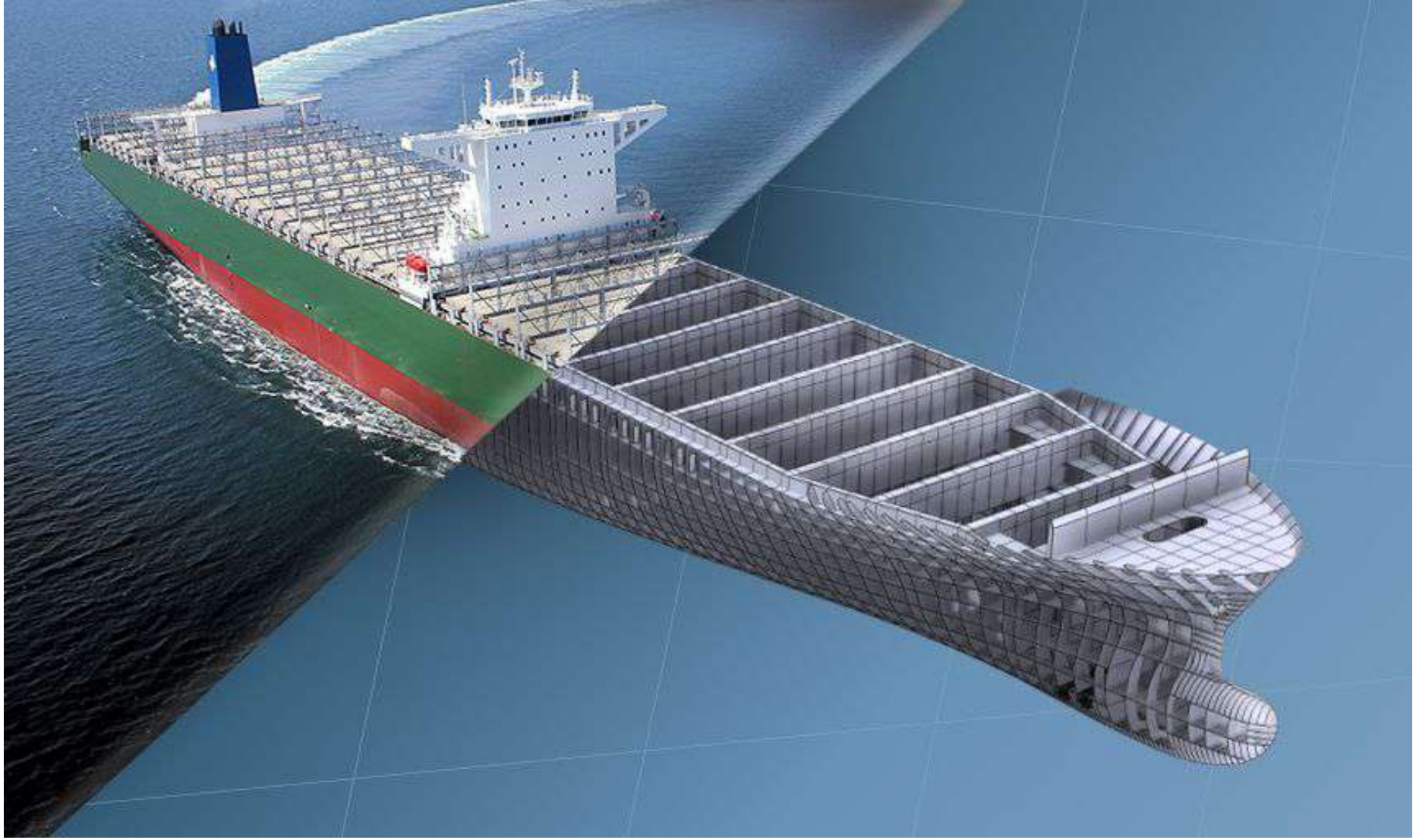


# Introduction to Naval Architecture

## II SEM –Module 4

# Syllabus

4. **Module IV**

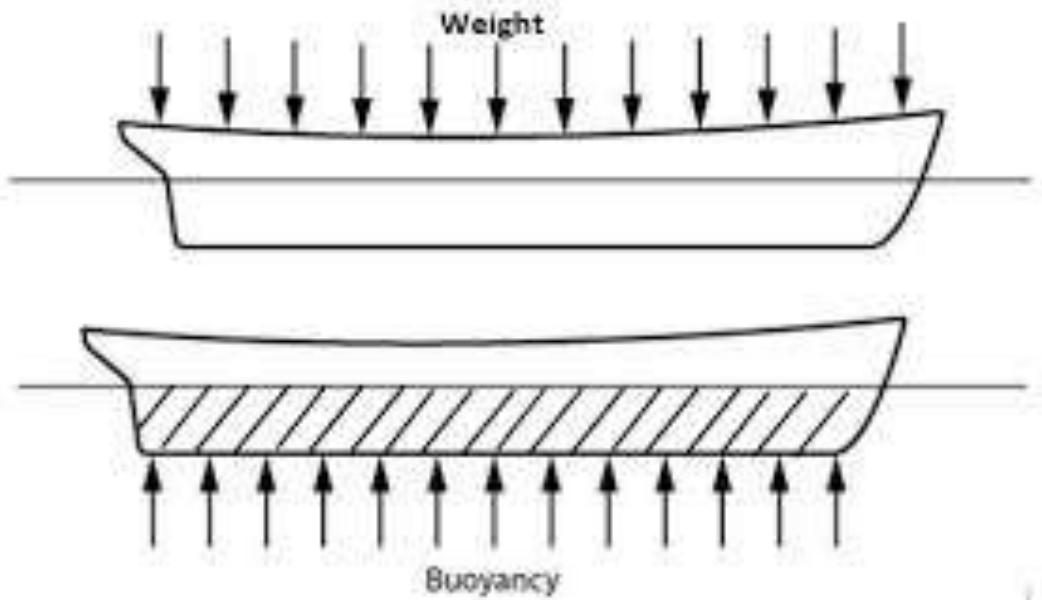
   **Introduction to ship structures**

   The ship and her structural members - shipbuilding materials (properties, compositions), Bottom structure, shell plating and framing, decks, hatches and hatch covers, Superstructures, bulkheads, tanks, holds, fore and aft structure, stern and rudder.

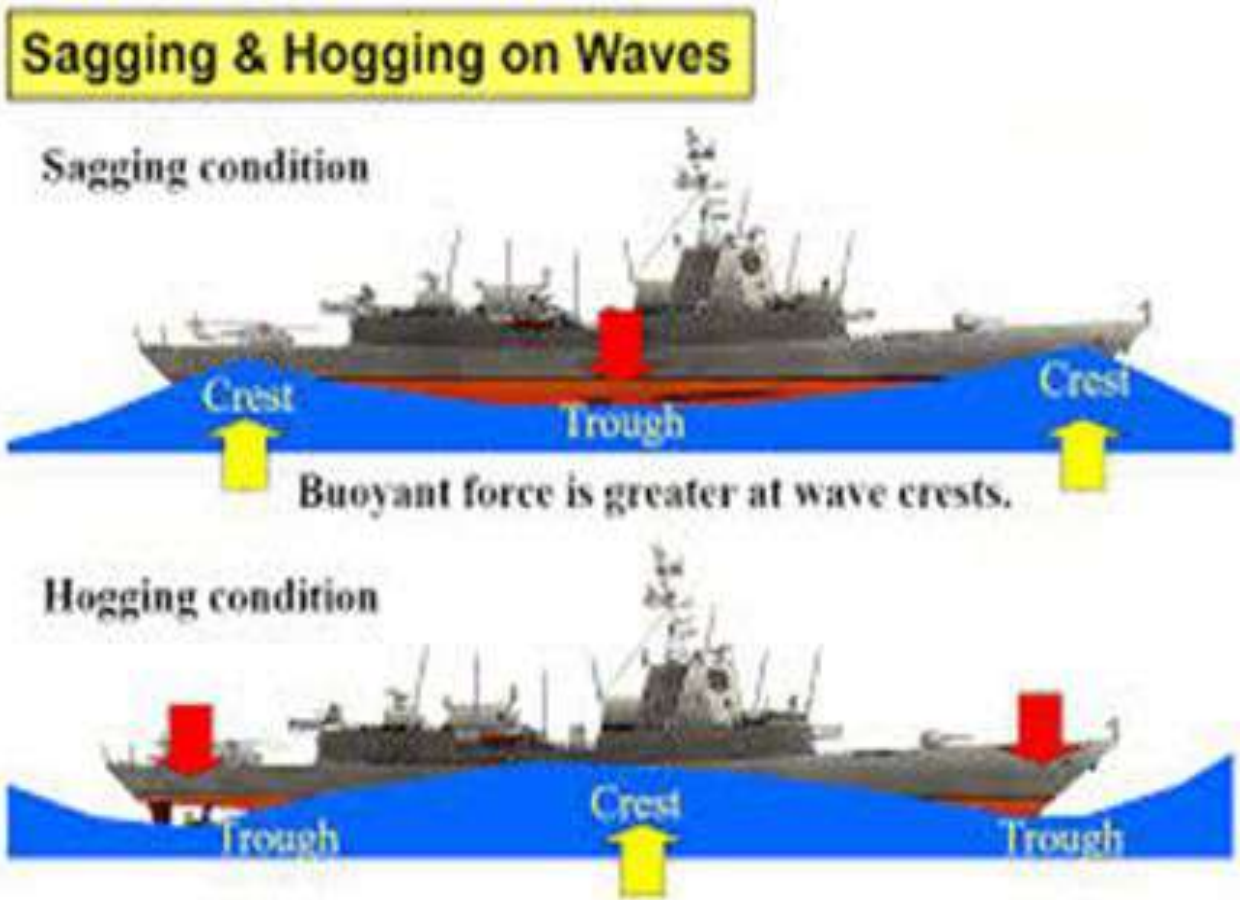
# Loads

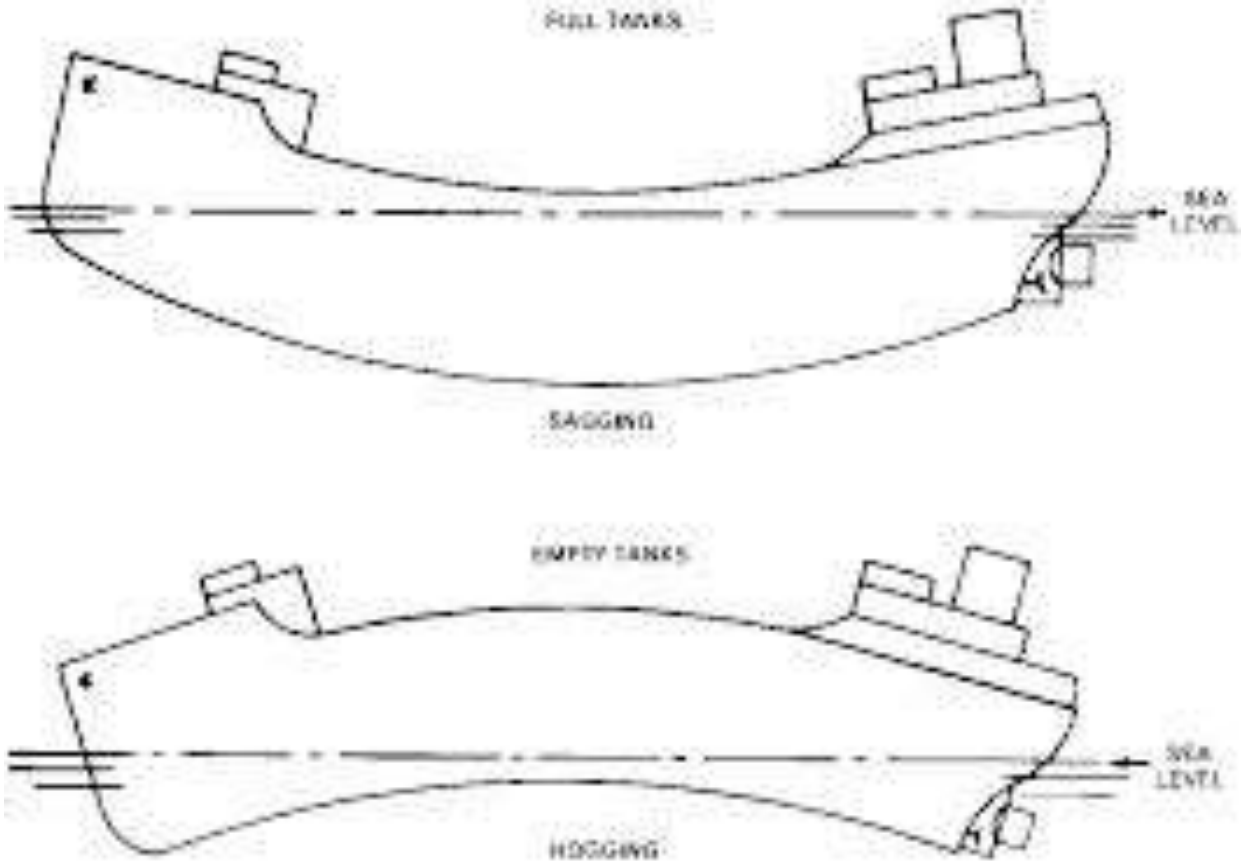
- Static
  - Hydrostatic pressure
  - Weight (structure, machinery, cargo etc)

- Dynamic (due to)
  - Ship Motions
  - External forces ( waves, wind, fixed structure)
  - Operation of Machinery (Vibration)
  - Movement of Internal fluids



# Hogging and Sagging



# Forces / Moments

Vertical Shear Force

Vertical Bending Moment

Horizontal Shear Force

Horizontal Bending Moment

Torsional Moment

# Ship Structure

- Ships are the largest mobile structures built by man.
- In contrast to land-based structures, the ship does not rest on a fixed foundation
- Entirely supported by buoyant pressures exerted by a `dynamic fluid environment.
- Design of structure to cater to
  - Withstand Forces and Moments
  - Functionality (access, ergonomics etc.)
  - Optimising hull  for other ship performance parameters (resistance, stability safety etc.)

