater loss of stability.

7 • Thus, to reduce the loss of GM, the trim would be small.

8 • Therefore, a vessel should enter the drydock with small stern trim.

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(b) What precaution will you take for drydocking a loaded ship (3 times)

Ans:- A vessel will generally be in light condition when she enters the drydock. However, in case of major damage requiring immediate repairs she may be req to enter the drydock, in loaded condition.

In such a case, following precaution are required:-

(i) vessel should be lightened if possible to ensure that damage portion is above the water to fasilitate repairs.

(ii) The list and trim of the ship can be adjusted in order that the repairs can be conducted.

(iii) All stability calculation should be carried out to ensure that she will have sufficient positive stability.

(iv) The drydock authorities should be informed of the condition of the vessel so that they may adjust the blocks accordingly. The number of blocks may be increased to have equal distribution of weight on the blocks.

(v) All plans and particulars should be provided to drydock manager in order to plan the drydock

(vi) A ship must have small stern trim

(vii) Minimum or no ballast on board to reduce the displacement of the ship

(viii) Further fuel oil & FW may be offloaded if required for this purpose.

(ix) If the ship is to be drydocked with the trim by head, then the forward structure should be strengthened by fitting additional web frames, girders etc

(x) The drydocking is to be conducted in a smooth manner employing divers if necessary to monitor progress of the ship.

(xi) All stability particulars are to be carefully recorded and the vessel is to be in the same condition during re-floating.

CONCLUSION:

Thus, we see that drydocking a loaded ship is a critical & dangerous operation and thus should be carried out with extreme care as to the stability of the ship.

NOTE: Always aim to lighten the ship as much as safely possible.

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Ques 13) Explain why the values of trim and the metacentric height in the freely afloat conditions are important when considering the suitability of a vessel for dry-docking (3 times)

Ans:-

TRIM

The value of trim in afloat condition are important because it is desirable to dry-dock with small stern trim

Reason:

Same as Ques 12.a (all)

METACENTRIC HEIGHT (GM)

The value of GM in afloat condition are important because the GM must be adequate to ensure the stable till it sits overall on blocks.

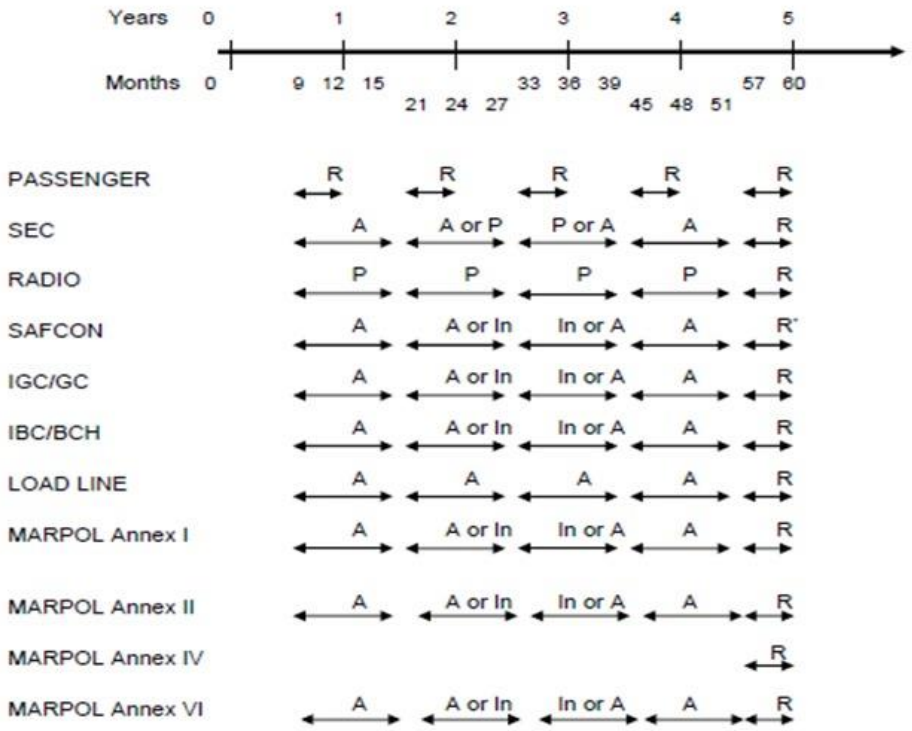
Reason:

Same as Ques 12.a (1, 5, 6)

Thus, GM should be positive and adequate depending on the vessel's type.

Q.7 Surveys and Certificates

(Page No 49 to 64)



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Q 7 Surveys and certificates

Ques 1) Write short notes on following: (4 times)

a) Harmonized system of survey and certification.

Ans:- The Harmonized system of survey and certification (HSSC) is an internati-onally agreed framework introduced by IMO to align the survey and certification regimes of major safety and pollution prevention convention.

Objective of HSSC

- The HSSC was introduced to standardise the validity periods and time intervals between surveys for the major convention certificates.
- The intention of HSSC was to simplify the process of a survey of ships.
- The purpose is to benifit the industry by making it easier for ship owner to submit their fleet for the survey.
- The new system also helps crew preparing their ships for a survey.
- The objective of HSSC is to reduce the total number of surveyor required and cut down the survey time, thereby reducing costs for shipowners.

Features & advantages of HSSC

- It provides a flexible system regarding the frequency & validity of surveys and certification.
- The surveys and expiry date of certificate are harmonized with the expiry date of safety construction or IOPP or loadline as applicable.
- A minimum standard interval of one year is required between surveys.
- The maximum validity for all ship's statutory certificates was extended to five years for all certificates other than for the Passenger Ship Safety Certificate.
- Annual survey are required for all cargo ship certificates.
- Annual survey may be carried out in a 6 month window which will ±3 months of the anniversary date.
- Intermediate surveys are required for all cargo ship certificates under SOLAS. & should take place with 2nd or 3rd Annual survey.

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- A 3 month window is provided before the expiry date to carry out & complete the renewal survey.
- When renewal survey is completed within the window, there will be no loss of validity of certificate and the expiry date is harmonized with the current anniversary date.
- There is an option for cargo ship safety certificate combining with safety construction, safety equipment & safety radio. (can skip)
- Periodical survey will take place of intermediate survey of safety equipment & annual survey of safety radio of all cargo ships.
- Extension to any certificate may be allowed by flag state but limited to maximum 3 months.

The various certificates covered by this system are as follows:-

a) Under SOLAS
   (i) Cargo Ship Safety Equipment certificate.
   (ii) Cargo Ship Safety Construction Certificate.
   (iii) Cargo Ship Safety Radio certificate
   (iv) Passenger Ship safety certificate.
   (v) Executive hull summary (Inspection of the outside of the ship's bottom)

b) Under Load Line Convention
   International Load Line certificate, (OR),
   International Load Line Exemption Certificate.

c) Under MARPOL Convention
   (i) International Oil Pollution Prevention Certificate.
   (ii) International Pollution Prevention Certificate for the carriage of Noxious Liquid Substances in Bulk.
   (iii) International Sewage Pollution Prevention Certificate.
   (iv) International Air Pollution Prevention certificate.

d) Under Ballast Water Convention
   (i) International Ballast Water Management Certificate.

e) Under Mandatory Codes
   (i) International Certificate of Fitness for the carriage of Dangerous Chemicals in Bulk
   (ii) International certificate of Fitness for the carriage of Liquified Gases in Bulk.
   (iii) Polar ship certificate.

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b) Condition Assessment Scheme

Write answers from Q.3

c) Enhanced survey Programme

Write answers from Q.4

Ques 2) Enumerate various types of surveys and draw a digrammatic arrangement of various surveys as required by harmonic system of survey and certification (2 times)

Ans:- a) Initial Survey

- A complete inspection & survey of the ship before the appropriate certificate is issued for first time.
- Scope of initial survey will cover every item as per flag state, IMO convention & codes and classification society rule related to the particular certificate.
- It will include thorough inspection & examination of
  a) plans, diagrams & specification for structure, machinery & equipment.
  b) construction arrangement of machinery & equipment are as per the approved plan
  c) supporting documents, certificates, record books, operation & maintenance manual
  d) operation test including performance test if required are carried out to ensure compliance

Anniversary date of survey & certificate is date of expiry of safety construction or loadline or IOPP certificate as applicable.

Initial	1st Annual	2nd Annual	3rd Annual	4th Annual	Renewal
28.04.2025	27.04.2026	27.04.2027	27.04.2028	27.04.2029	27.04.2030
Date of Delivery.	27 Jan ~ 27 JULY	27 Jan ~ 27 July	27 Jan ~ 27 July	27 Jan ~ 27 July	27 Jan ~ 27 Apr

Intermediate: either during 2nd or 3rd Annual

after that if survey done on 25.02.2030

Radio survey : I - P - P - P - P - R
Equipment Survey : I - A - A/P - A/P - A - R

DOI = 25.02.2030
DOE = 27.04.2035

Hence, 27th is known as Anniversary date.

b) Annual Survey

- It is a general inspection of the items related to particular certificate to ensure they are properly maintained and in good operation condition & fit for surveys.
- For all cargo ship certificate, annual survey must be conducted within ±3 months of the anniversary date for the particular certificate.
- Further inspection and survey may be conducted in case of any doubt.

c) Intermediate survey.

- It involves a greater scope of inspection & survey than the annual survey.

Note: Intermediate survey are not applicable to International Loadline certificate bcz not given in loadline convention.
And, the scope for loadline survey for annual & intermediate is same.

- Intermediate survey should take place of 2nd or 3rd Annual survey.
- This means that intermediate survey can only be carried out within ±3 months of 2nd or 3rd anniversary date.

d) Renewal survey.

- It is a complete inspection & survey of the ship which will lead to issuing a new full term certificate related to particular survey.
- The renewal survey should be completed within not more than 3 months before the expiry date.
- Under the HSSC code, the new certificate if completed before the expiry date will have validity of 5 years harmonized with the expiry date.

e) Periodical survey.

- It consist of inspection, testing and survey of items which are related to the safety of the ship.
- For cargo ship safety equipment, periodical survey can take place of intermediate survey.
- For cargo ship safety radio, periodical survey can take place of annual survey.

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- The scope of periodical survey is much more than intermediate surveys will not require conduct of annual or intermediate surveys.

F.3 oral ** Phase 2

f) Inspection of the outside of ship's bottom or docking survey

- As per SOLAS CH-I minimum of two inspection of outside of ship's bottom must be carried out in any five year period.
- In all cases, the interval between two consecutive inspection should not exceed 36 months.
- One of the inspection must be carried out after 4th annual survey in conjuction with renewal surrey. for cargo ship safety construction.
- The inspection of the outside of ship's bottom is normally carried out in the dry dock
- However for cargo ships, less than 15 years of age alternate inspection may be carried out with ship afloat.
  This is called in-water survey (IWS)
- In all cases, dry-docking is required for renewal survey

g) Additional surrey.

- Should not be normaly require
- However, the classification society may be require to attend the ship to carry out survey in following cases:-
  (i) Contact damage like collision, allison or grounding
  (ii) In case of fire
  (iii) In case of structural defect or equipment failure which are reported by the ship or third parties like PSC etc.
- It ensures that repairs or renewals are effectively carried out
- This surrey can be general or partial, depending on circumtances.

Diagrammatic arangement of HSSC

see next page

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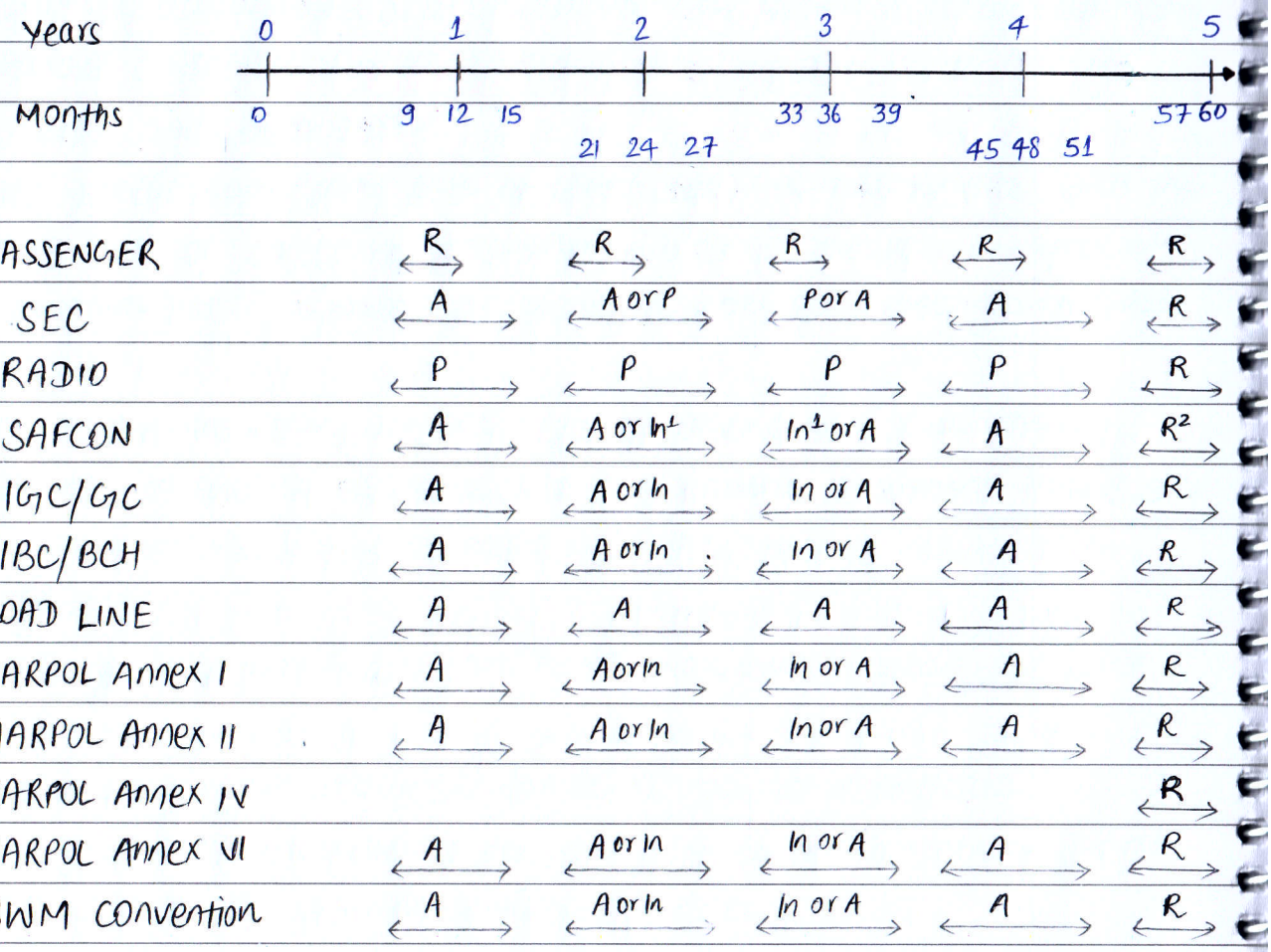

R - Renewal
P - Periodical
In - Intermediate
A - Annual

Ques 3.a) Explain the need for vessels to undergo CAP survey (3 times)

Ans:-

- Many oil majors require a CAP survey as part of their vetting process.
- A CAP rating allows charter to assess risk and ensure the vessel meets their operational requirement.
- Since CAP survey has more scope than standard class survey, which helps identify potential issues that may not be apparent during standard survey.
- The CAP survey highlight areas requiring repair or maintenance, which allows owner to prioritize repairs.
- It can also enhance the vessel's value in the sale and purchase market.

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Ques 3.b) Discuss as to how the condition Assessment Programme differs from Condition Assessment Scheme (2 times)

Ans:-

S.NO	REMARKS	CAS SURVEY	CAP SURVEY
1.	Full Name	Condition Assessment Scheme	Condition Assessment Programme
2.	Requirement	It is an old requirement for oil tanker.	It is a voluntary requirement
3.	Application	Single hull oil tanker not complying with protective location of cargo tank under the old MARPOL Annex 1 Reg. 13G	Apply to any type of ship or her equipment based on owner's requirement.
4.	Type of survey	Statuatory along with IOPP	This is optional/value added or voluntary.
5.	Purpose	Prevention of oil pollution from single hull oil tanker due to structure deterioration or in case of damage due to collision or grounding.	Detailed independent assessment of a group of machinery or equipment which is usually not covered by regular surveys (E.g. Oil tanker piping & pumping system)
6.	Objective	To verify the structural condition remain suitable for service	To provide owner with assessment of ship's actual condition for maintenance & repair planning.
7	Scope of survey	Cargo tank area & ballast tank area & all hull structure in that area.	Systematic inspection of machinery & equipment as required by the owner. Hull inspected may be included if the ship outside of ESP requirement.
8	Authority for survey & certification	Recognized organisation on behalf of flag state	Seperate contract with any member of international member of classification societies.
9	Outcome and certification	Statement of compliance will be issued by the RO on behalf of flag state.	CAP rating is provided to the owner to use as value addition for commercial benifit.
10	Present status	Obsolete & superceeded by ESP for all oil tanker	Available as value added survey from most classification surrey.

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Ques 4) For which type of ship is "The Enhanced system of survey" compulsory? Briefly describe the system (3 times)

Ans:- International code on the Enhanced Programme of Inspection during surveys of Bulk carriers and oil tankers, 2011 (2011 ESP Code)

- adopted under SOLAS regulation XI/Part-1
- Code should apply to all self-propelled bulk carriers and oil tankers more than 500 GT.

Purpose: To enhance the safety of bulk carriers and oil tankers by

→ monitoring the structural condition of the ship.
→ Application, control & monitoring of corrosion prevention system.
→ Carrying out close up surveys beyond the requirement of normal safety construction surveys.
→ Carry out periodical testing of watertight compartments to monitor the integrity.
→ Carry out periodical thickness measurement to avoid structural failure due to reduction in strength.

Outcome of ESP & certification

CONDITION EVALUATION REPORT
EXECUTIVE HULL (OR) SUMMARY

Issued by the Recognized organisation on behalf of flag state.

Salient features of ESP

(i) Overall survey

Overall survey reports the overall condition of the hull structure and identifies the requirement for close up surveys.

(ii) Close up survey

- close up survey is an inspection of the structural details within close visual inspection range, normally within reach of hand.
- The extent of areas to be inspected under close up survey will be provided in table format for special survey 1 (SS1), SS2, SS3 and so on.
- The scope of survey increase from special survey 1 to all component in special survey 3 and continue for rest of the ship life.

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(iii) Suspect areas

- These are locations on ship where substantial corrosion is observed.
- It is areas where surveyor suspect rapid wastage is occuring.
- The areas are identified during surveys, often from previous inspection report or thickness measurement data.
- It is crucial for maintaining the structural integrity of the ship and preventing potential failure.

(iv) Substantial corrosion

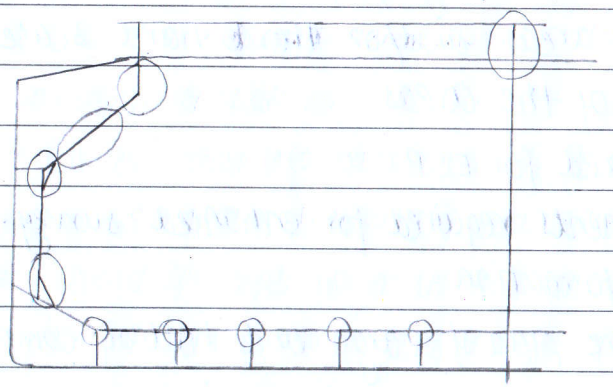
→ This is the extent of corrosion such that the wastage of component is more than 75% of allowable limit, but within the acceptable limit

→ The allowable limit for each structural component is provided by classification society & mentioned in the thickness measurement report.

→ If the wastage of component is beyond the allowable limit, the component must be renewed.

→ For areas of substantial corrosion the location will be condition evaluation report & will be treated as critical structural areas.

E.g: If a deck plate is 20mm thick, Allowable limit is 10% i.e 2mm. Hence upto 18 mm, no need to change
But 75% of 2mm = 1.5mm, 20-1.5 = 18.5 mm; so if less than 18.5mm, consider it as substantial corrosion which need more monitoring



(v) Critical structural areas

→ these are location which require closer monitoring because they are sensitive to cracking, buckling or corrosion which will adversly affect the structural integrity.

→ these location are determined by:

a) stress calculation
b) service history of own ship
c) service history of sister ship & similiar ship

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(vi) Thickness measurement

→ Should be carried out by company approved by flag state or RO
→ Extent of thickness measurement will be provided in tabular form based on age of ship.
→ In all cases, suspect area must be included
→ Thickness measurement should be carried out simultaneously with the close up survey.

(vii) Corrosion protection system

→ As per SOLAS CH-2 Part 1, corrosion prevention system will be normally considered as a full hard coating using epoxy paint & equivalent
→ The type of coating for each tank should be mentioned in condition evaluation report and other inspection reports.
→ Coating condition is to be provided as good, fair or poor
→ Good condition means only minor spot rust
→ Fair condition means local breakdown of coating and/or light rust over 20% or more areas.
→ Poor condition means general breakdown of coating over 20% or more of the areas and/or hard scale (thick rust) over 10% or more of the areas.

* Documents required for ESP

(i) ESP file

1. Basic ship information
2. Main structure plan of cargo and ballast compartment
3. Arrangement plan of tank with their purpose
4. List of tank with their use, corrosion prevention system in use and their service history.
5. Means of access to the structure for close up survey.

** SHIP STRUCTURE ACCESS MANUAL is required for all new ship providing the arrangement plan inside individual tanks ← Compartment for access to structure to carry out close up survey.

6. Condition for survey i.e. Requirement for cleaning, ventilation, gas

freeing etc.

7. Identification of tanks & areas for:
   a) Close up survey
   b) Thickness measurement
   c) Testing & method of testing for leaks & structural integrity.
   d) Critical structural areas & suspect areas
8. Details of conversion, modification or damage experience by the ship
9. Identification of thickness measurement company
10. owner inspection report during the current cycle & atleast previous 3 years.

Owner inspection report should contain the following:-
   a) Tank No & location
   b) Purpose of the tank
   c) Any damages or repair
   d) Any thickness measurement or maintenance carried out
   e) any cracking, bucking or corrosion identified
   f) corrosion protection system is used
   g) condition of coating

(II) Ship construction file (SCF)

Applies to all oil tanker & bulk carrier greater than or equal to 150m in length delivered on or after 1 July 2020 and updated as appropriate throughout the ship's life in order to facilitate safe operation, maintenance, survey, repair and emergency measures (SOLAS II-1/3-10; MSC-1/Circ. 1343)

(III) Ship structure access manual

Applies to oil tanker of 500 GRT & over and bulk carriers of 20000 GRT and over, constructed on or after 1 January 2006. A ship's means of access to carry out overall and close up inspection and thickness measurement shall be described in a ship structure Access Manual. (SOLAS regulation II-1/3-6)

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(iv) Coating Technical File (CTF)

Contains documentation relevant to the selection, specification, installation and inspection of coating applied to a ship's seawater ballast tank and double skin spaces and updated with-in service maintenance and repair of coating system (SOLAS regulation II-1/3-6)

Ques 5) How the flag states ensure that their rules and regulations are effectively enforced on ships register with them? (3 times)

Ans:-

- Under SOLAS CH-11, flag state can authorize organisation as ROs to carry out survey & certification on their behalf.
- In present scenario, only full time member of IACS are able to meet the requirement of the RO code under SOLAS CH-11/1.
- The classification society as RO supervise the design, construction, equipment & survey of the ships at the time of building & periodically thereafter.
- After successful completion of required surveys, flag states issues statutory certificates to ship.
- Flag state itself also carry out scheduled or unscheduled inspection on their own flagged vessel to verify compliance.