# Ship Building Materials

- Steel (Iron alloyed with C, Mn, P, Si, S)
  - Mild Steel (Grade A,B,D,E), High Tensile Steel
    - Used in main hull structure
  - Stainless Steel
    - Used in lining of tanks
- Aluminum Alloys (alloyed with Mg,Mn,Cr)
  - Used in small ships
  - Superstructure
- Glass Re-inforced Plastic(GRP) / Fibre Re-inforced Plastic(FRP)
  - Used in boats
  - Superstructure

# END

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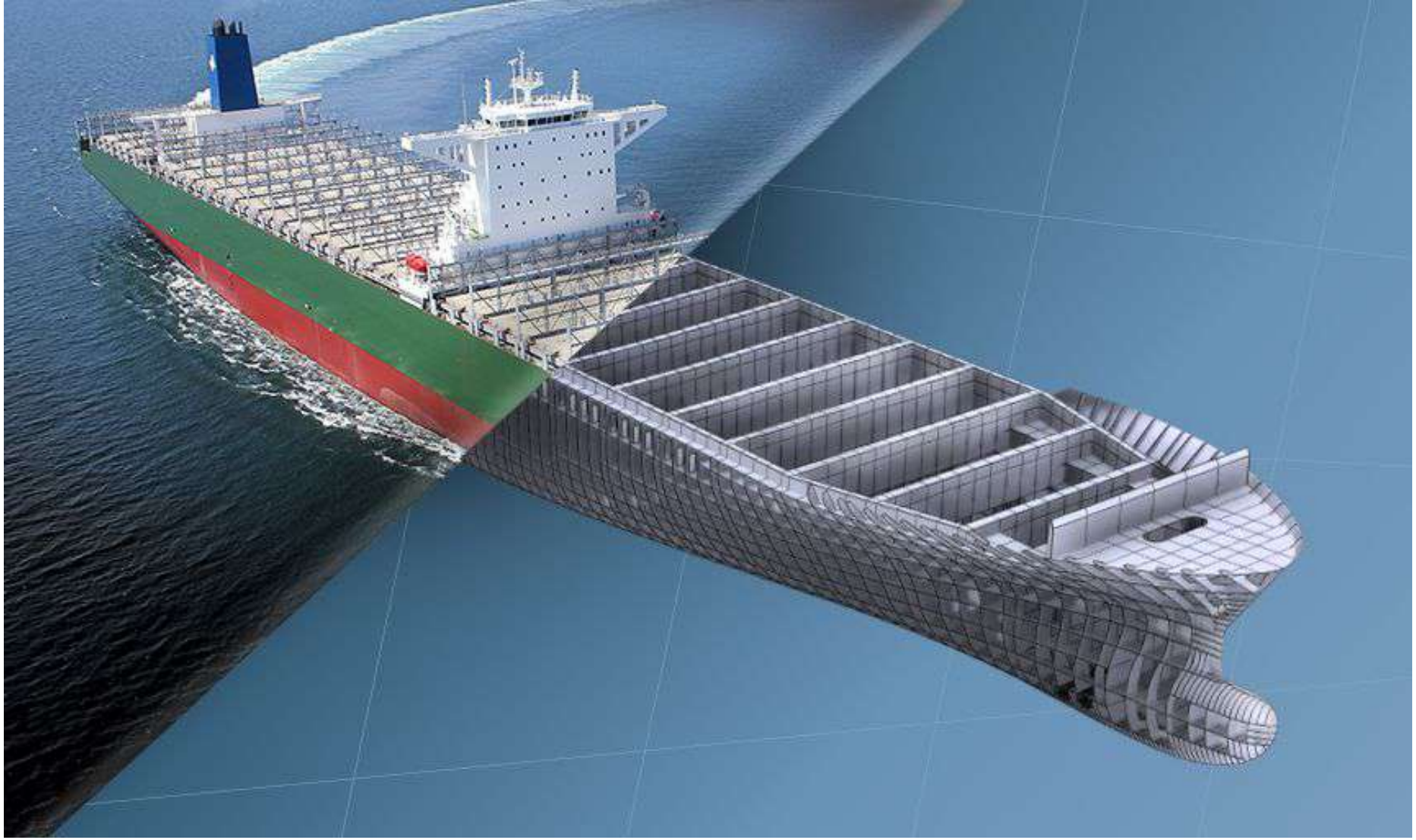

# Introduction to Naval Architecture

## II SEM –Module 4

# Syllabus

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# Ship Structure - Categorisation

- Main parts of ship's structure can be categorized based on the following different criteria

  - Type / Shape
  - Location
  - Participation in Load bearing
  - Special Structure / Fittings

# Ship Structure – Type /Shape

**Plating**

- Shell
  - Bottom Shell
  - Side Shell
- Deck
- Bulkhead
- Inner Bottom / Tanktop

**Strengthening**

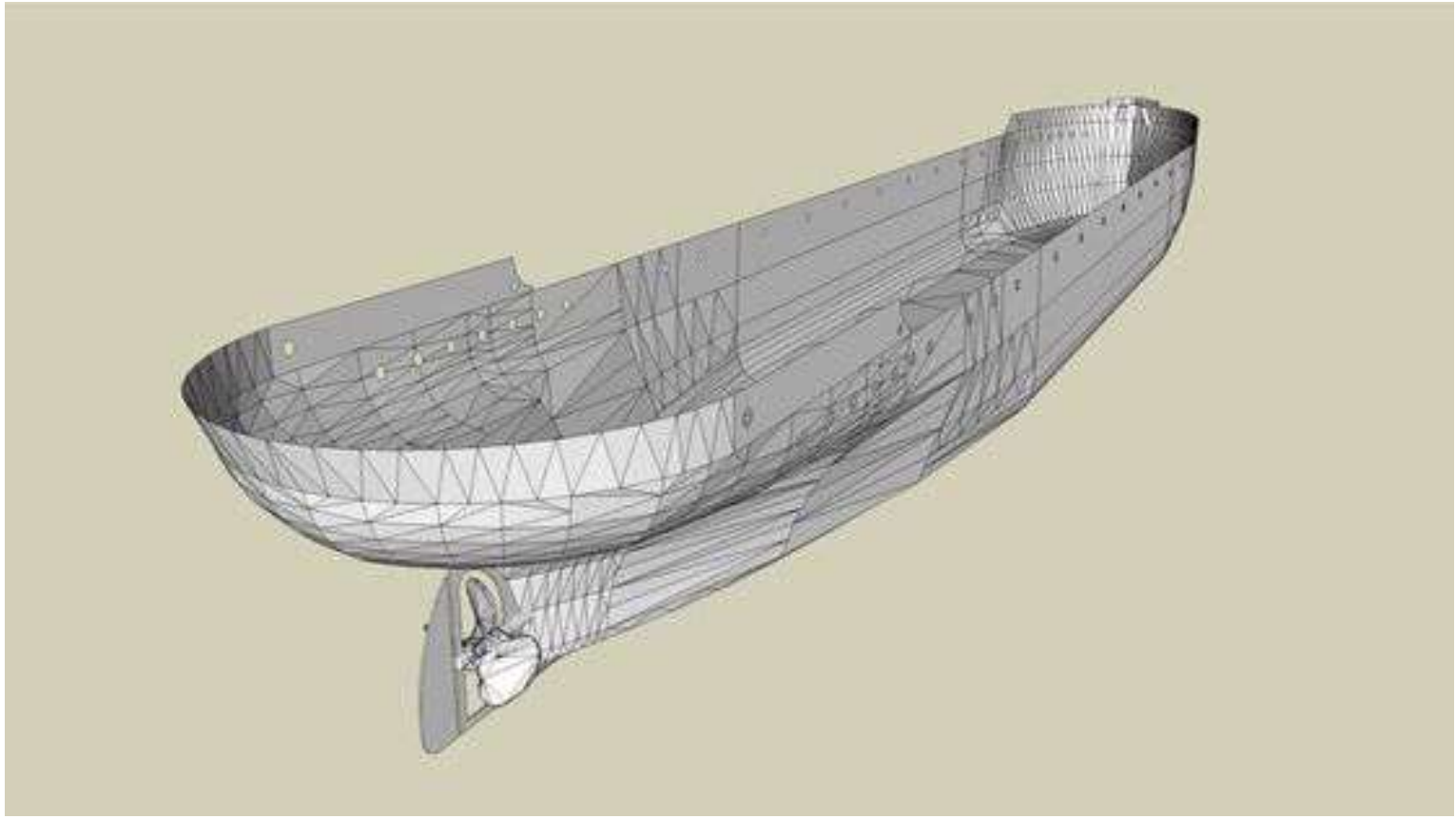
- Stiffeners
- Beams
- Girders
- Floors
- Brackets
- -Pillars/Stanchions

# Plating

- When manufactured
  - Flat
  - Rectangular
  - Standard sizes and thickness
- Cut and bent to required shape for welding on ship
- Forms the boundary surface for ship and its compartments

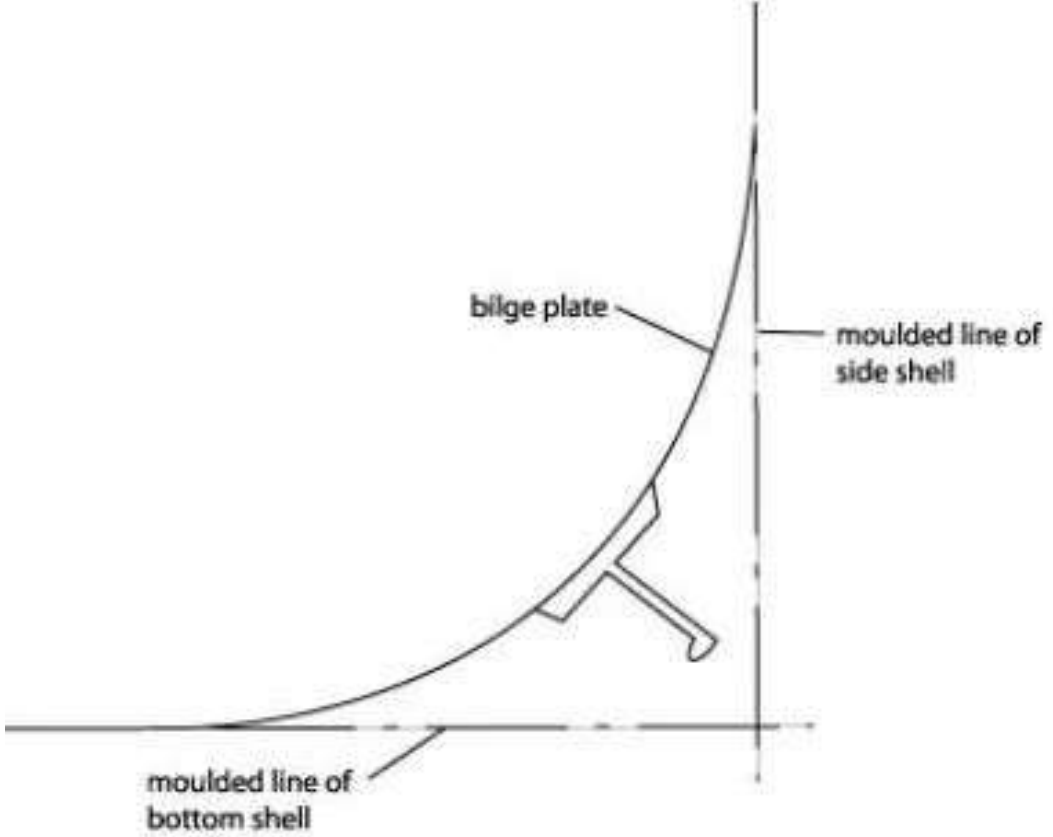
# Plating – Shell or Shell Plating

- The shell plating forms the watertight skin of the ship
- Contributes to the strength.
- Formed by welding plates together
- Plates of the shell plating are called “**STRAKES**”