Q.7 Surveys and Certificates

6) State the objectives and features of ESP with reference to: a) Age of the vessel b) Access to the Surveyor c) Coating Condition d) Owner's Responsibility.

Below are the objectives and key features of ESP with reference to the specified points:

a) Age of the Vessel
Objective: To increase the frequency and extent of inspections as the vessel ages, due to higher risk of structural deterioration.
Features:

- Special Surveys and intermediate surveys become more extensive with vessel age.
- Thickness measurements and close-up surveys are mandatory at:
- 10 years: Initial ESP application, more detailed inspections begin.
- 15 years: More extensive hull structure checks (cargo holds, ballast tanks, etc.).
- 20 years and older: Annual surveys require increased scope of close-up inspections and structural assessments.

b) Access to the Surveyor
Objective: To ensure surveyors have safe and effective access to all critical structural areas for proper assessment.
Features:

- Ship must provide permanent means of access to critical areas (e.g., catwalks, ladders, staging).
- Portable staging, rope access, or drones may be used if safe access is not otherwise possible.
- Access plans must be included in the Survey Planning Document (SPD) before survey begins.
- Any limitations in access must be recorded, and may lead to increased inspection requirements or even rejection of the survey.

c) Coating Condition
Objective: To evaluate the condition of protective coatings, which are crucial in preventing corrosion and structural weakening.
Features:

- Coating condition is categorized as Good, Fair, or Poor.
- If coating is assessed as Poor, more extensive thickness measurements and close-up surveys are required.
- Uncoated or poorly coated tanks are treated as higher-risk areas and surveyed accordingly.
- Early degradation in coating may lead to shorter intervals between surveys or additional inspections.

d) Owner's Responsibility
Objective: To ensure the shipowner proactively facilitates effective and timely surveys, and maintains the vessel in a seaworthy condition.
Features:

- Owner must prepare a Survey Planning Document (SPD) before ESP surveys.
- SPD includes:
  - Ship drawings
  - Tank arrangement
  - History of defects/repairs
  - Coating conditions
  - Thickness measurement reports
- Owner is responsible for:
  - Making all areas accessible
  - Providing manpower and equipment (e.g., for staging or lighting)
  - Carrying out required repairs or maintenance identified during the survey
  - Failure to cooperate can lead to delay, suspension, or failure of the survey.

7) Describe the procedure for preparing the vessel for (SAFCON) safety construction renewal survey. (5 times)

Check & ensure the following:

- All certificates and documentation except SAFCON Certificates valid.
- Whether any new equipment has been fitted and, if so, confirm that it has been approved before installation and that any changes are reflected in the appropriate certificate; (Attach the list of new equipment fitted)
- Ship-specific emergency towing procedure
- Stability information, including damage stability, where applicable, and the damage control plans are on board
- Manoeuvring booklet is on board and that the manoeuvring information is displayed on the navigating bridge
- Log-book entries that the testing and the emergency drills of the steering gear have been carried out
- A complete file of the enhanced survey reports and the Condition Evaluation Report are on board
- Suitable Material Safety Data Sheets are available on board;
- For oil tankers and bulk carriers when appropriate, that the Ship Structure Access Manual is on board
- confirming when appropriate that the coating technical file is available on board
- The hull and its closing appliances are satisfactions maintained
- examining the anchoring and mooring equipment as far as can be seen.
- examining the collision and the other watertight bulkheads as far as can be seen
- examining and testing the operation of main and auxiliary steering arrangements, including their associated equipment and control systems
- confirming the operation of the ventilation for the machinery spaces
- confirming that the engine room telegraph, the second means of communication between the navigation bridge and the machinery space and the means of communication with any other positions from which the engines are controlled are operating satisfactorily

8) Explain process of preparing for Safety equipment survey of your ship

LIFE-SAVING APPLIANCES:

- Lifeboat
  - Stores and equipment.
  - Particular attention to bottom boards and buoyancy material.
  - Thwarts free of cracks.
- Overhaul and grease which davits and blocks. Falls to be renewed or turned end to end. Repaint markings on the lifeboat.
- When boats are in water run the boats ahead and astern.
- Inflatable liferafts to be serviced within the last 12 months.
- Lifebuoys- si lights, grab lines, markings well painted
- Lifejackets- lights, whistles and markings.
- Pyrotechnics- expiry dates

FIRE FIGHTING APPLIANCES CHECKS IN SEQ SURVEY:

- Fire control plans legible.
- Check fire hoses, nozzles and applicators in good condition.
- Test emergency fire pump.
- Overhaul all extinguishers.
- Test and overhaul fixed fire equipment system.
- Check breathing apparatus and firemans suit.
- Check fire and smoke detection system.

OTHER CHECKS IN SEQ SURVEY:

- Emergency lighting system.
- Check closing arrangements for- ventilators, skylits, doors and funnel.
- Check navigational equipment.
- Check pilot ladders and pilot hoists.

In general all checks to be carried out as per the record of inspection form at the back of the SEQ certificate.

9) Under the Harmonized system of surveys & Certification explain how will you prepare you vessel for an annual Load Line survey? (2 times)

PREPARATION FOR A LOAD LINE SURVEY

- Check that all access openings at ends of enclosed structures are in good conditions. All dogs, clamps and hinges to be free and well greased. All gaskets and water-tight seals should be crack free. Ensure that the doors open from both sides
- Check all cargo hatches and access to holds for weather tightness
- Check the efficiency and securing of portable beams
- If portable wooden hatch covers are used check that they are in good condition
- If tarpaulins are used at least two should be provided for each hatch and in good condition, waterproof, of ample strength and an approved material.
- Inspect all machinery space opening on exposed deck
- Check that any manholes and flush scuttles are capable of being made watertight
- Check that all ventilator openings are provided with efficient weather tight closing appliance and repair any defect
- All air pipe should be provided with satisfactory means for closing and opening
- Inspect any cargo ports below the freeboard deck and ensure that all of them are watertight
- Ensure that non return valves on overboard valves are operating in a satisfactory manner
- Side scuttles and openings below the freeboard deck must have efficient internal watertight deadlights
- Check that all freeing ports are in satisfactory conditions
- All guard-rails and bulwarks should be satisfactory condition
- Derust and paint the deck line, loadline marks, load line and the draught marks
- Non return and overboard valves functioning properly.

10) List out the various items to be opened and examined in dry dock as part of classification society surveys.

1. SHELL PLATING: Side, bottom, stern & bow plating examined to confirm that these are in satisfactory condition
2. SHELL OPENINGS: Plating, fittings & connection in way of shell openings examined to confirm that these are in satisfactory condition
3. STERN FRAME & RUDDER: Stern frame & rudder examined to confirm that these are in satisfactory condition. The clearance in the rudder bearings satisfactory.
4. RUDDER BEARING/BUSH CLEARANCES: Rudder bearing/bush clearances examined to confirm that these are in satisfactory condition.
5. SEA INLETS AND DISCHARGES & OTHER OPENINGS: Sea inlets and discharge openings in shell and particularly the shell plating in way liable to excess corrosion examined to confirm that these are in satisfactory condition.
6. PROPELLERS: Propellers checked for erosion, pitting, cracking of blades or possible contact damage. Fastenings & gratings examined to confirm that these are in satisfactory condition
7. OTHER PROPULSION: Exposed parts of steerable propellers, azimuth thrusters, side thrusters, vertical axis propellers and water jet units are to be examined for satisfactory condition.
8. SEA CHESTS & GRATINGS: Sea chests and their gratings, sea connections and overboard discharge valves and cocks and their fastening to the hull and sea chests examined to confirm that these are in satisfactory condition
9. CONDITION OF OIL GLAND/S: Oil gland/s (approved type) found tight when examined under a head of oil
10. STERN BUSH CLEARANCE / POKER GAUGE READINGS: Confirmation that stern bush clearance / poker gauge readings recorded below are considered to be satisfactory.
11. GENERAL CONDITION: Examination of the ship as far as practicable in order to confirm her general condition is satisfactory.
12. CHAIN CABLES: The chain cables are ranged and the anchors and the chain cables are to be examined (At special survey no. II and subsequent special surveys, the chain cables are to be gauged)
13. DREDGERS: Where the docking survey is part of the special survey, examination of hopper bottom doors and accessories such as hinges, actuating rods, hydraulic systems to confirm these are in efficient condition.
14. HOSE TEST OF HATCH COVERS FOR CONTAINER SHIPS: Checking the effectiveness of sealing arrangements of all hatch covers by hose testing or equivalent.

15. DOCKING SURVEY AS A PART OF THE INTERMEDIATE OR SPECIAL SURVEY: When survey in dry dock is part of an intermediate or special survey, confirmation that, overall and close up surveys, thickness measurements and repairs applicable to the lower portion of cargo spaces and ballast tanks (i.e. parts below light ballast water line) has been completed in the dry dock.
16. MAJOR REPAIRS TO MAIN /STEERING GEAR & CONTROLS: Trial of relevant machinery item (proplusion and steering) including sea trial as considered necessary by the surveyor to verify proper operation of the machinery.
17. RECOMMENDATION: Docking survey has been completed satisfactorily and the date may now be assigned.
18. ENDORSEMENT OF SAFCON CERTIFICATE: On satisfactory completion, SAFCON certificate has been endorsed as applicable towards bottom survey.
19. SEA WATER LINES: Visual examination of the seawater main line and any other seawater line having a direct connection to the shell plating.
20. STEERING GEAR: Functional test and visual examination of the steering gear and rudder trunk space (if fitted).

11) How will you as Chief Officer, prepare the ship for special survey?

1. Ensure all cargo operations are completed and cargo spaces are emptied, cleaned, and ventilated.
2. Clean ballast tanks, void spaces, and other structural areas to be inspected; obtain gas-free certificates.
3. Ensure safe access to all inspection areas using ladders, staging, or man-lifts; arrange lighting and ventilation.
4. Assist in identifying and marking areas for ultrasonic thickness measurements and close-up inspections.
5. Coordinate with the chief engineer to ensure all machinery and systems (steering gear, bilge system, emergency generators) are operational and ready for demonstration.
6. Test watertight doors, fire doors, and hatches in presence of surveyor.
7. Prepare firefighting systems and structural fire protection arrangements for inspection.
8. Arrange for dry-docking if required, and ensure underwater hull, sea valves, propeller, and rudder are accessible.
9. Ensure lifesaving appliances are in place, tested, and ready for inspection.
10. Provide all necessary manpower, safety measures, and support to surveyors during inspection.
11. Keep a record of all survey findings, and coordinate with the company for any required repairs or follow-ups.

12.a) What are the survey requirements for an oil tanker undergoing 3rd special survey? **b)** What are the preparations to be carried out for the above vessel prior to the commencement of the survey? (2 times)

a) During 3rd special survey, vessel has to undergo
(i) Renewal survey (Write answer same as Q.2.d)
(ii) Docking survey (Write answer same as Q.2.f)
(iii) ESP: Overall survey, Close up survey & Thickness measurement (Write answer same as Q.4)

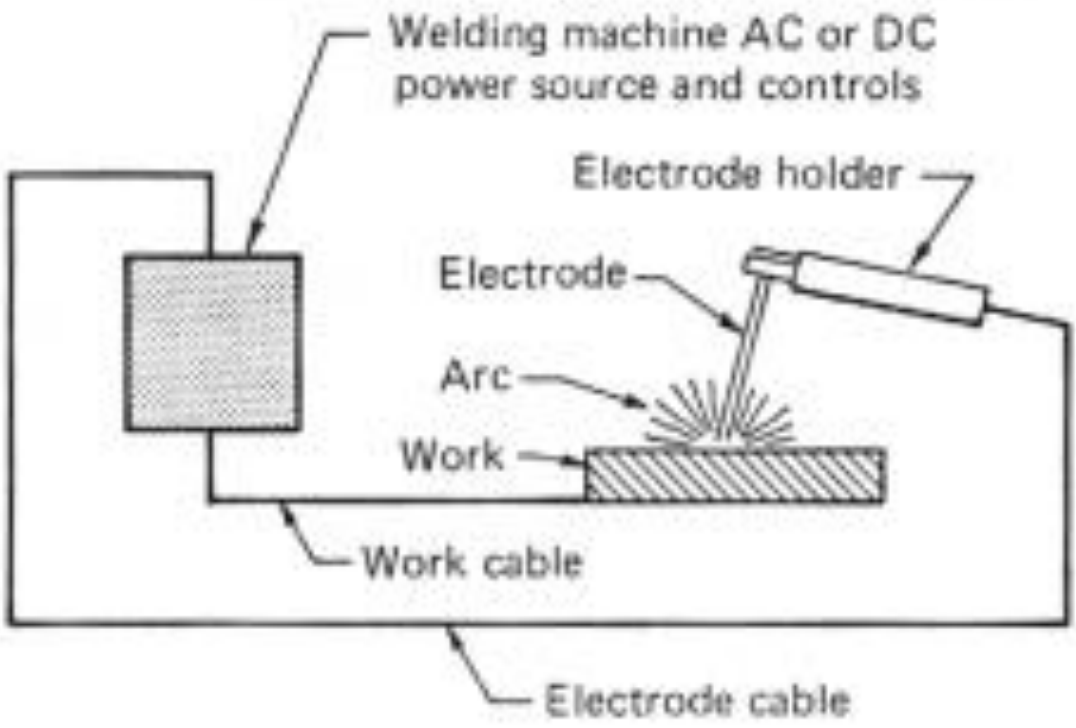
b) Write answer same as Q.11

13) List the certificates required to be carried on board an oil tanker in addition to statutory & mandatory certification carried by cargo ships.

1. Crude Oil Washing (COW) Operations and Equipment Certificate – if the ship is fitted with and operates a COW system
2. Inert Gas System (IGS) Certificate of Compliance – confirming compliance with SOLAS regulations on inert gas systems
3. Shipboard Oil Pollution Emergency Plan (SOPEP) Approval Letter/Certificate – as per MARPOL Annex I
4. Oil Discharge Monitoring and Control System Certificate (ODME Certificate) – confirming installation and approval of ODME
5. International Energy Efficiency Certificate (IEEC) – applicable to all ships, but machinery/fuel use on tankers may vary
6. Certificate of Insurance or Financial Security in Respect of Civil Liability for Oil Pollution Damage (CLC Certificate)
7. Certificate of Insurance or Financial Security under Bunker Convention – for bunker oil pollution (applicable to all ships)
8. International Ship Security Certificate (ISSC) – includes tanker-specific security measures under ISPS Code

Q.8 Welding (Types, Faults, Tests)

(Page No 66 to 78)



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Q.8. Welding (Types, Faults, Test)

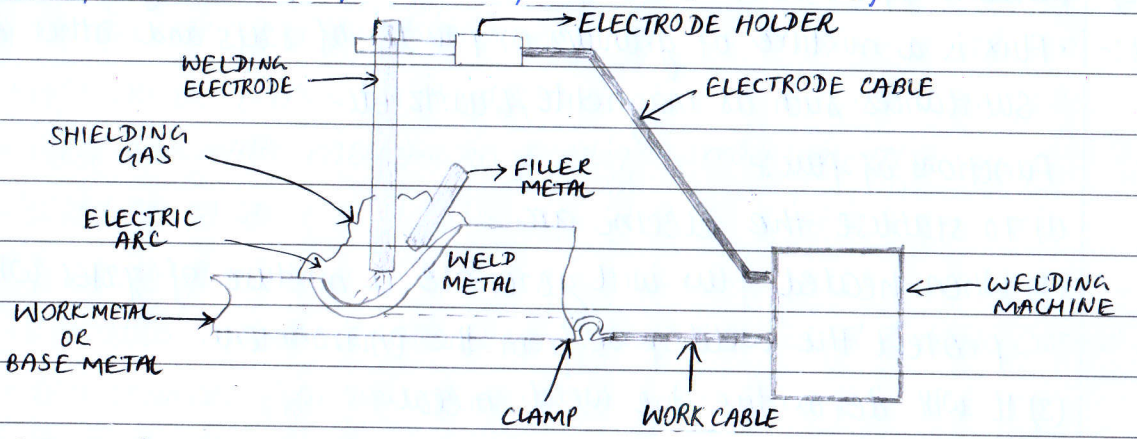
Ques 1) List various types of welding (2 times)

Ans:- The various types of welding are as follows:-

(I) Shielded metal arc welding (SMAW) - OR - Manual metal arc welding (MMAW)

DESCRIPTION

- In this process, an electric arc is generated between a flux covered electrode & the work metal.
- The filler metal is provided by the electrode itself.



Precautions to take are as follows:-

- Ensure the work area is clean, dry and well ventilated.
- Wear proper PPE.
- Check all equipment connections for damage or loose fittings.
- Keep electrode holders and cable dry to avoid electric shock.
- Ensure the welding machine is properly earthed.
- Keep flammable material away from welding area
- Use exhaust fans if working in confined or enclosed spaces.
- Do not touch the electrode or metal part of the electrode holder while welding.
- Follow a hot work permit system.
- Keep fire extinguisher or fire blanket nearby in case of emergencies.

5

Description
Sketch
Equipment
Advantage
Disadvantage

EQUIPMENT

(i) welding machine for electrical control
(ii) welding cables for connection to electrode & return cable from work piece by use of a clamp.
(iii) Electrode holder
(iv) Flux covered electrode.
(v) Clamp.

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Advantages:-
- Widely developed, versatile & widely accepted process.
- Relatively simple, portable & cost effective equipment.

Disadvantages:-
- High level of expertise & skill is required.
- Molten weld pool will create slag which must be removed.

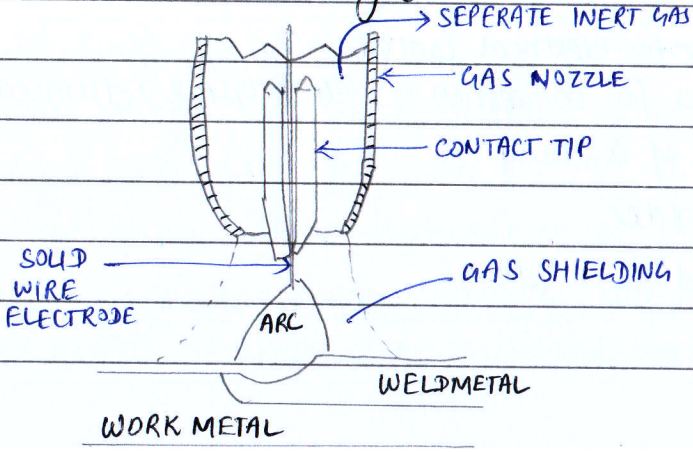
Ques 2) What is flux? What is the purpose of flux in welding? (6 times)

Ans:-
- Flux is a mixture of granules or powder of salts and other substances such as magnetite, Quartz etc.

Functions of flux:-
(1) To stablise the electric arc
(2) When heated flux will generate a mixture of gases which will protect the weld pool from the environment
(3) It will de-oxidise the weld metal
(4) It will help in controlled alloying of the weld metal for uniform strength.
(5) To increase the viscosity of weld pool to prevent the dripping of molten metal in vertical and overhead welding.
(6) SLAG is formed by mixing the impurities of liquid weld pool and creating oxides.
(7) The density & viscosity of SLAG is residued so that it can float above the weld pool.
(8) The molten SLAG will soldify the become brittle so that it can be easily removed from surface of weld.

Contd. Of Ques. 1

(2) Gas metal arc welding (GMAW) -or- Metal Inert Gas (MIG) welding



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DESCRIPTION:-

- Metal inert Gas (MIG) welding is carried out by generating electric arc between a wire electrode and the base metal.
- Shielding gas is supplied seperately using industrial inert gas.
- The filler metal is provided by the electrode which passes through the contact tip inside the gas nozzle.

EQUIPMENT:

- Welding machine with control
- Seprate inert gas supplier
- Gas nozzle with welding gun
- Electrode with mechanical feeding arrangement
- Welding cables.

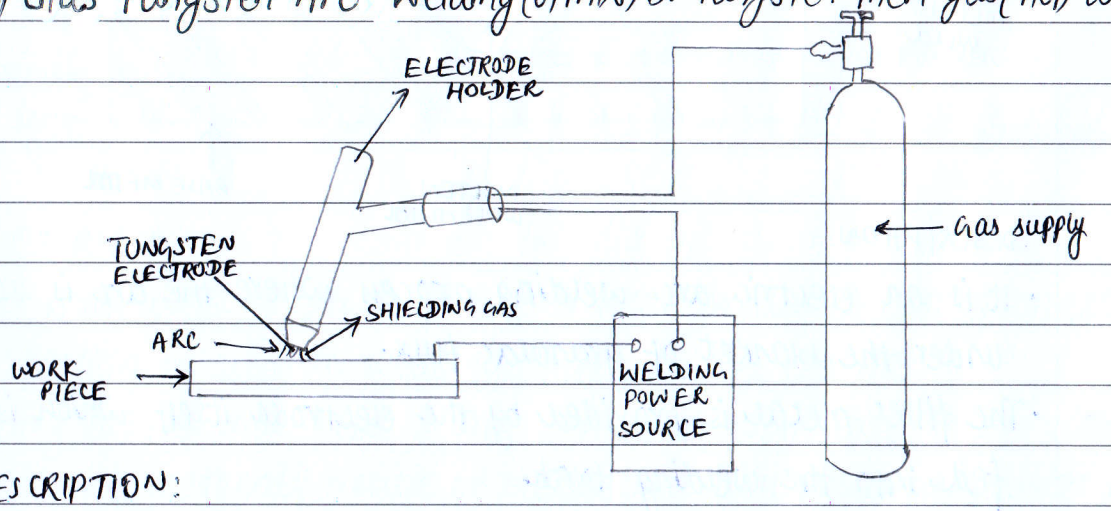
Advantages:-

- Versatile process, can be used for stainless steel & other carbon steel
- less smoke & fumes are created.
- There is no SLAG generated.

Disadvantage:

- High cost of equipment & maintenance.
- Portablity is restricted.
- Shielding gas may be blow away by wind.

(3) Gas Tungsten Arc Welding (GTAW) or Tungsten Inert gas (TIG) welding.