# Plating – Shell or Shell Plating

# Bilge

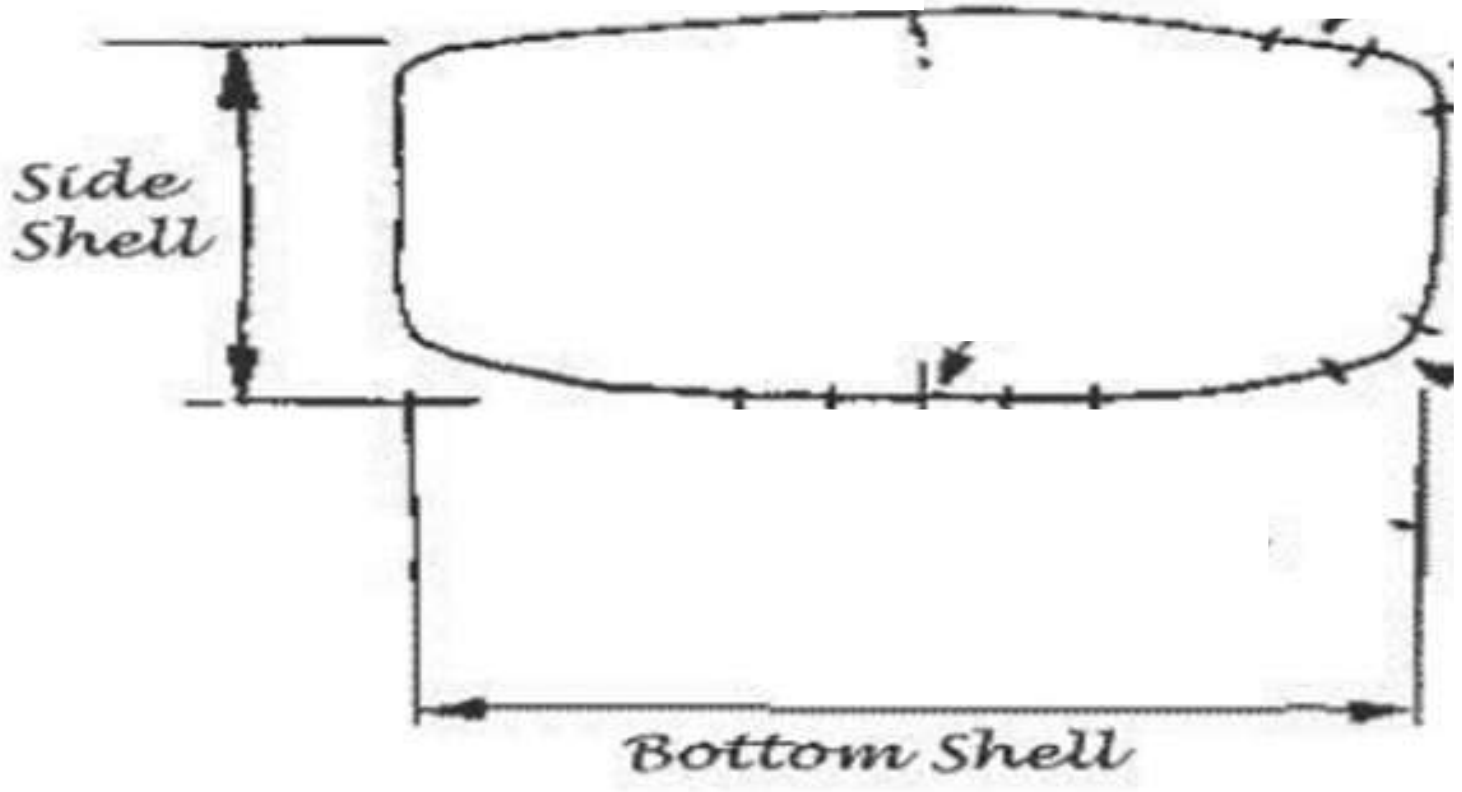



- Lowest space in the ship
- Part of the hull that would rest on the ground
- Region of the bottom shell  from the keel to the turn of the bilge.
- Bilge Water- Leakage/ overflow from machinery, cleaning water, rainwater, etc, collected in the bilge space
- Turn of the bilge" is the region where the bottom shell  transitions to the side shell.

# Plating – Shell or Shell Plating:Regions

- Bottom Shell – Extends from centre of the ship to the turn of the bilge

- Side Shell – Extends from the turn of bilge to edge of main deck



# Plating – Shell : Keel Strake

- At the centre line of the bottom shell is the keel,
- Forms the backbone of the ship.
- Contributes substantially to the longitudinal strength and effectively distributes local loading caused when docking the ship.

- Other strakes are welded to either side of the keel strakes and numbered A,B,C, D …etc

# Single and Double Hull (Skin)

- **Marine Disasters**
- Mar 1967 – ***Torrey Canyon*** , Kuwait to Wales, Grounded at Wales coast
- 1973 : MARPOL Convention
- Mar 1978 – ***Amoco Cadiz***, Persian Gulf to Rotterdam(Netherlands) , Grounded at French coast
- 1978:MARPOL Convention
- Mar 1989 – ***Exxon Valdez***, Alaska to California, Grounded at Alaska
- 11 Dec 1999 – ***Erika***, Dunkirk (France) to Livorno (Italy), Structural failure on French Coast

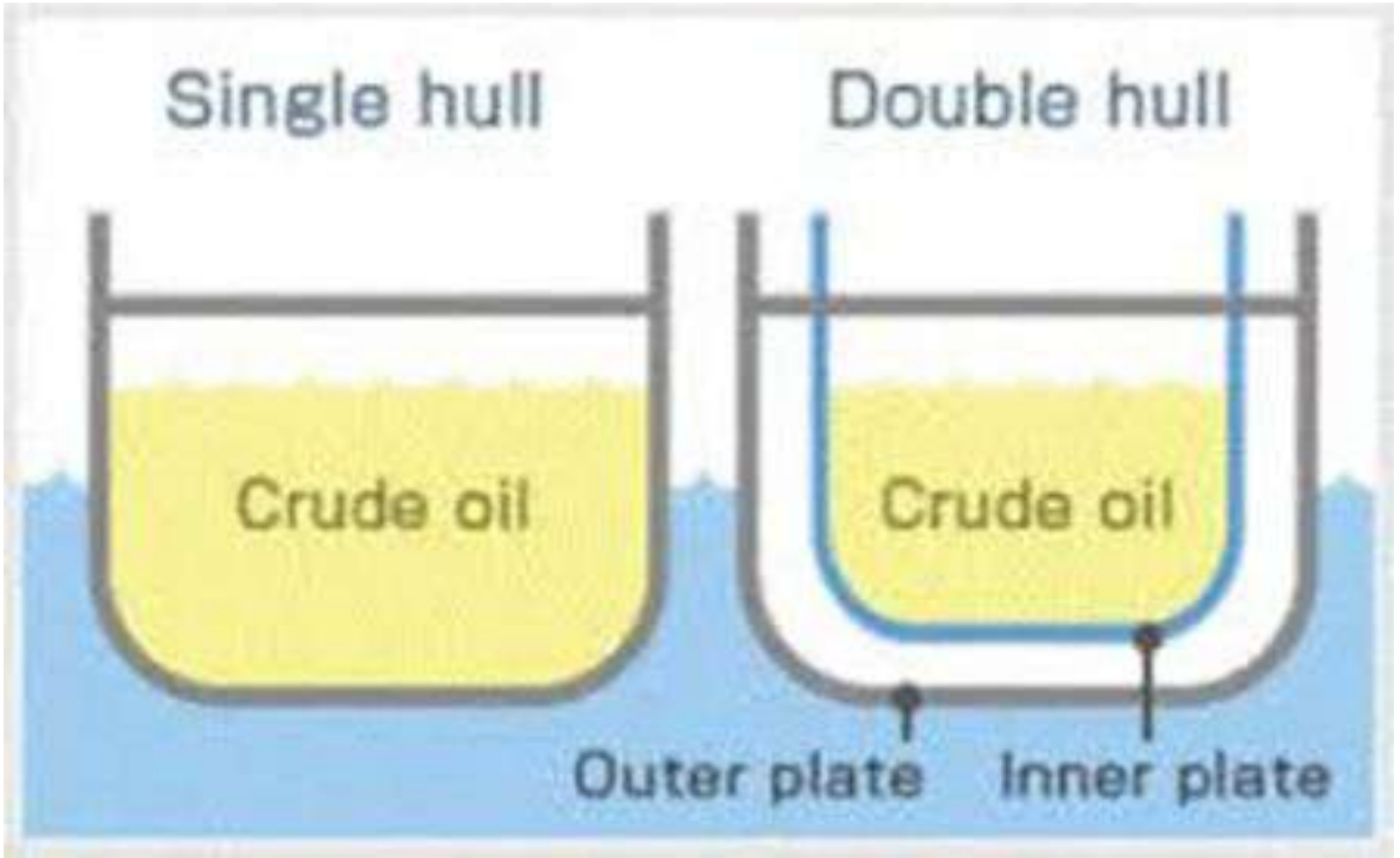
# Torrey Canyon

# AMOCO CADIZ

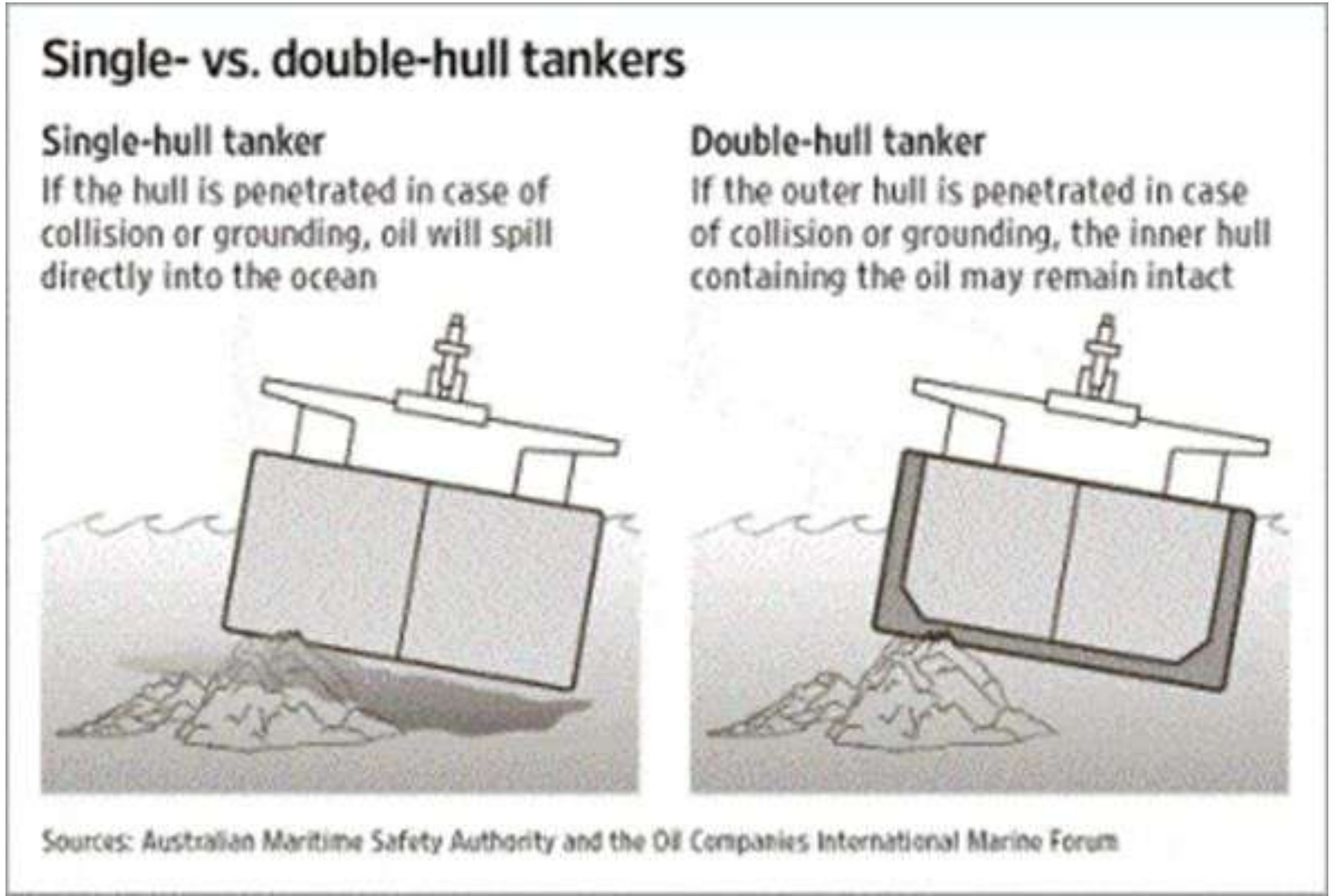
# Exxon Valdez

# ERIKA

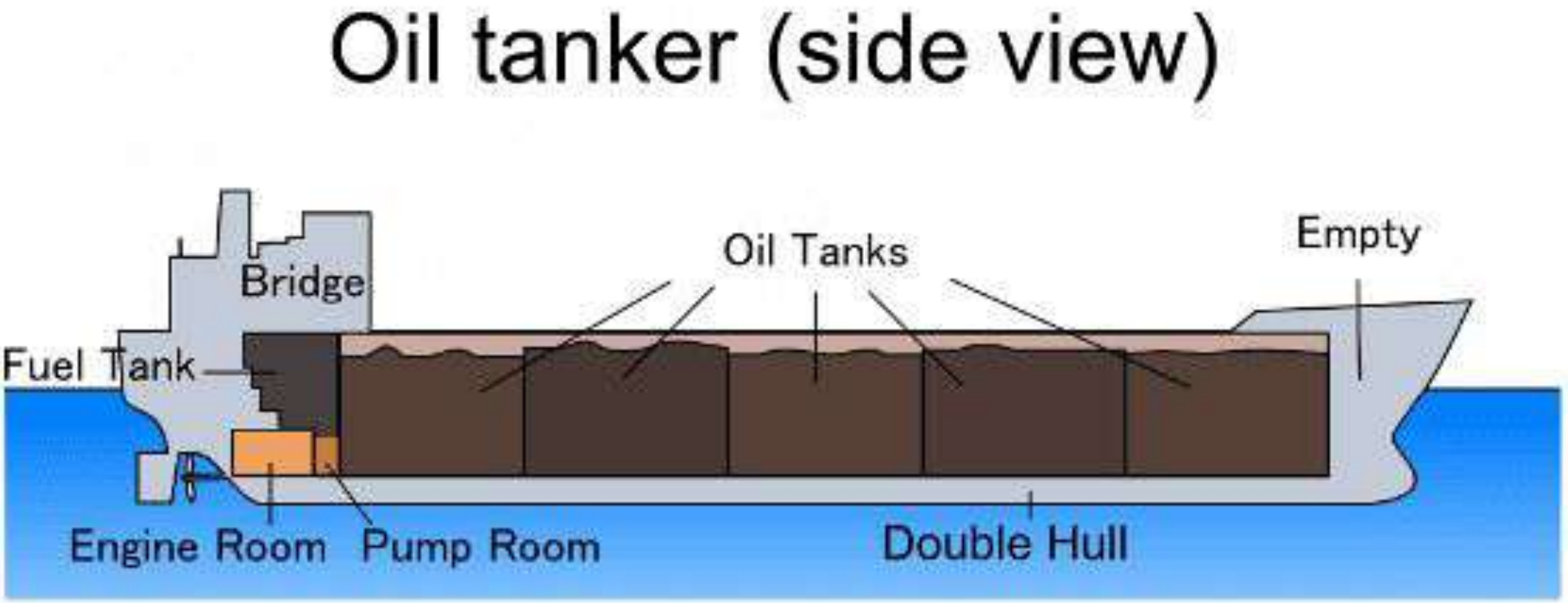
# Single Hull(Skin) vs Double Hull(Skin)