DESCRIPTION:

- It is a specific type of metal inert gas electric arc welding process which is used for welding of almost all commercial metals and those

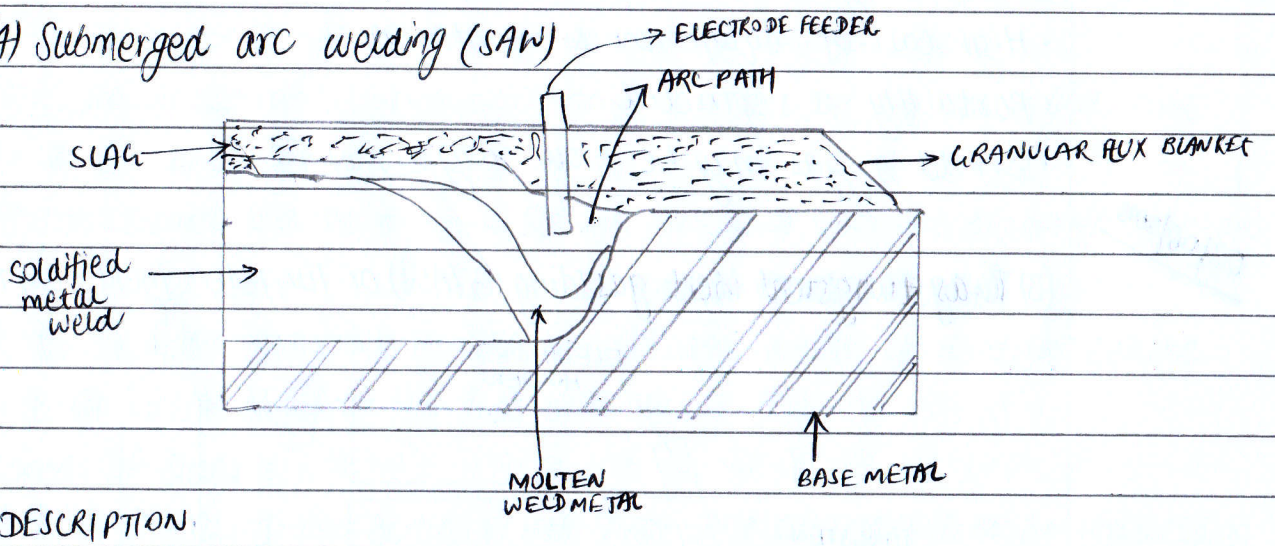
where the thickness is very less.
- The use of tungsten electrode provides a non-consumable electrodes to create the electric arc.
- Shielding gas is provided by seperate supply of inert gas.

Equipment
- Tungsten electrode with holder
- Welding machine and cable
- Filler metal (if required)
- Supply of inert gas

ADVANTAGES
- Can be used for very thin metals
- Filler rods may not be required as the tungsten electrode can weld by fusion of the base metal itself.

DISADVANTAGES
- Very high level of skill is required for the operator.
- Cost of equipment & shielding gas is high.

(4) Submerged arc welding (SAW)



DESCRIPTION
- It is an electric arc welding process where the arc is submerged under the blanket of granular flux.
- The filler metal is provided by the electrode itself which is automatically fed into the welding torch.

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EQUIPMENT:-

- Welding machine
- Programmable controuer.
- Welding torch with travel mechanism.
- Filler electrode wire with travel mechanism.
- Hose for flux with hopper & travel mechanism.
- A flux recovery system is usually included.

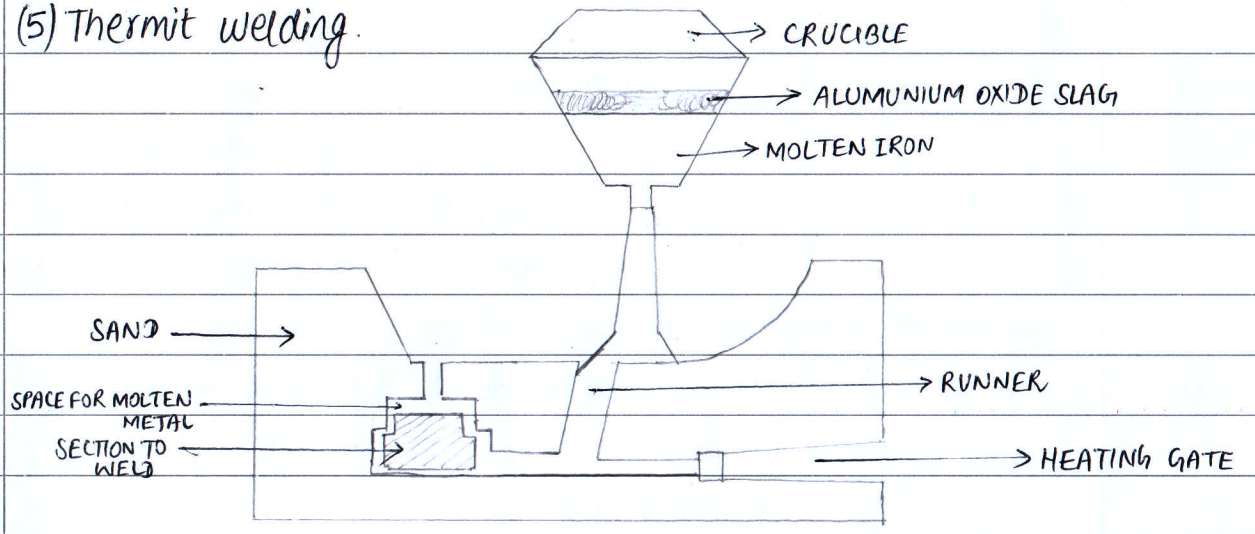
Advantages:-

- Excellent for automatic welding
- NO radiation, smoke or fumes for the operator.

Disadvantage:

- Weld pool can not be sighted
- Slag must be removed
- Limited position i.e. overhead & vertical is difficult.
- NO portablity.

(5) Thermit welding.



DESCRIPTION:

- It is an welding process in which heat produced during an exothermic reaction is used to weld two metal pieces together.
- Only an external heat source is needed to initiate the process.
- Thermite material (mixture of metal oxide, aluminium powder and fuel) is used for welding process.
- This welding process is known as exothermic welding.

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Equipment:
- Crucible
- Thermit portion
- Igniter
- Sand/Graphite Mold

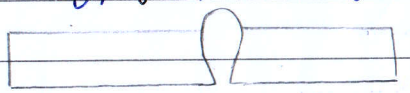
Advantage:
- Strong durable welds.
- Suitable for various metals

Disadvantage
- High cost
- Slow welding speed.

Ques 3) Describe with sketches, the various type of weld joints. (5 times)

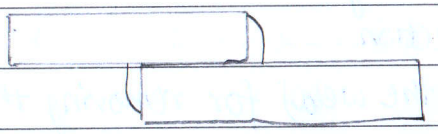
Ans:- The various type of weld joints are as follows:-

1) BUTT JOINT



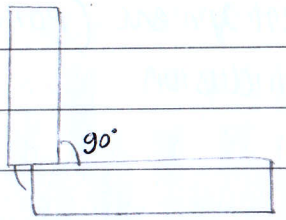
- The two plates are in same plane i.e. 180°
- E.g. :- Hull plate, deck plate, plain bulkhead

2) LAP JOINT



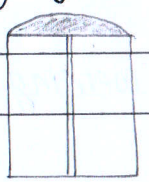
- The two plates are also 180°. But the edges are joining at ends i.e. overlap each other. E.g. Collar plate, doubler plate

3) CORNER JOINT



- The two plates are perpendicular to each other.
- Welding is at the edges of two plates
- E.g. Bulkhead on deck, hatch coaming.

4) Edge joint



- Formed by placing the edge of two pieces of material next to each other.

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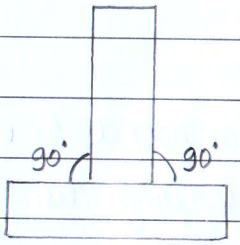
5) T joint or Fillet joints.



- One plate is welded in between of others.
- The two plates are perpendicular to each other.
- E.g.: Stiffeners, stringers, girders.

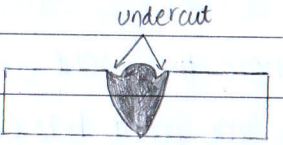
Ques 4.a) Describe various types of defects that could be found in welded joints, with sketches as relevant (3 times)

Ans:- The various defect that can be found in welded joints are as follows:-

(i) Overlap

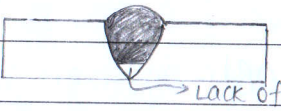
It is a defect where the weld metal flows over the base metal's surface without properly fusing with it, creating a superficial layer.

(ii) Undercut



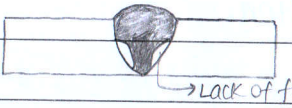
It is a defect that appear as a groove in the base metal, along the edges of the weld caused by excessive heat, travel speed & arc voltage.

(iii) Lack of penetration



It is defect that occur when the weld metal doesn't fully fuse with the base metal at the root of the joint, resulting in a week and potentially defective weld.

(iv) Lack of fusion



It is a defect that occur when the weld metal doesn't properly fuse with either the base metal or previously deposited weld beads, resulting in week, unbonded area within the weld.

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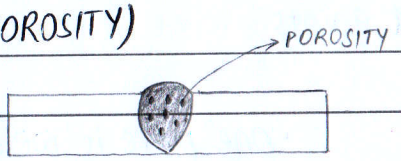
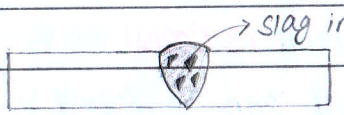
(v) Gas entrapment (POROSITY)



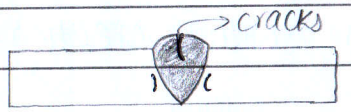
It is a defect occurs by the formation of gas pockets or voids within the weld metal, caused by trapped gas escaping during the solidification of the molten weld pool.

(vi) Slag inclusions.



It is a defect that occurs where non-metalic slag particles become trapped within the solidified weld metal.
This occurs when slag is not properly removed during welding.

(vii) Cracking.



It is a defect occurs where the weld or surrounding metal cracks when the localized stress at some point has exceeded the ultimate strength of the material.

4.b) Also explain their causes and how they can be minimized by good welding practice.

(OR),

List & describe the main causes of faults in welding and show how they may be overcome by good welding practice (3 times)

Ans:- The main causes of defects/faults in welding are as follows:-

(i) Improper welding techniques
(ii) Improper edge preparation.
(iii) Improper current
(iv) Improper cleaning of the base metal.
(v) Improper shielding gas or flux.
(vi) Improper removal of the slag.

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The good welding practice to minimize defect are as follows:-

(i) Proper joint preparation.
(ii) Correct welding parameters
(iii) Use of correct filler material
(iv) Use proper welding technique
(v) Use of backing/back-run
(vi) Control of interpass temperature.
(vii) Welder should be trained and qualified.
(viii) Follow proper welding procedure
(ix) Use destructive and non-destructive testing methods.
(x) Detect and correct defect before they propogate.

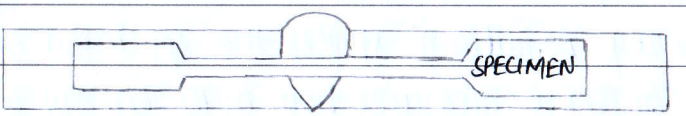
Usual method for correction of defect in welds:-

- Gouge (to heat & reliquiefy the weld for removing the weld
- To reweld using correct parameters.