# Single Hull vs Double Hull



# Single Hull(Skin) vs Double Hull(Skin)



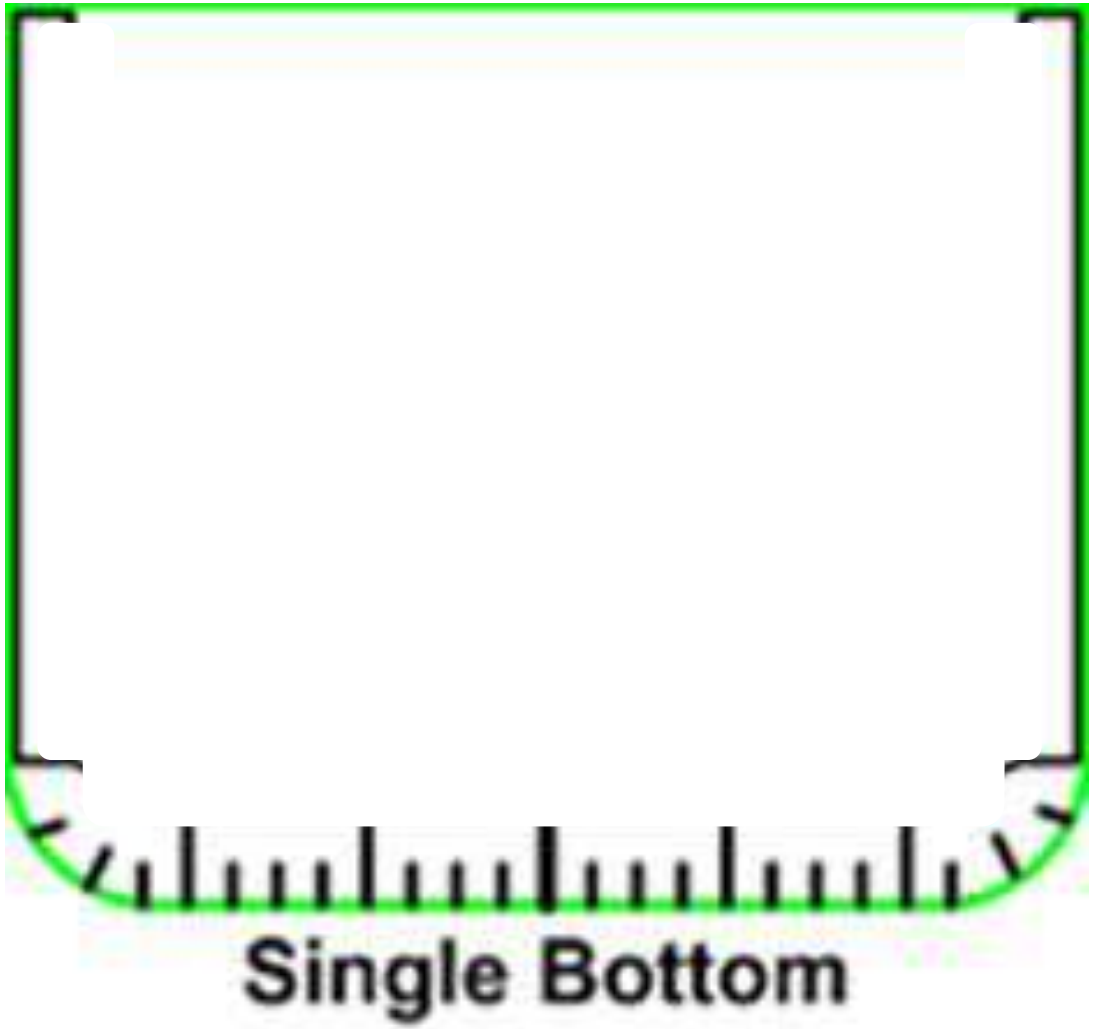
# Double Hull(Skin)

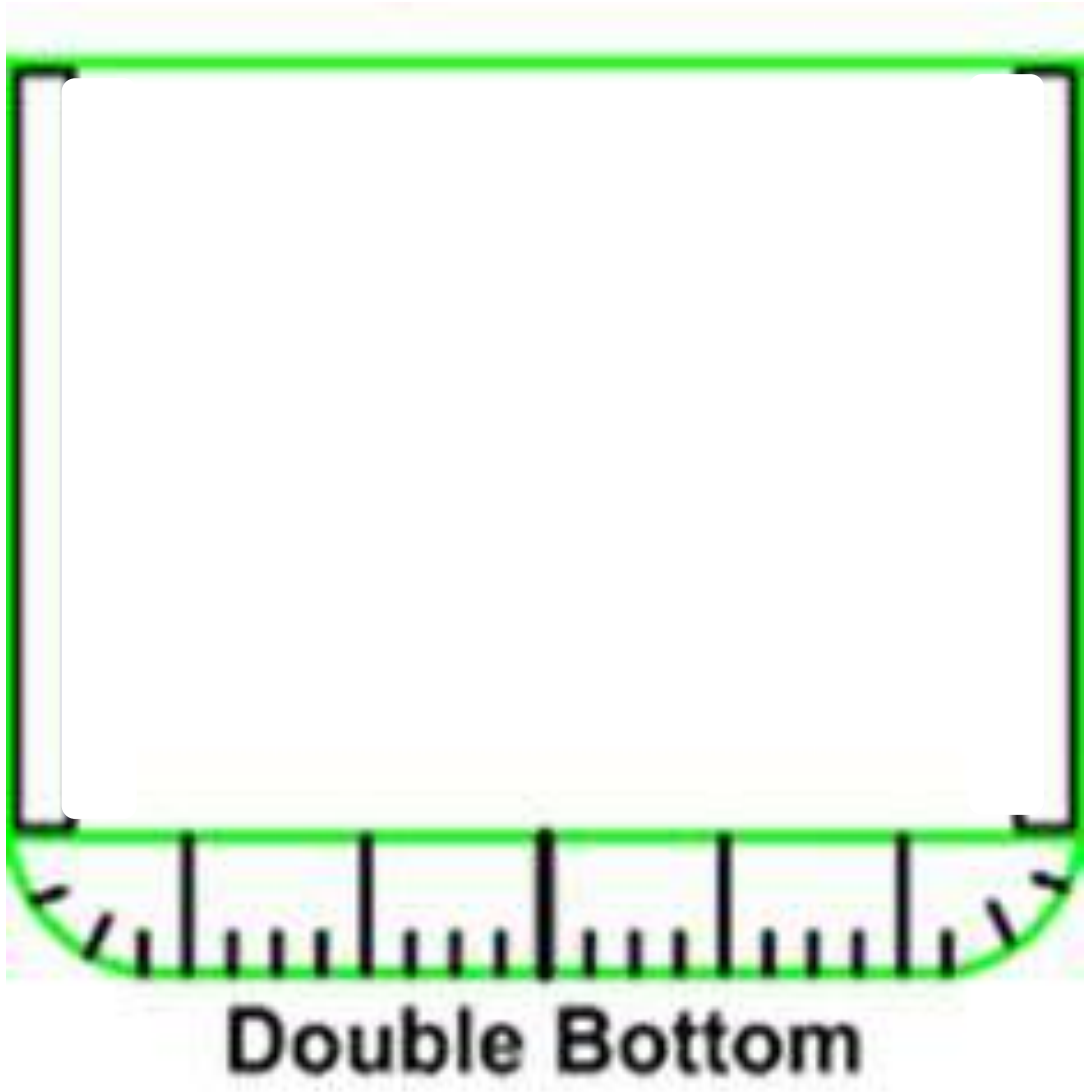
# Double Hull(Skin)

# Double Hull(Skin)

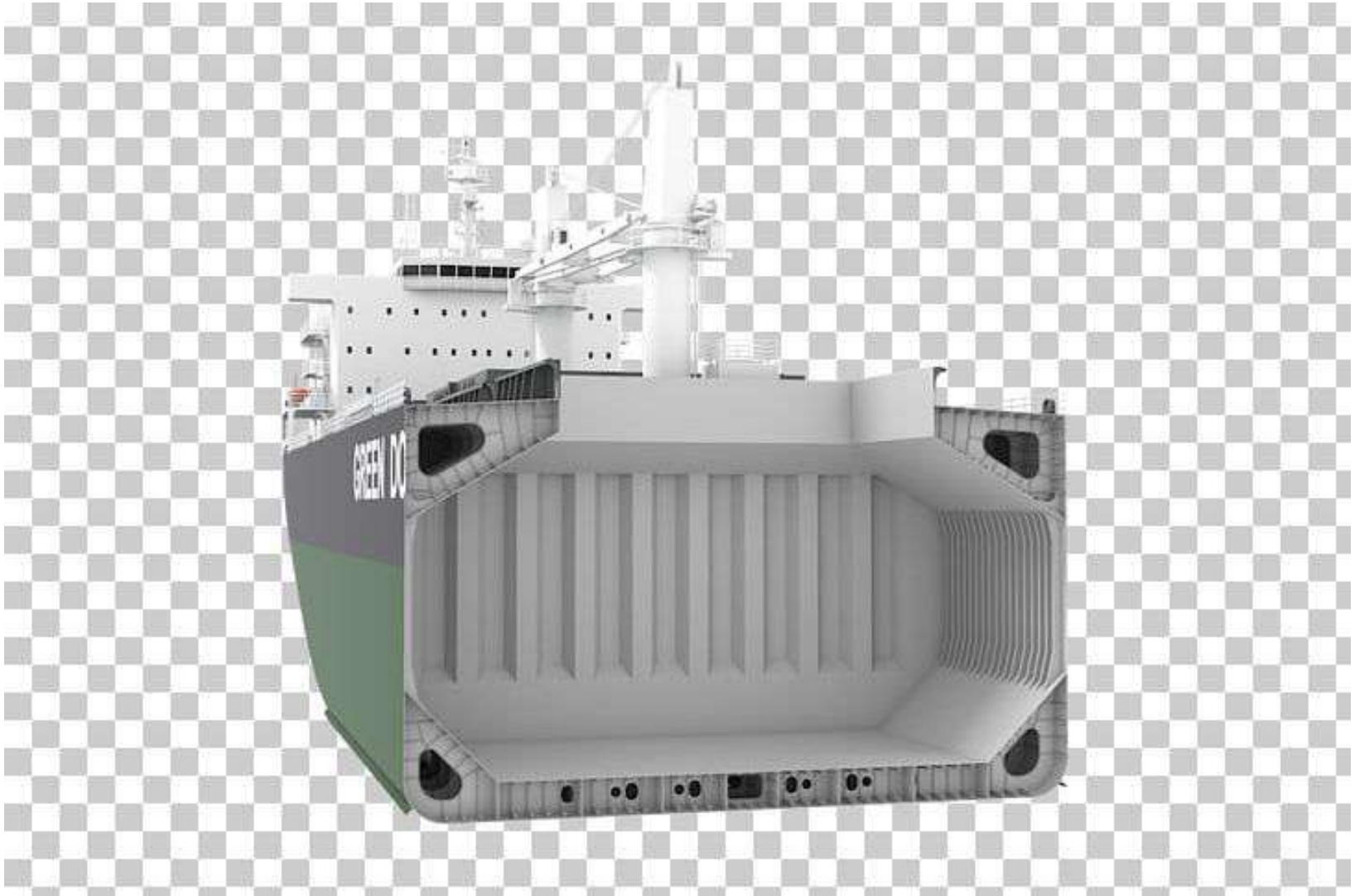
# Double Hull(Skin)