4.c) Describe the destructive and non-destructive methods of testing welds (3 times)

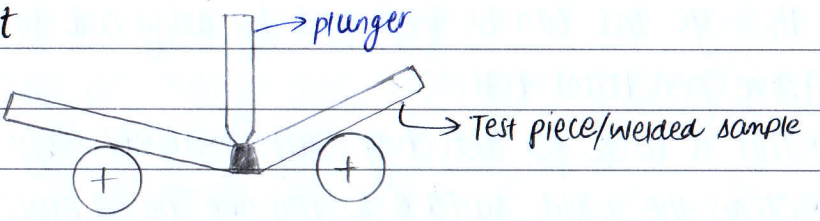
Ans:- The destructive tests for welded joints are as follows:-

(i) Tensile test



- A test piece is cut from the welded joints.
- It is put in a tensile testing machine.
- The machine pulls the piece from both end until it breaks.
- The maximum load it took before breaking is recorded.

(ii) Bend test



- A test piece is cut from the welded joints.
- It is placed on a bend test machine.
- A plunger presses the sample to bend it to certain angle (usually 180°)

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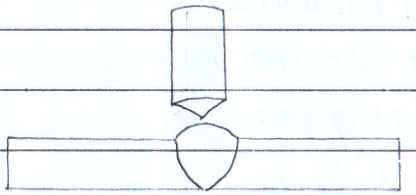
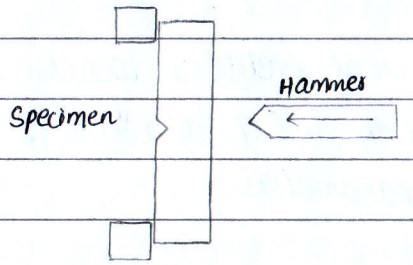
- The outer surface of the bend is checked for cracks, lack of fusions, open defects (if any).

(iii) Hardness test



- A small indenter (cone or pyramid) is pressed into the surface of test piece at a fixed load.
- The size or depth of the indention is measured.
- Harder material will have smaller indention.

(iv) Toughness test



- A small notched specimen (with a V- or U- shaped cut) is taken from the welded joint.
- It is a placed in a machine called as charpy Impact Tester.
- A heavy pendulum strikes the specimen and breaks it.
- The machine measures how much energy was absorbed in breaking it.

The non-destructive test for welded joints are as follows:-

(i) Visual Inspection.

Visual inspection relies upon the detection of surface imperfection using the eye and can be improved by using aid such as magnifying glass.

(ii) Dye penetrant test

- This is used for detecting surface defects only.
- Clean the weld surface to remove oil, grease, rust or dirt.
- Spray or brush a liquid dye (penetrant) over the weld.
- Let it sit for 5-30 minutes to enter any crack.
- Wipe out the surface using cloth or cleaner.

- Then suitable developes like talc or chalk powder is sprinkled over the surface.
- Developer sucks liquid dye whereever it is present in surface discontinuties.
- Liquid die changes the colour of developer and indicates location and size of surface defects.

(iii) Magnetic particle testing

- Clean the weld area to remove dirt, grease, rust or paint.
- Create a magnetic field using electromagnet or passing current through the weld.
- Spray fine iron particles over the test surface.
- If there is a crack, it interrupts the magnetic field.
- Particles gather at the defect, forming a visible indication.

(iv) Radiographic testing.

- A source of radiation is placed on one side of the weld.
- A radiographic film is placed on the opposite side of the weld.
- The radiation passes through the weld and hits the film.
- Defect block radiation creating a dark image & sound metal creates a light image.
- Dark spots or irregularities on the image show internal defects.

(v) Ultrasonic testing.

- Place the probe (transducer) on the weld surface.
- The probe sends high-frequency sound waves into the metal.
- Sound waves reflect back from any defect inside the weld.
- These reflections are shown on the screen.

Ques 5) With the help of sketches, write short notes on:

a) Edge preparation of plates for welding.

Ans:- It is the process of shaping and cleaning the edge of plates before welding to ensure: Good penetration
Strong welds
No defects.

It is done by flame cutting, milling, grinding or machining

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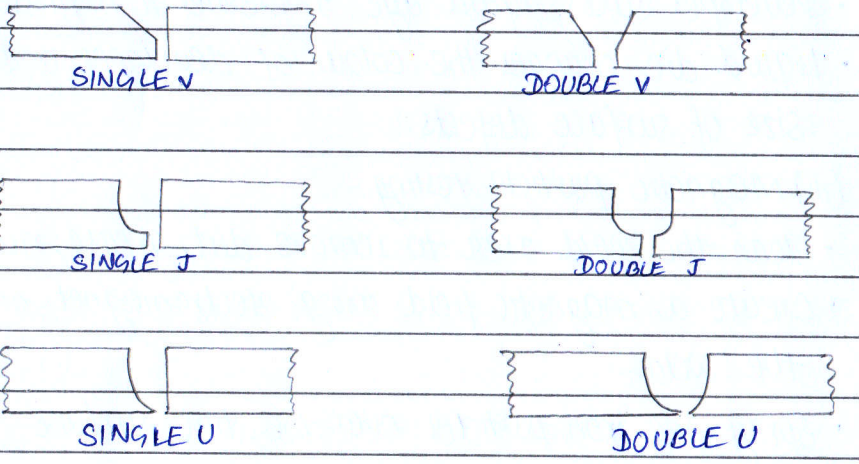
Common types of edge preparation are:-



b) Tack welding

Ans:-
- Tack welding means making small temperorary welds to hold metal parts in position before final welding.
- It prevent movement, distortion or gap changes during welding.
- It act as a temperory clamp.
- It can be part of the final weld if clean & defect free.
- Should be strong enough to hold, but easy to remove if needed.

c) Measures adopted in minimum distortion.

Ans:-
- Use proper welding sequence.
- Use lowest possible current and smaller electrodes.
- Use skip welding instead of continuas welds.
- Hold the work metal firmly using clamps or tack welds.
- Use strong backs or stiffeners during welding. 5
- Weld on both side of the joint, if possible
- Avoid rapid cooling - let the weld cool slowly and evenly.

d) Back-run

Ans:-
- It is a welding made on the back side of the weld joint after the initial welding has been completed from the front side.
- This is done to ensure complete joint penetration and to address any incomplete fusion in the root.

Ques 6) How effective weld penetration is achieved while welding thick plates? (2 times)

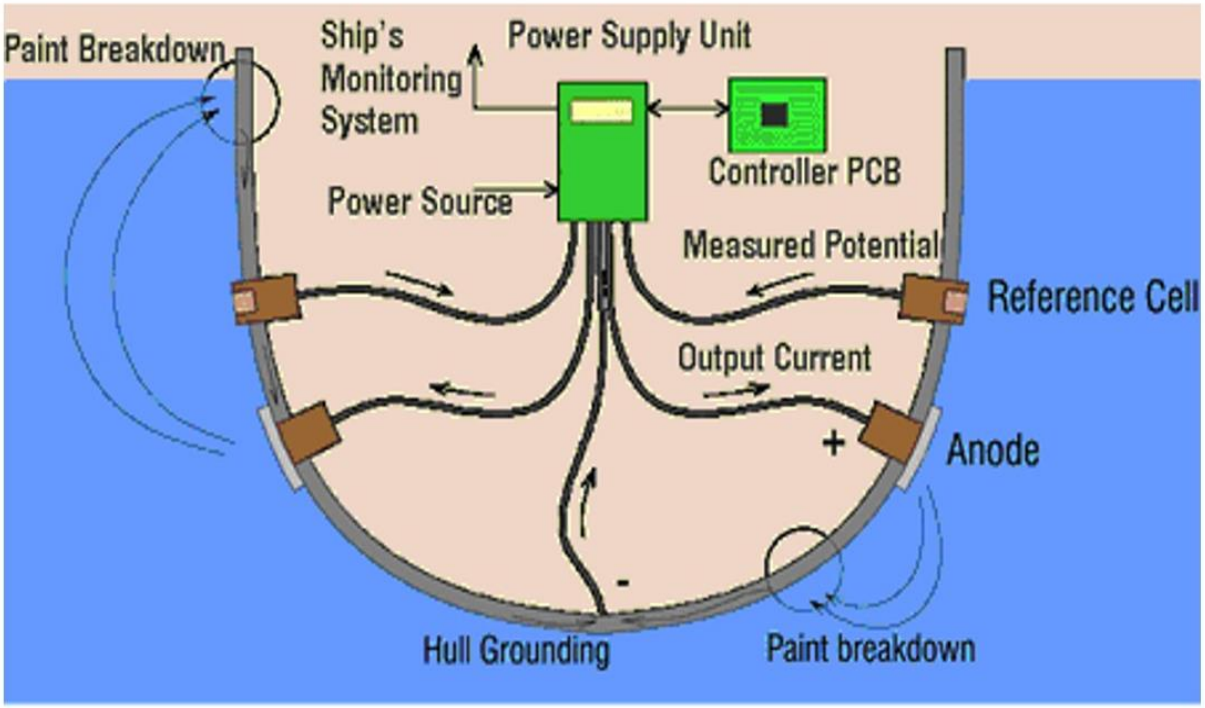
Ans:-

- Proper edge preparation is to be done.
- Maintain correct root gap, thickness and angle.
- For full penetration, perform back gouging and weld from opposite side (back-run)
- Use sufficient current and voltage to melt through the thickness
- Use low travel speed to allow deeper penetration.
- Weld in multiple layers for proper fusion throughout the thickness.
- Clean each pass before applying the next
- Preheat thick plates to reduce thermal stress and allow better fusion.
- Choose electrodes designed for deep penetration.
- Maintain correct arc length, electrode angle and manipulation.

5

Q.9 Corrosion/ Painting

(Page No 80 to 93)



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PAPER: NAVAL ARCHITECTURE PAPER-I

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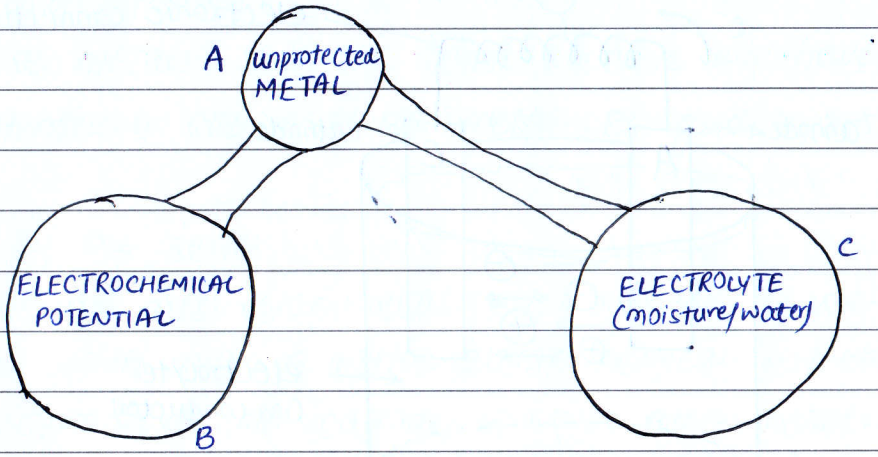
Q.9. CORROSION/PAINTING



A+B+C = corrosion

Nitrogen eliminates the Electrolyte (C), therefore the equation is not complete & corrosion can be inhibited

Corrosion is detioration (deduction in thickness) of a material due to electrochemical reaction with the environment

Three parts of corrosion traingle which are required for corrosion to occur:

(A) Unprotected metal

(B) Electrochemical potential i.e. ability of the metal to react electrochemicaly

(C) Electrolyte i.e. liquid which is good conductor of electricity.

For ships which are built of iron & steel, electrochemical reaction of iron in sea water & presence of oxygen will create rust leading to reduction in thickness of iron plates.

* Erosion: Erosion is the removal of surface materials from Earth's crust & their transportation by natural agents such as wind, water, ice etc.