# Double Bottom vs Single Bottom

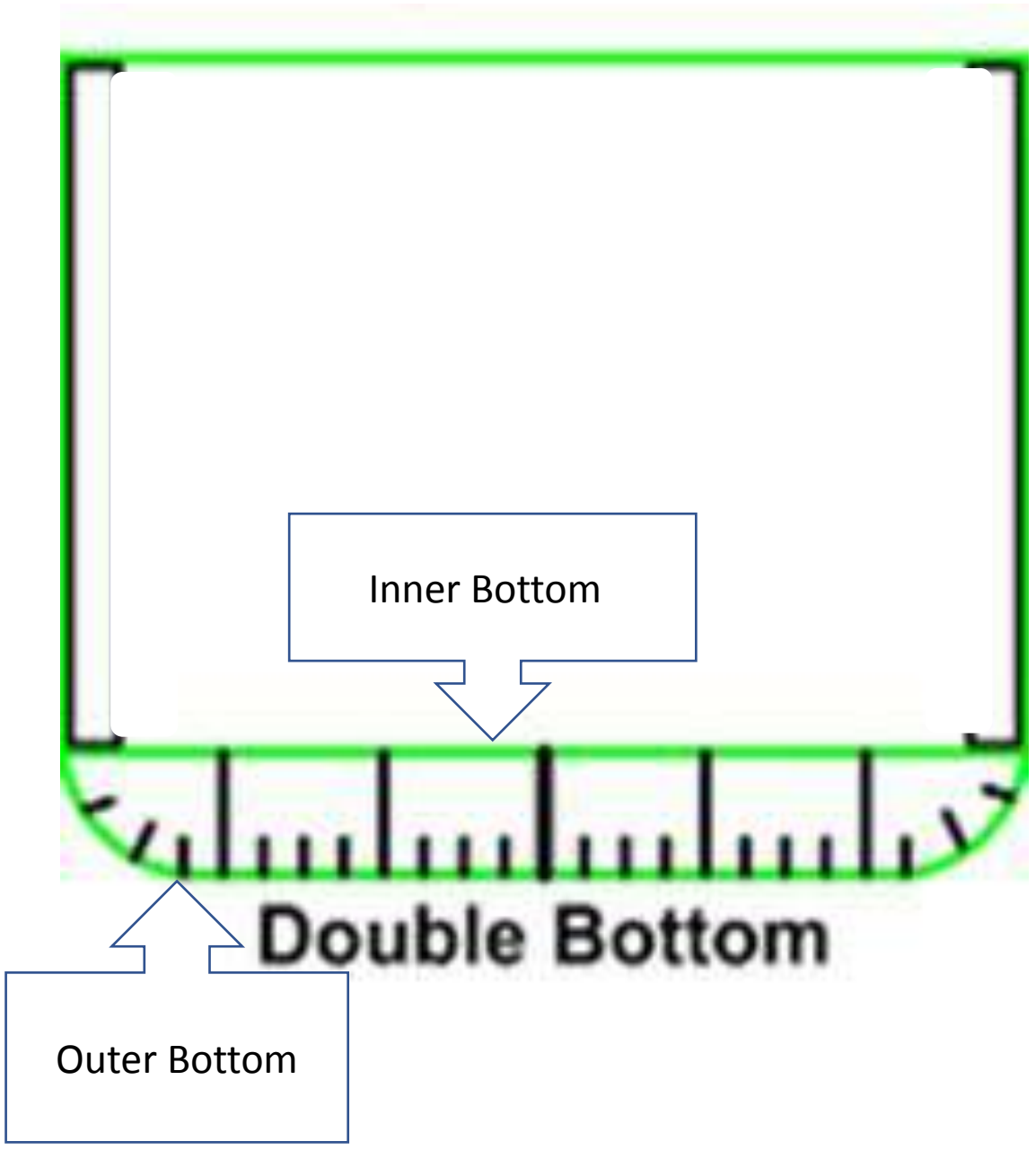


# Double Bottom (of Bulk Carrier)



# Double Bottom



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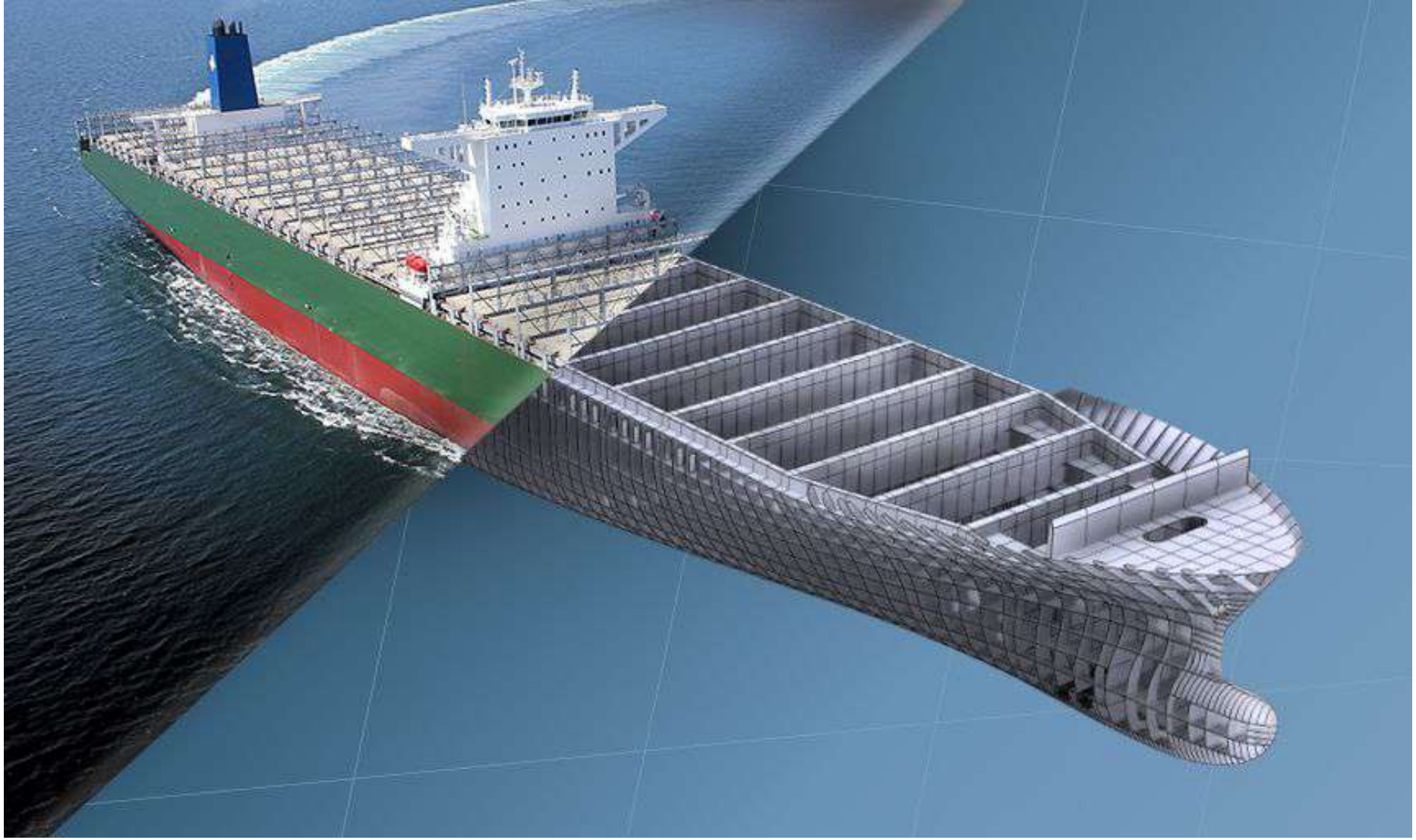


# Introduction to Naval Architecture

## II SEM –Module 4

# Ship Structure – Type /Shape

**Plating**

- Shell
  - Bottom Shell
  - Side Shell
- Deck
  - Inner Bottom / Tanktop
- Bulkhead

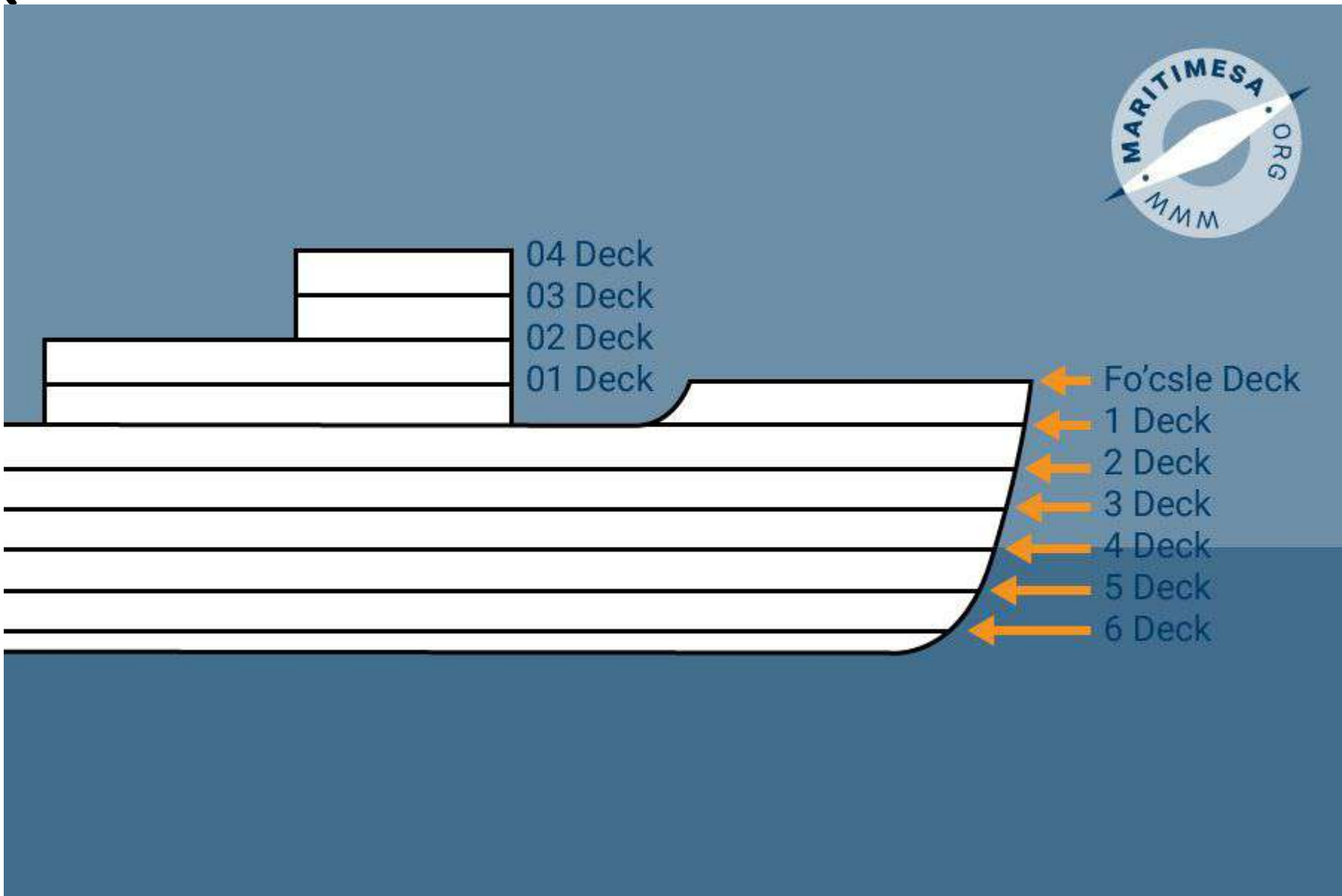
**Strengthening**

- Stiffeners
- Beams
- Girders
- Floors
- Brackets
- -Pillars/Stanchions

# Plating – Deck


# Plating – Deck

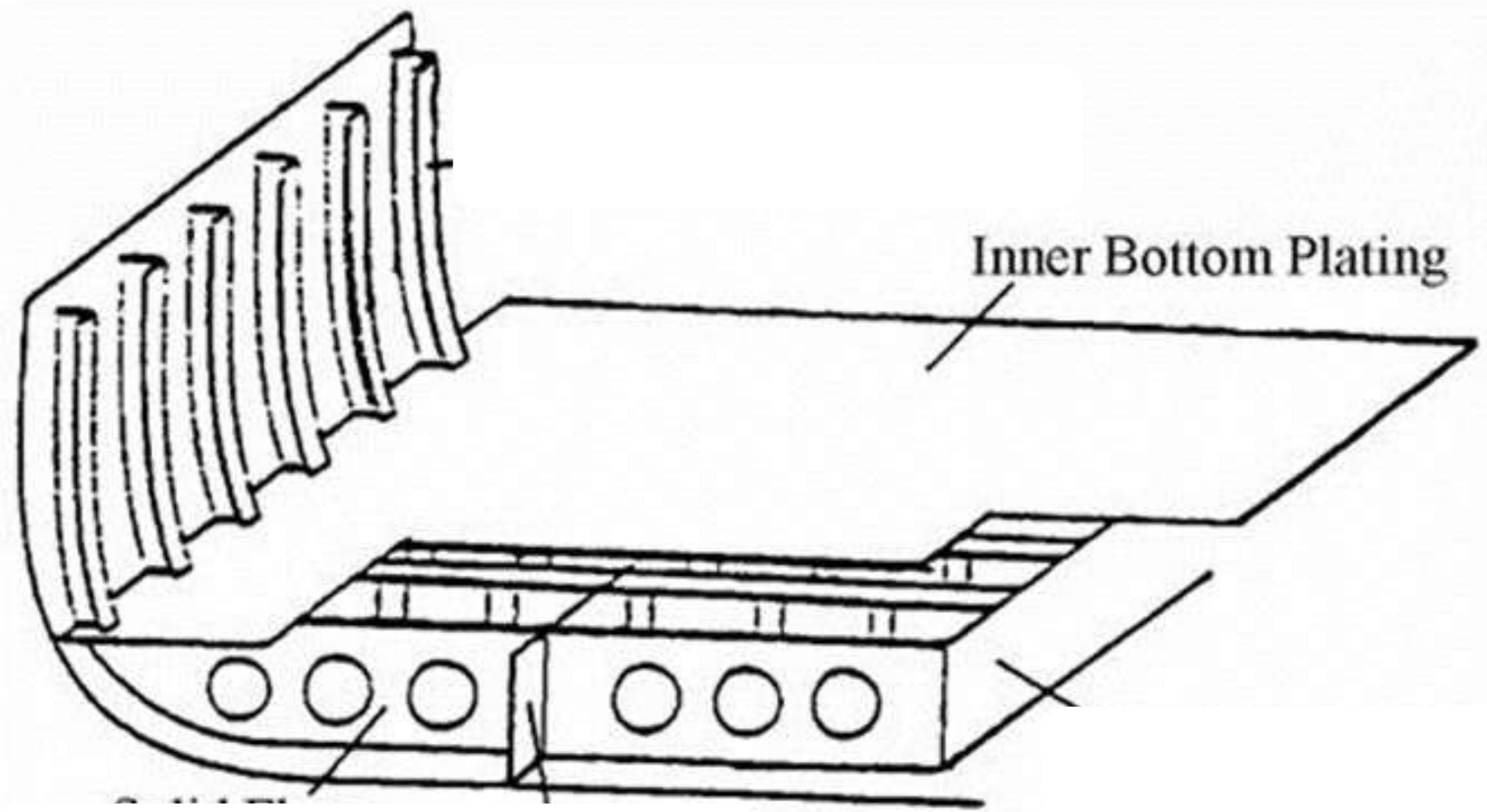
# Plating – Deck



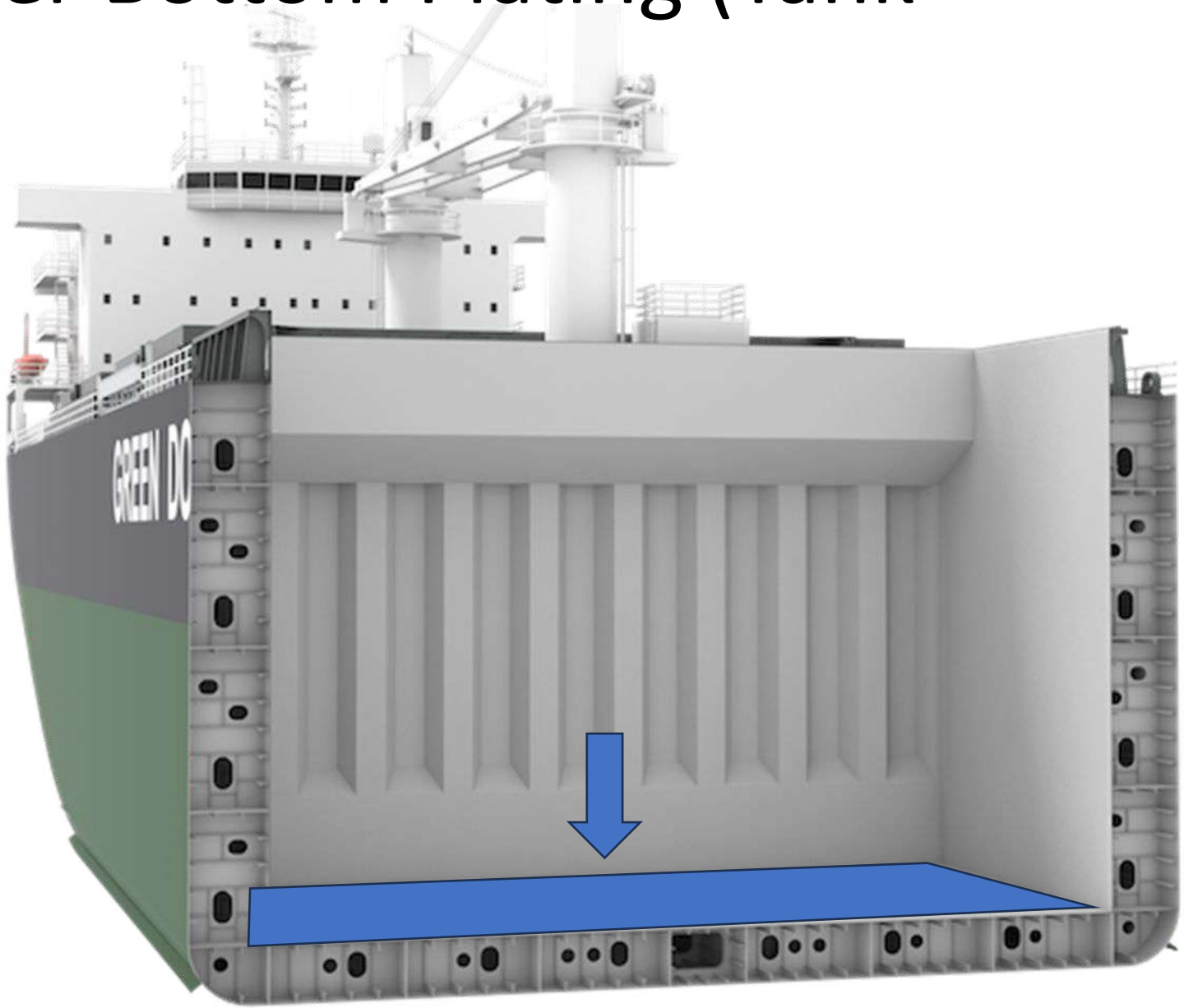
# Plating – Deck :Inner Bottom Plating (Tank Top)

- Inner Plating of double bottom hull
- Extending the whole breadth of the ship and almost the entire length of the ship.
- Creation of a double bottom hull, by constructing an inner bottom plating is a mandatory requirement of MARPOL regulation for certain types of vessels.
- The space created can be used as tanks for storing ballast water, fresh water etc.
- Since this space is generally used as a tank, the inner bottom plating is also referred to as Tank top.

# Plating – Deck :Inner Bottom Plating (Tank Top)



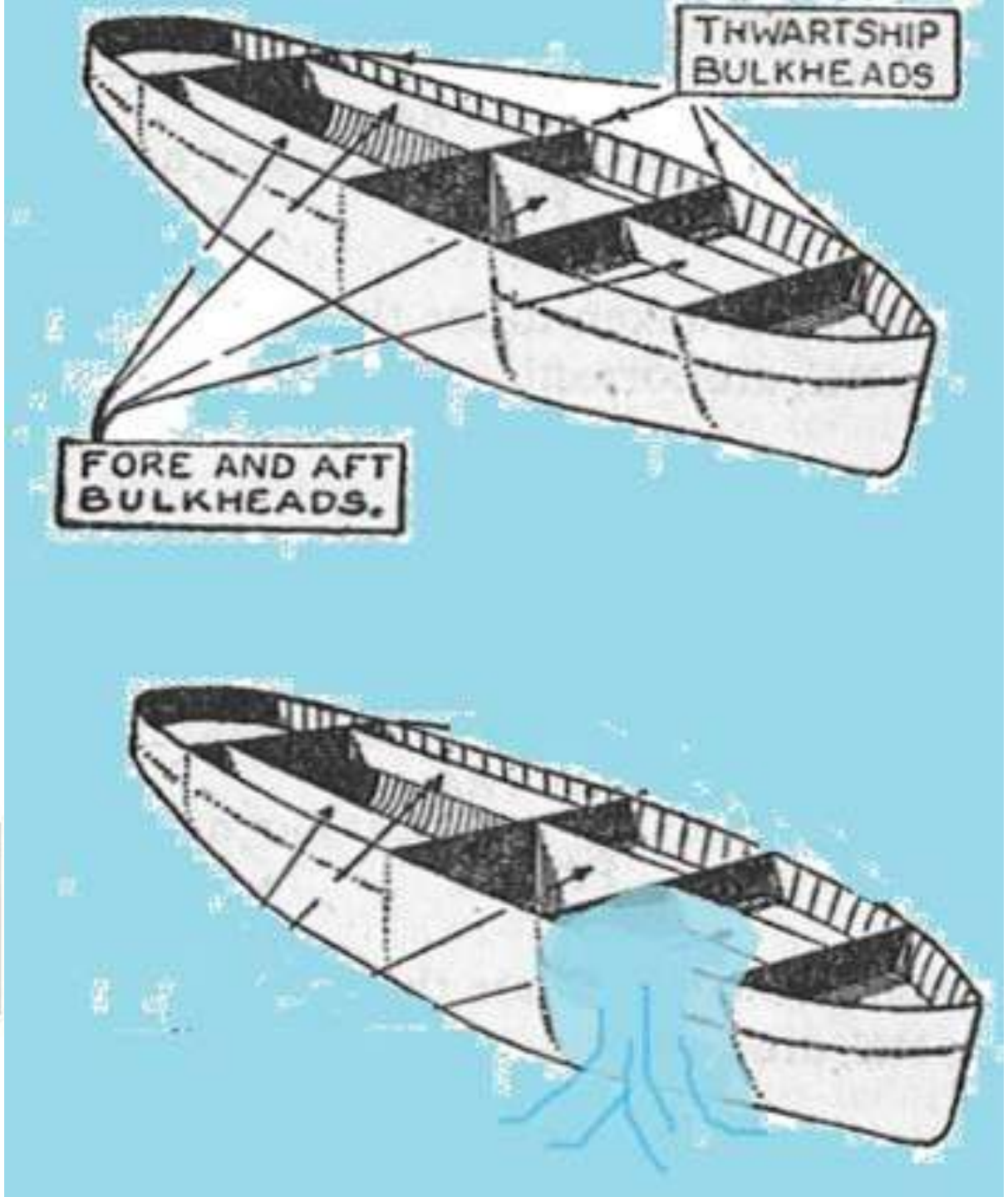
# Plating – Deck :Inner Bottom Plating (Tank Top)



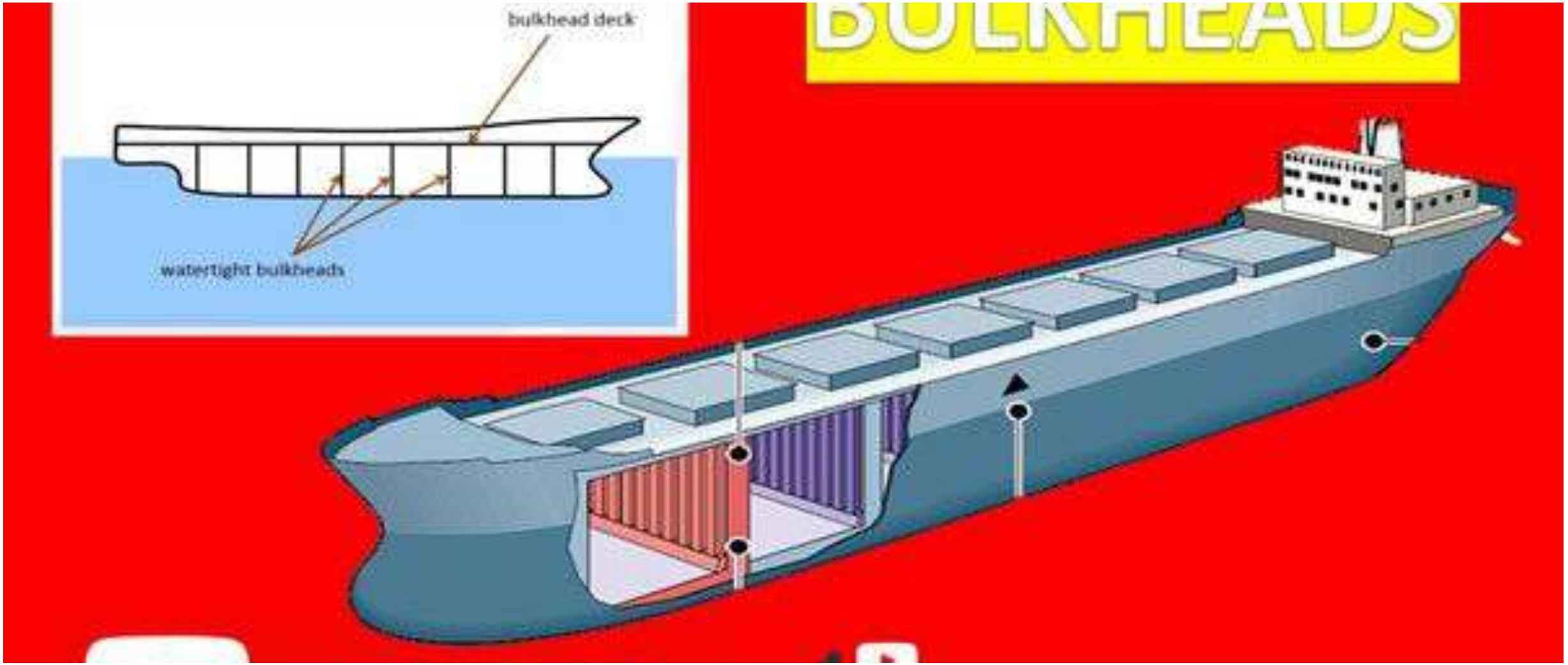
# Plating - Bulkhead

- The plating that is in vertical orientation
- Could be in the longitudinal or transverse orientation
- Forms the walls of a space or compartment
- May be watertight or non-watertight
- Main Watertight bulkheads continue from keel to main deck
- Serves as a fire, temperature or waterproof boundary
- Provides structural strength
- Minor bulkheads help is segregating compartment space