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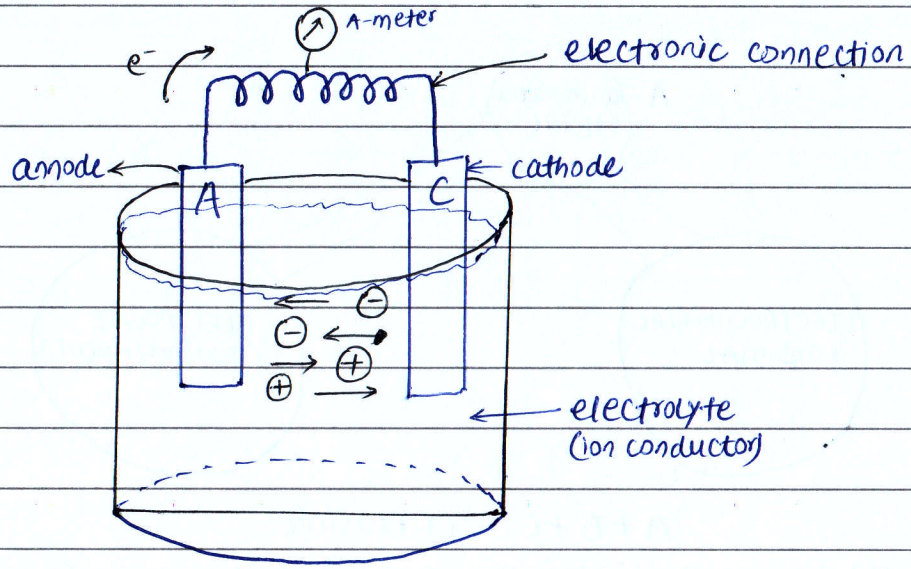
* THE CORROSION CELL



⊖ electrons

⊕ protons

* Components of the corrosion cell:

(i) Two electrochemically dissimilar metals are partly ~~are~~ immersed in an electrolyte and wired together above the surface with a connection to A-meter

(ii) The metal which is electrochemically more reactive will become the anode which will corrode.

(iii) The metal which is electrochemically less reactive will become the CATHODE & not corrode.

* Electrochemical series or Galvanic series of metals showing the surface potential or electrochemical potential.

(-) : more reactive

(+) : less reactive

- The galvanic series of metals is used as a quick reference chart for electrochemical potential of metals.
- Hydrogen is used as reference with potential of 0.000.
- Metals which are more reactive will have '-' potential.
- ~~Metals~~ The most reactive metals like pottasium & magnesium will have maximum negative electrochemical potential.

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- Metals which are less reactive with respect to Hydrogen will have positive potential.
- Those metals which are least reactive will have very high positive potential & called Nobel metals. Ex: gold & platinum.

* Use of the electrochemical series.

- When two dissimiliar metals are exposed in same electrolyte, the metal with more negative electrochemical potential will become the anode & will corrode w.r.t to other metal.
- In Shipboard corrosion cell iron is more anodic in compare to rust. Therefore, will continue to corrode.

* Factor affecting corrosion rates.

1. Oxygen: The corrosion rates are reduced if oxygen availability is reduced. Example:- Inside inerted cargo tank, corrosion rate will be low.
2. Temperature: Corrosion rates increases if temperature of electrolyte & metal is increased. Example: Underside of deck plates of tanks containing heated cargo.
3. Conductivity of electrolyte: Higher the conductivity, faster is the the corrosion. Example: corrosion rate is more in SW, less in river water, and much reduced in FW.
4. Acidity of electrolyte: If the electrolyte is acidic, corrosion rate will be faster & reduced if the electrolyte is alkaline. Example: Using lime wash in cargo holds & bilge wells to make alkaline.
5. Electrochemical potential difference: Higher the difference in electro - chemical potential, faster the rate of corrosion.
6. Presence of corrasive ions: like chloride & sulphide will accelerate corrosion. Example: Sour crude oil which has high concentration of sulphide.

Ques:- List 6 types of corrosion. Explain each in 3 lines.

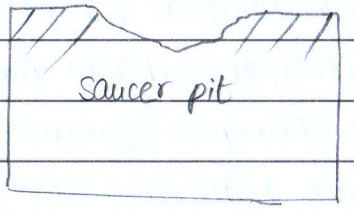
Ans:- (a) Uniform corrosion: The most common type of corrosion is uniform corrosion in nature. The loss of metal occurs at the anode sites and there is a continual change of the anode sites in the surface over time.

With progressive metal loss, areas which were initially anodic cease to be active and new anodic sites take over.

There is a continuos interchange between the anodic and cathodic areas, such that over a period of time the loss of metal over the entire surface is fairly uniform.

(b) Pitting corrosion:

- The characteristics of this type of corrosion is extremely localized and the penetration is deep in relation to the surrounding areas
- Pitting is one of the most dangerous form of corrosion as it often occurs in places where it cannot be readily seen.
- Pits form where there is a small anodic area which is supported by a large cathodic area, such as a situation of broken mill scale on steel surface



(c) Cervice corrosion

- Cervice corrosion is characterized by a geometrical configuration in which cathode reactant, oxygen, can readily gain access to the metal surface outside the cervice and have the less access in way of the cervice.
- The metal within the cervice is therefore anodic to the surrounding steel and suffers preferential corrosion.
- When mud, poorly adherant coating, sand and other debris cover a passive surface it undergoes a similar corrosion mechanism to that occuring in crevices. Whereever loose debris collects, there is a depletion of oxygen in a crevice. Consequently, the corrosion is localized there

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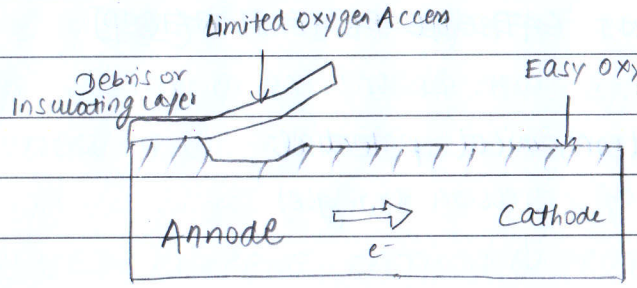

(d) Galvanic corrosion.

- It refers to the corrosion damage induced when two dissimilar materials are coupled in a corrosive electrolyte
- When a galvanic couple forms, one of the metal becomes the annode and corrodes while the other becomes the cathode and is protected.
- In order to have galvanic corrosion, the dissimilar metal must contact in an electrolyte (e.g. sea water)
- Annode corrode in preference to cathodes. SKETCH (same as of corrosion cell)

(e) Deposition corrosion.

- It is a subtle form of galvanic corrosion that occurs when the ions of the more noble metal (cathodic metal) come into contact with a less noble metal (anodic metal)
- This results in a local galvanic couple being formed and the less noble metal corrodes.
- A common example is that of copper ions from pipe work and heating coils being deposited on exposed steel tank tops and rapid pitting corrosion can develop.

(f) Corrosion due to stress.

- Stress is the intensity of the internally distributed forces or component of forces that resist a change in the volume or shape of a material that is or has been subjected to external forces.
- Stress corrosion cracking is a process that requires the simultaneous action of a corrodent and sustained tensile stress.
- Stress-relief cracking is a cracking process that occurs when susceptible alloys are subjected to thermal stress relief after welding to reduce residual stresses and improve toughness. Stress-relief cracking occurs only in metals that can precipitation-haraen during such elevated-temperature exposure.

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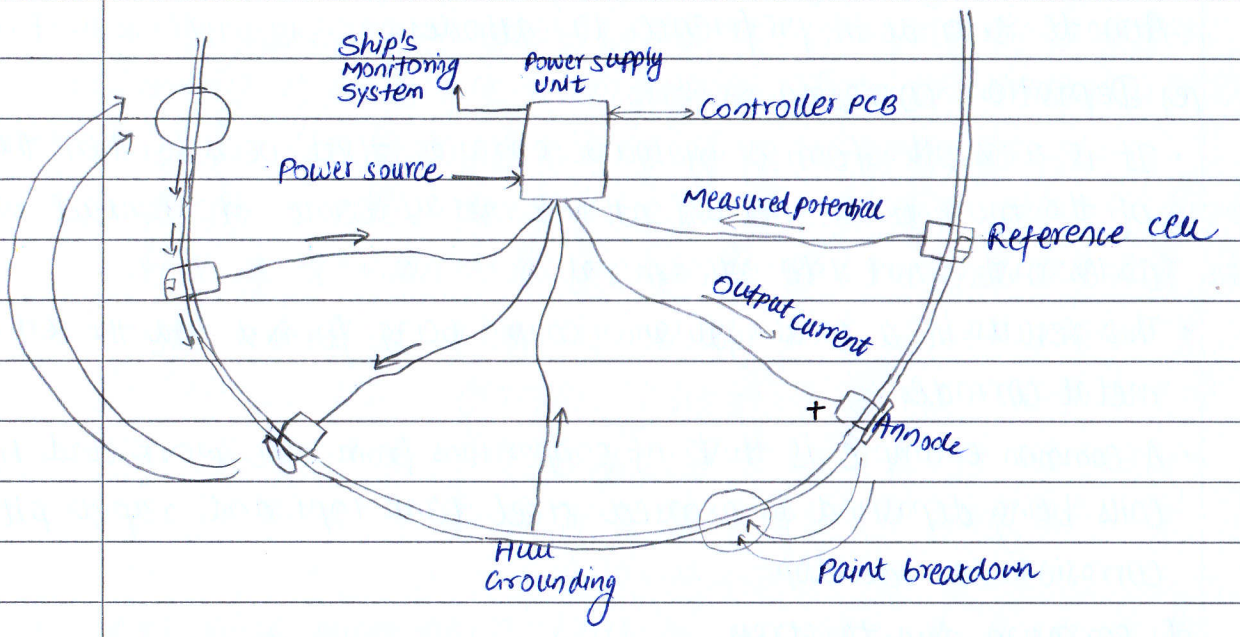
★ ~~IMPRESSED CURRENT CATHODIC PROTECTION (ICCP)~~

Electrochemical potential
(B of corrosion traingle)
↓
protection by cathodic protection

Impressed current	Sacrificial annodes
ICCP	SACP

↓



Principle of cathodic protection.

The electrochemical reaction in a corrosion cell based on two factors:-

(i) The difference of electrochemical potential between metals which will create the annode (more reactive) & the cathode (less reactive)

(ii) The rate of corrosion can be measured by the voltage or current generated by corrosion cell

(iii) Therefore, the concept of cathodic protection will be to replace the target metal will a more anodic metal. Thereby, making

it the cathode.

(iv) This system can be made more effective by introducing electric current in the opposite direction of the corrosion cells.

* IMPRESSED CURRENT CATHODIC PROTECTION (ICCP)

- In this system, an external supply of electric current is used to convert the electrochemical reaction in a corrosion cell.
- To Fascilitate the process, zinc anode will be introduced in the system.
- Impressed current will be send out through zinc anodes or return's to ship's hull from the area of paint breakdown, thereby making the hull cathodic.

SKETCH

* Working of ICCP system

(1) Areas of paint breakdown will expose the bare metal of hull to sea which is a good electrolyte, and, therefore will crease a corrosion cell locally.

(2) Reference cell is introduced into the outer hull to measure the existing current created by the corrosion cells around the ship's hull

(3) Power Supply Unit (PSU): The measured potential from the reference cell is sent to power supply unit which converts it into electronic signal & send to (4) Controller PCB.

(4) Controller PCB: It calculates the output current required to convert the corrosion cells & give the signal to PSU.