# Plating - Bulkhead

# Bulkhead



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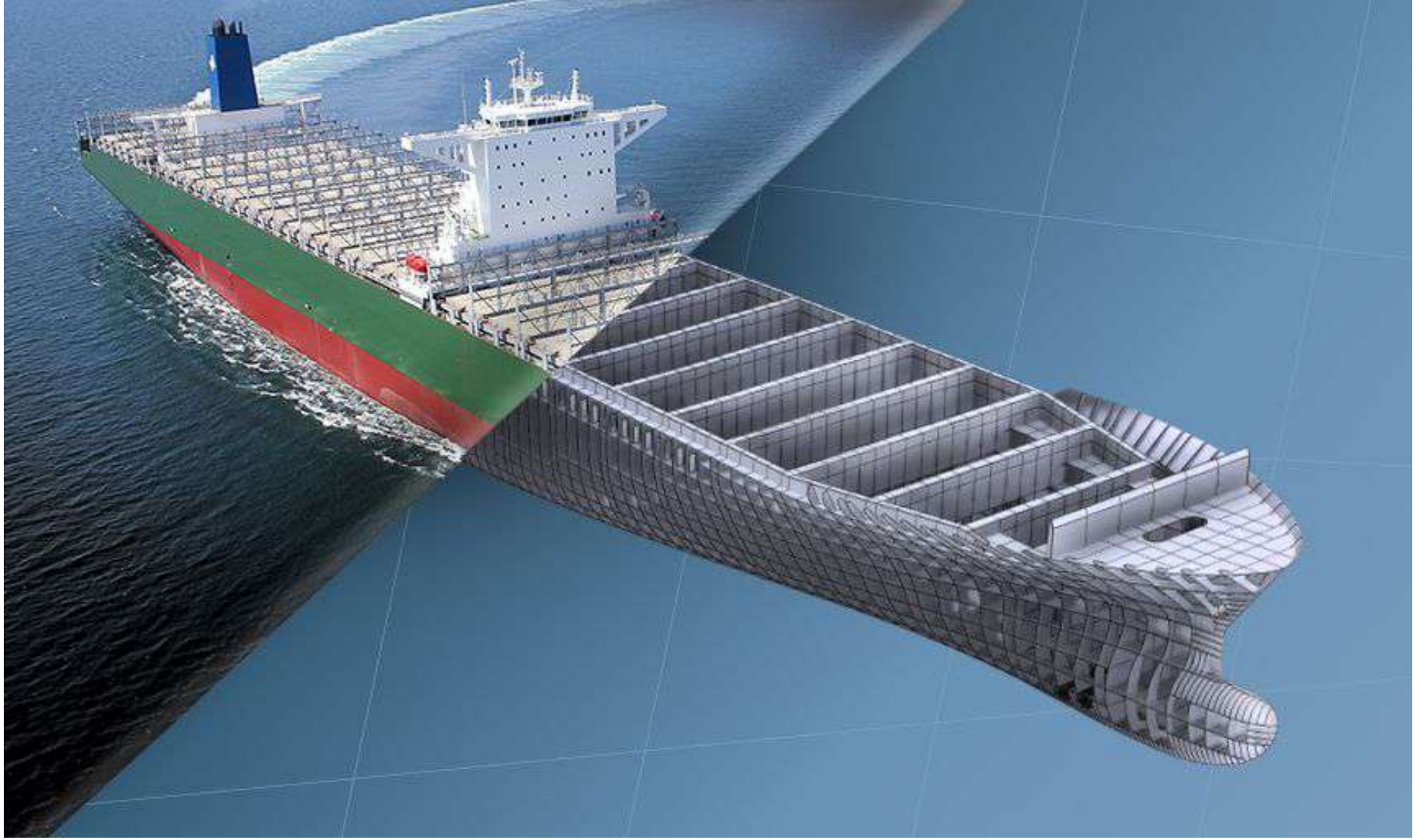

# Introduction to Naval Architecture

## II SEM –Module 4

# Ship Structure – Type /Shape

**Plating**

- Shell
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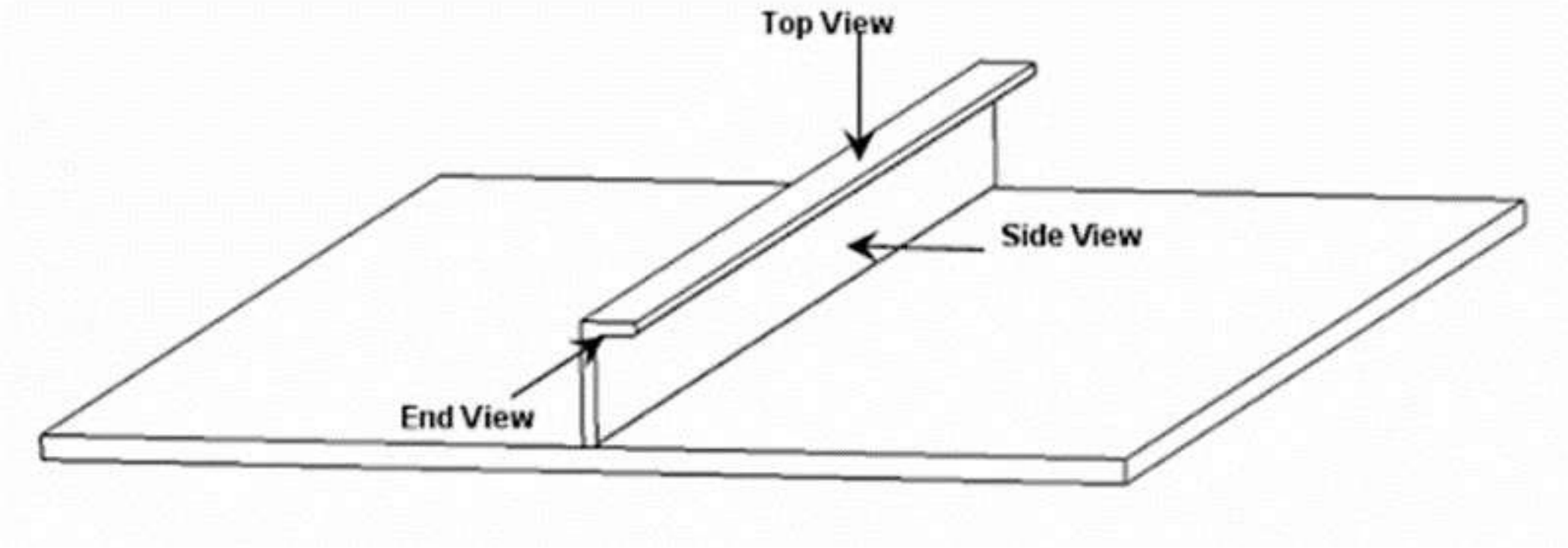
- Inner Bottom / Tanktop

**Strengthening**

- Stiffeners
- Beams
- Girders
- Floors
- Brackets
- -Pillars/Stanchions

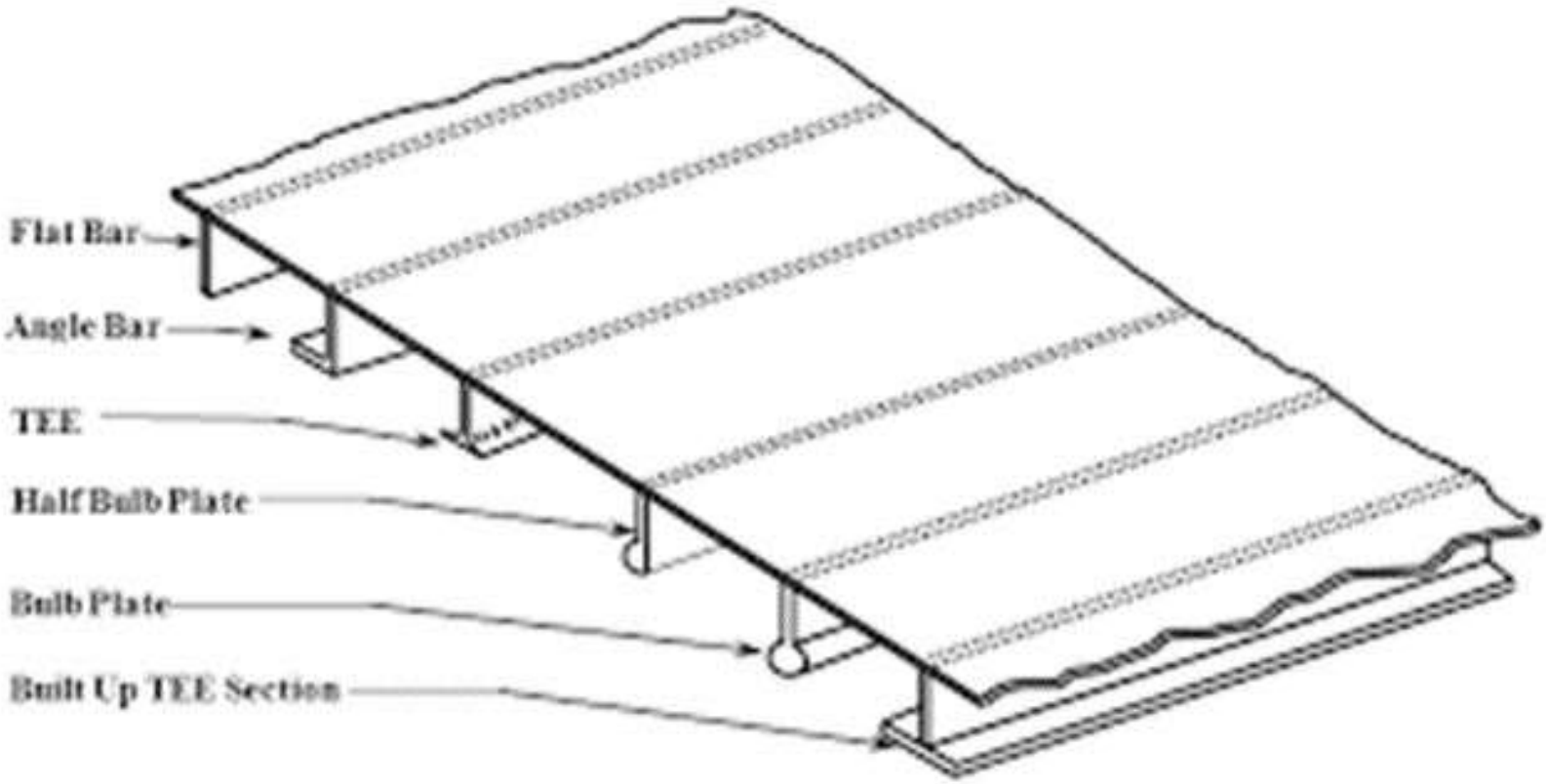
# Strengthening Structure : Stiffeners

- These provide support to a plating.
- They are welded perpendicular to the plating, thus providing strength



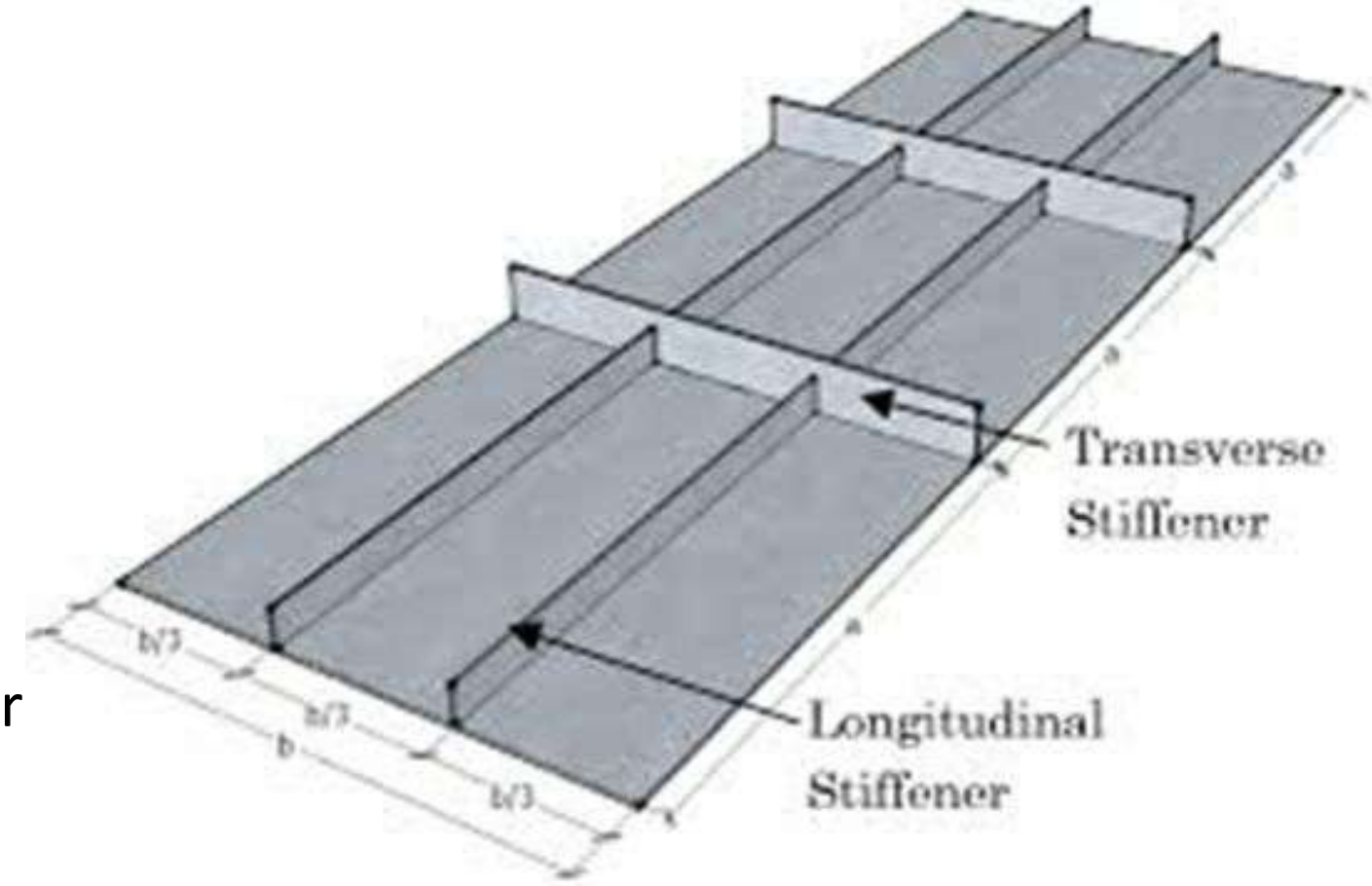
# Strengthening Structure : Stiffeners

- They are available in different cross sections. Common ones are
- - Flat Bar
- - Angle Bar
- - Tee Bar
- - Half Bulb
- - Bulb