(5) ICCP anodes: These are introduced at outside of the hull with connection from PSU to send the current into the sea

(6) The impressed current (ICCP current) from ICCP anodes will find the areas of paint breakdown & return back to the hull. In this way, the areas of paint breakdown will be converted into cathode & so will be protected.

(7) Hull grounding: A grounding cable is provided from hull to PSU to complete the circuit.

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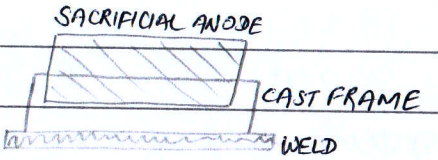
(8) Ship's monitoring system: It is usually provided locally, in ECR & in engineer's office with facility for data monitoring, recording, printing & controlling and usually with internal connection to shore monitoring service.

* Use on-board ships
(i) Bow area
(ii) Stern area around the propeller & rudder.
(iii) Large sea water inlets & outlets.

* SACRIFICIAL ANODE CATHODIC PROTECTION on hull and in tank



* Principle of cathodic protection (same as

- Sacrificial anode is any metal when introduced in corrosion cell will corrode in preference to the metal being protected.
  Ex:- For ship's made of iron & steel, aluminium & zinc are most commonly used as sacrifical anodes.
  Other metals can be used which are sufficiently more reactive than iron & steel
- It is used on outer hull in conjuction to ICCP system.
- Inside the hull, they are mainly used in ballast tanks, sea water pipelines, sea water pump strainers.
- For a compartment to be protected using sacrificial anodes, the total quantity is calculated using classification society.
- Annodes are usually designed in regular shapes rectangular or cylindrical & cast in brackets
- Each anode should be welded to the hull for electrical continuity.
- The number & distribution of anode should be as per classification societies drawings

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- Magnesium is prohibited to use on tankers as it is highly reactive & may generate sparks if falls from height.
- The survey of annodes are usuall part of safety construction survey. (Every dry-docking or 5 years renewal if required)

* contd. from type of corrosion

g) Impingement corrosion

It is a combination of corrosion & erosion due to high velocity liquid hitting the surface of the compartment

It will remove the paint & start corrosing. Example: hot sea water washing.

h) Microbiologicaly influenced corrosion.

- It is caused due to anaerobic bacteria generaly found in crude oil. Example: acid producing bacteria.

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Ques:- SURFACE PREPARATION STANDARDS

This answer is for after surface preparation.

Ans:- (i) ISO Sa 3 : Blast cleaning to visualy clean steel

When viewed without magnification, the surface shall be free from visible oil, grease and dirt and shall be free from mill-scale, rust, paint coating and foreign matters. It shall have a uniform metalic color.

(ii) ISO SA 2.5 : Very thorough blast cleaning.

When viewed without magnification, the surface shall be free from visible oil, grease and dirt and shall be free from mill-scale, rust, paint coating and foreign matters. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes.

(iii) ISO SA 2 : Thorough blast cleaning.

When viewed without magnification, the surface shall be free from visible oil, grease and dirt and from most of the mill-scale, rust, paint coating and foreign matters. Any residual contamination shall be firmly adhering.

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(iv) ISO SA1 : Light blast cleaning.
When viewed without magnification, the surface shall be free from visible oil, grease and dirt and from poorly adhering mill-scale, rust, paint, coating and foreign matter.

Ques:- (c) How to do surface preparation for painting?

Ans:- (i) Power tool cleaning (rotary grinders, wire brush, needle gun etc)
- Suitable for small repairs
- A life span obtain with a good coating may be about 2-5 years

(ii) Hydro jetting (water pressure above about 100 MPa)
- Loose rust, scale and coating will generally come off
- Mill scale and hard black rust will not be removed
- A life span obtain with a good surface tolerant coating can be 5 years or more

(iii) Ultra high pressure hydro jetting (pressure above about 200 MPa)
- Usually give better result than above method (grit injection available)
- Depending on the cleanliness achieved, life span with good coating can be upto 10 years

(iv) Slurry blasting
- Similar to dry grit ballasting but water is used as propellant instead of air
- Advantages are reduced dust & salt level
- Disadvantage is that the surface is wetted, which implies re-rusting.
- A life with good coating may be 5 years

(v) Chemical de-scaling with magnesium/calcium or hydrochloric acid
- All traces of chemicals must be removed by thorough fresh water washing before coating.
- Expected life with good coating can be 2-5 years.

b) What are the defects of painting?

Name of defect
Description
Correction

* Answer in Fosma PDF

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* Protective coating (Paints)

- Coating are for corrosion protection of metals by creating barr with the environment
- Three principles are used: (i) Create barrier & prevent penetration oxygen & electrolyte i.e. sea water

(ii) Using more anodic metals to create cathodic protection E.g. use of zinc & aluminium for iron & steel pl

(iii) By changing own property in contact with air or water for protection of metal.

Curing :- It is process of drying of the paint i.e. conversion of the applied liquid into hard coating.

Ques:- What is paint? What are the composition of paint?

Paint is a liquid applied on the surface which will dry and hard to form a hard protective ~~cloth~~ coating.

Components of paints:-

(a) Binder
(b) Pigment
(c) Solvent

→ (a) Binder: It is the film-forming component of paint. It will deter -ine the principle property of the paint both physical and chemica Binder will form a continuos film which will adhere to the surfa Paints are named after the binder.

- There are two classes of Binder:-

(i) Thermoset: • These are binders which will change their physical and chemical properties during curing.

- It means that hard coating cannot be dissolve by solvents.
- They are usually supplied in two different packs
- The two packs of liquid must be mix together in proportion immediately before application.

Example 1) Epoxy resins: These are widely used & accepted to meet hard protective requirement. They are most

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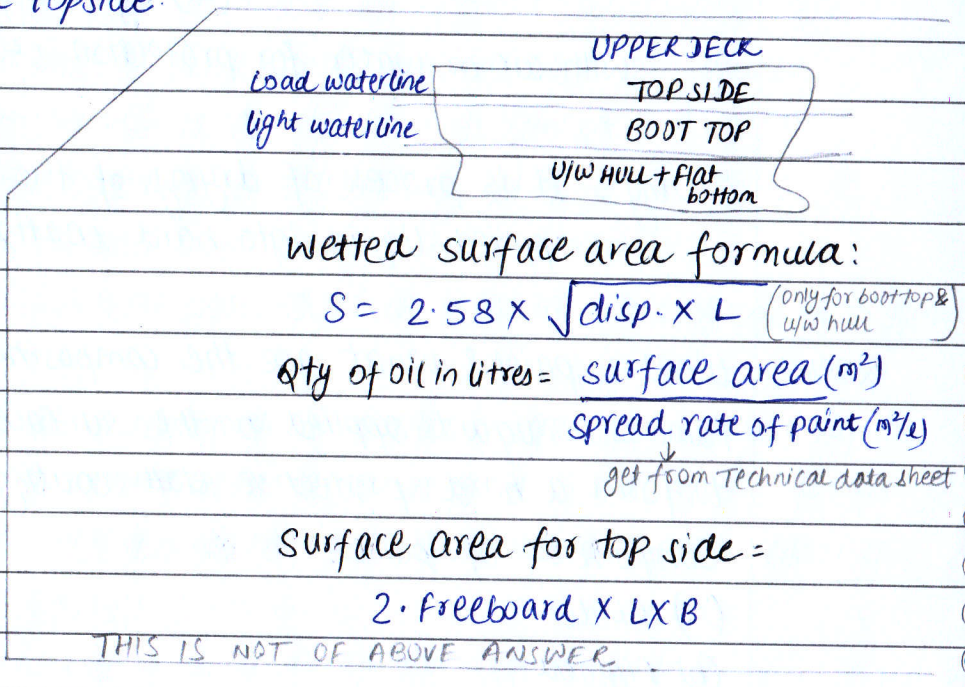
such as inside ballast tanks. Epoxy paints are degraded by sunlight & avoided for exposed areas.

- Example 2) Polyurethane resins

→ These are resins having excellent chemical resistance including acids

→ The finish coat has very good gloss retention

→ So, they are preferred as finish coats on exposed decks, superstructure external & hull topside.



Wetted surface area formula:

$S = 2.58 \times \sqrt{disp. \times L}$ (only for boot top & u/w hull)

Qty of oil in litres = $\frac{\text{surface area } (m^2)}{\text{spread rate of paint } (m^2/L)}$

↓ get from Technical data sheet

Surface area for top side =

$2 \cdot \text{freeboard} \times L \times B$

THIS IS NOT OF ABOVE ANSWER

(ii) Thermoplastic binders

- They can be completly dissolve in their corresponding solvents.
- They do not change their properties and retain their property during curing process.
- They are usually supplied in single packs & very cost effective for maintenance & causemetic work inside superstructure & machinery spaces.
- Example 1: Chlorinated rubber

→ They have very good acid & sea water resistance.

→ They were very popular in the internals for sea water piping, seachest, strainers & bilge wells.

→ If exposed to high temperature & over period of years, they tend to peel off from surface which has caused ● chocking of lines.

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- Example 2: Vinyl Resins
  - → They are vinyl polymers which are normally used for creating acrylic paint.
  - → ~~Example~~ Coal tar can be added to increase water resistance.
  - → It is used in internal surfaces of accomodation & machinery spaces.

(b) Pigment

- Pigments and extenders are fine powders which are dispersed/mixed with the binders to achieve specific purpose.
- Types of pigments:-

(i) Colouring pigments.

→ Purpose is to provide permanent colour to the paint.

→ Titanium dioxide is used for white colour etc.

(ii) Barrier pigments.

→ They increase the durability of the paint by using special pigments such as aluminium & glass-flake (glass flake epoxy has very good strength and anti-corrosive property)

(iii) Anti-corrosive pigments

→ Pigments like zinc & aluminium may be used to protect the metal by cathodic protection i.e. by electrochemical means.

(iv) Extender pigments.

→ They are used to increase pigment volume concentration.

→ They may be in various sizes and shapes.

→ A common example is anti-skid extenders.

(c) Solvents

- They are liquids which are used to facilitate the application of paint.
- Their purpose is to dissolve the liquid binder & reduce the viscosity of the paint for application.
- Solvents can also be used for cleaning the surface before application and for dissolving the liquid paints.

- Types of solvents are as follows:

(i) True solvents
→ Those which are completly compatible with the binder & recommended by manufactures in Technical data sheet

(ii) Latent solvent
→ These are usually much more stronger than true solvents.
→ They are usualy supplied as universal thinners.
→ They are used for cleaning the equipment.

(iii) Diluent solvent
→ These are usualy not a manufacturer supplied solvents
→ They are usualy used to reduce the cost. Example: Kerosene, turpentine.

Ques:- Anti-fowing paint

Ans:-
- Fowing means the attachement of unwanted organism on the ship's hull. Example: barnacles, seaweed, algae, mussels, tubeworms etc.
- Effect of fowing of the hull is to increase under water hull resistance and accelerate corrosion.
  This will lead to increased fuel consumption and reduced sea speed for the same RPM.
- Anti-fowing system means coating or surface treatment or systems which will prevent the attachment of unwanted marine organisms.
- The AFS convention & codes of 2001 was adopted by IMO to regulate the toxins which are used for anti-fouling.
  Some toxins such as TBT (TRI BUTYL TIN) have lasting adverse effect on marine environment & therefore they are prohibited.
- Application of AFS code: All ships off 400 GRT & above engaged on international voyages.
- International Anti-fowing system certificate should be carried with the attachment to mention the type of anti-fowing system in use & period for which it is valid
- Item that can be used for anti-fowing: self polishing polymers & resins are provided by paint company for anti-fowing.