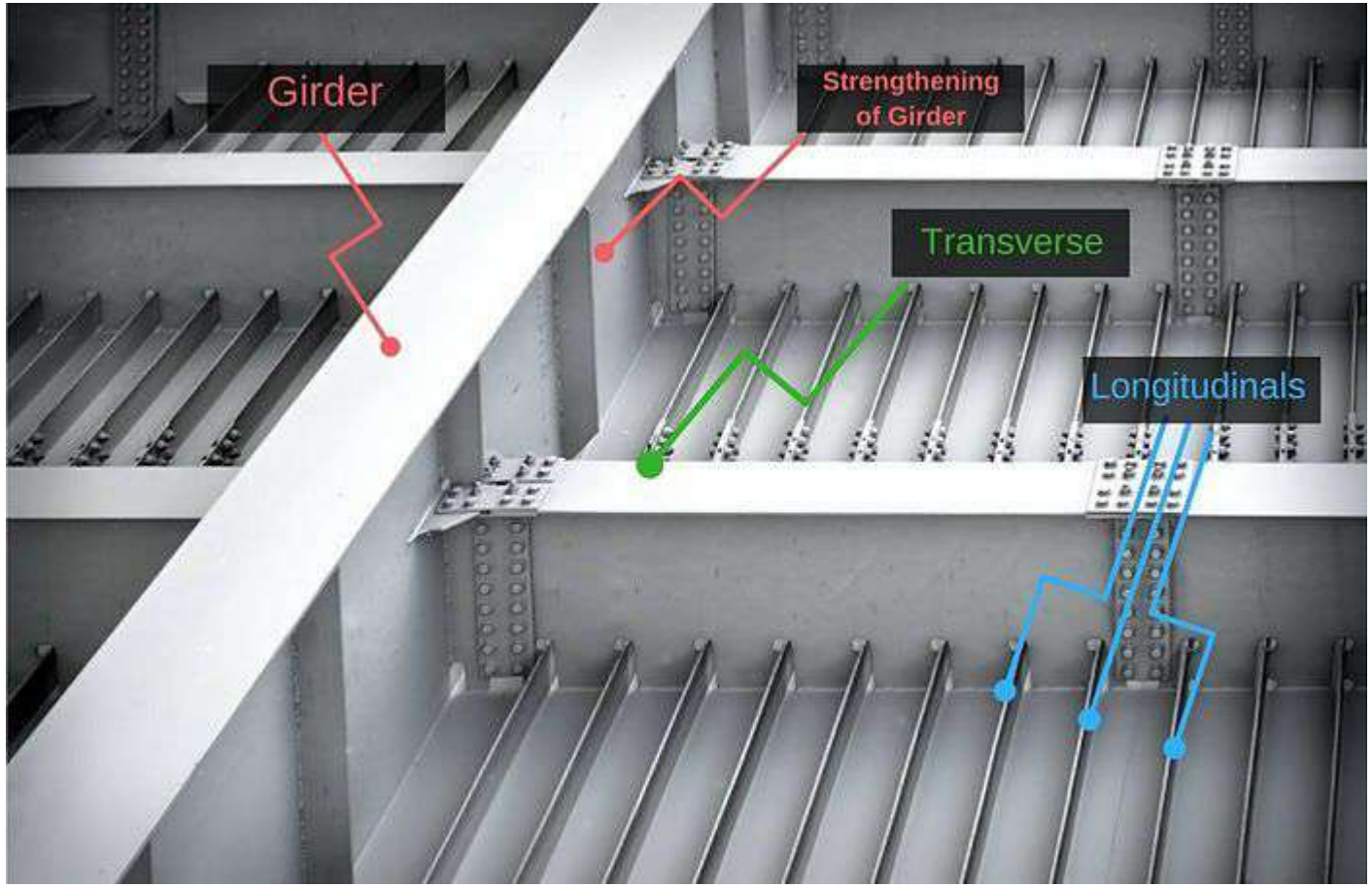
# Strengthening Structure : Stiffener Types

- Based on orientation
- Stiffeners oriented in the fore and aft direction of the ship are called **longitudinal stiffeners** (or longitudinals)
- Stiffeners oriented in athwartship direction are called **transverse stiffeners** (or transverses or frames)



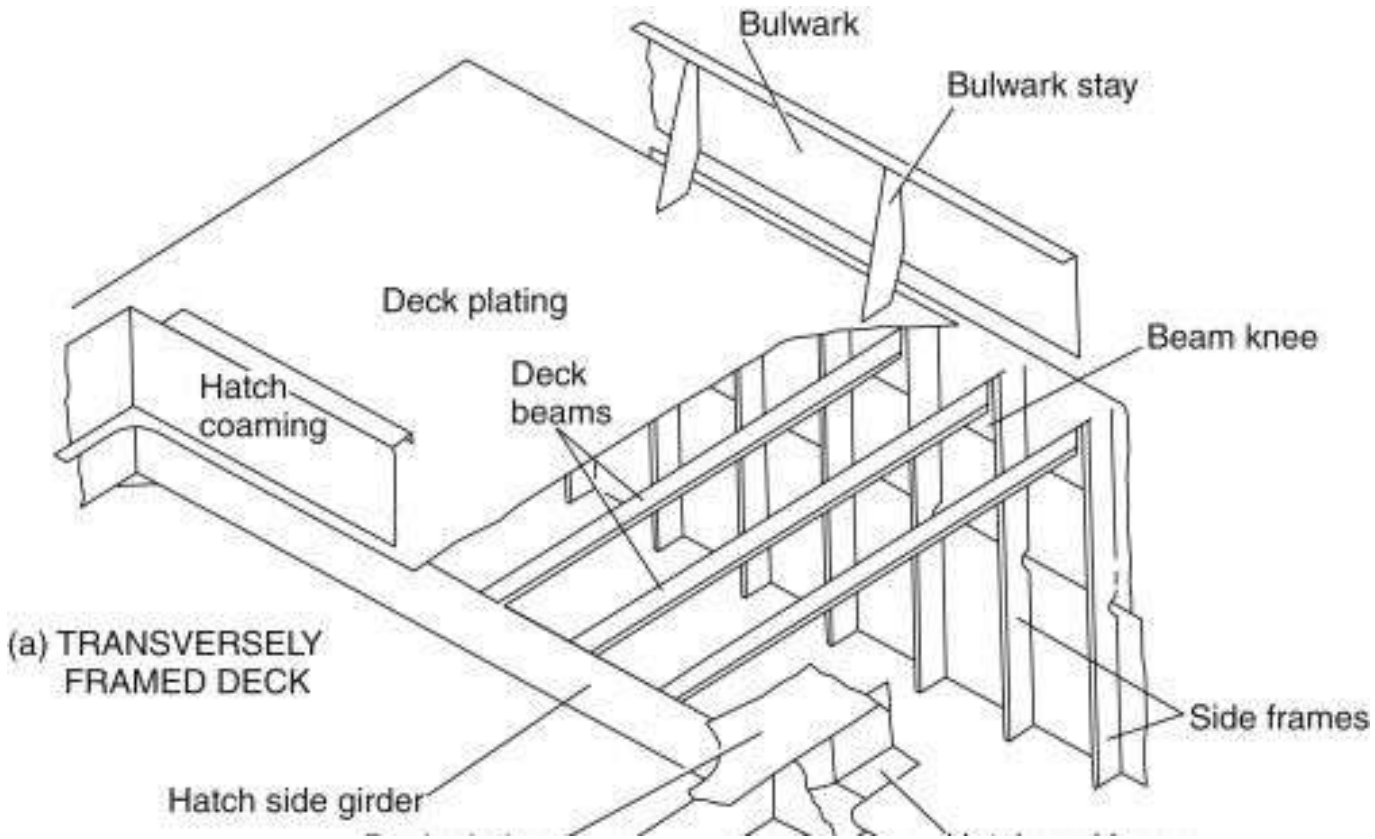
# Strengthening Structure : Stiffener Types

- Based on size (dimensions)
- **Girder**- Longitudinal stiffening member with larger dimensions
  - Centre Girder- welded on centre of keel
  - Side Girder – welded on bottom plating
  - Deck Girder – welded on underside of a deck.



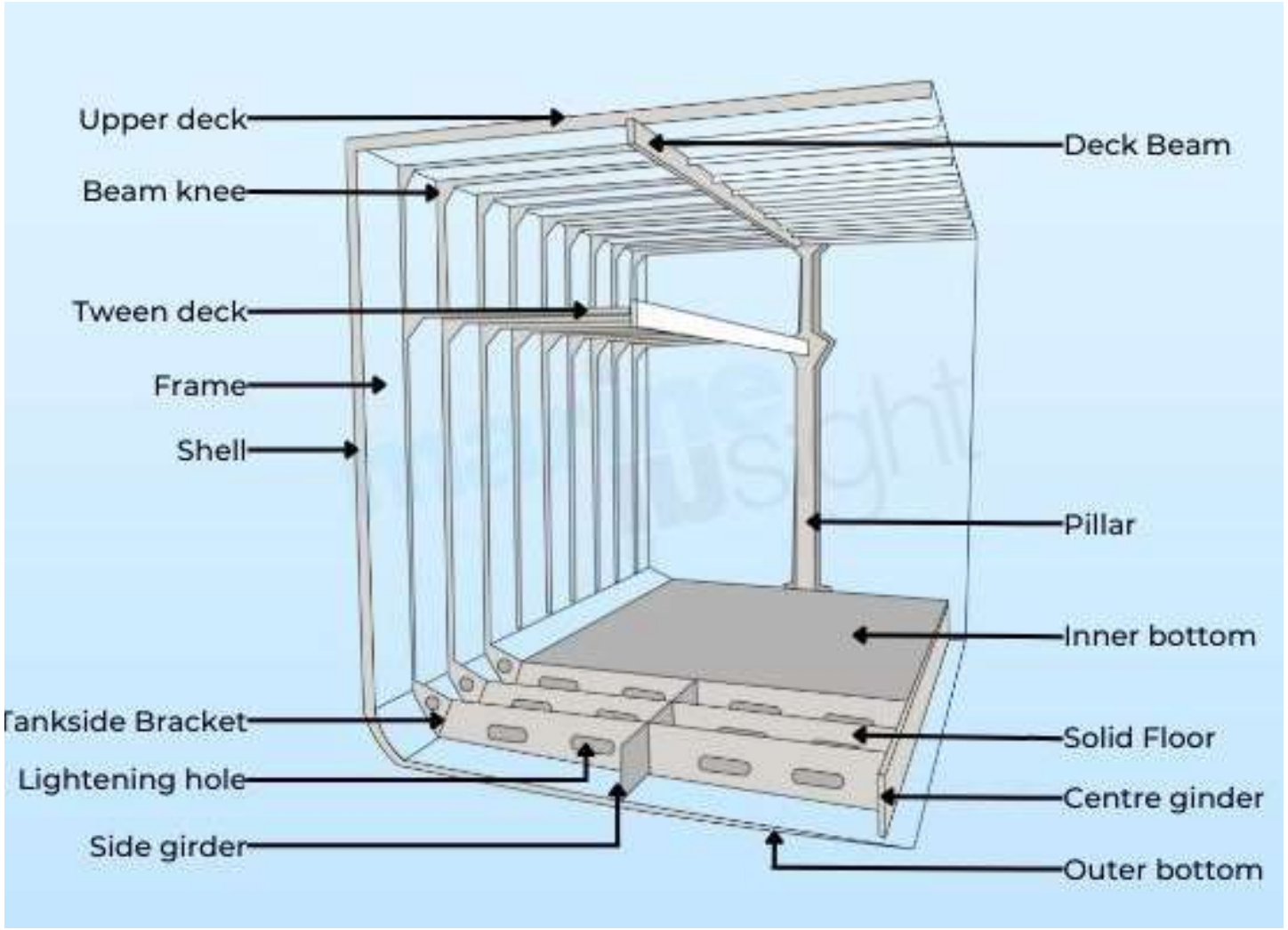
# Strengthening Structure : Stiffener Types

- Based on size (dimensions)
- **Beam-** It is a transverse stiffener with comparatively bigger dimensions,
- Supporting structure for decks. They may also be called deck beams.



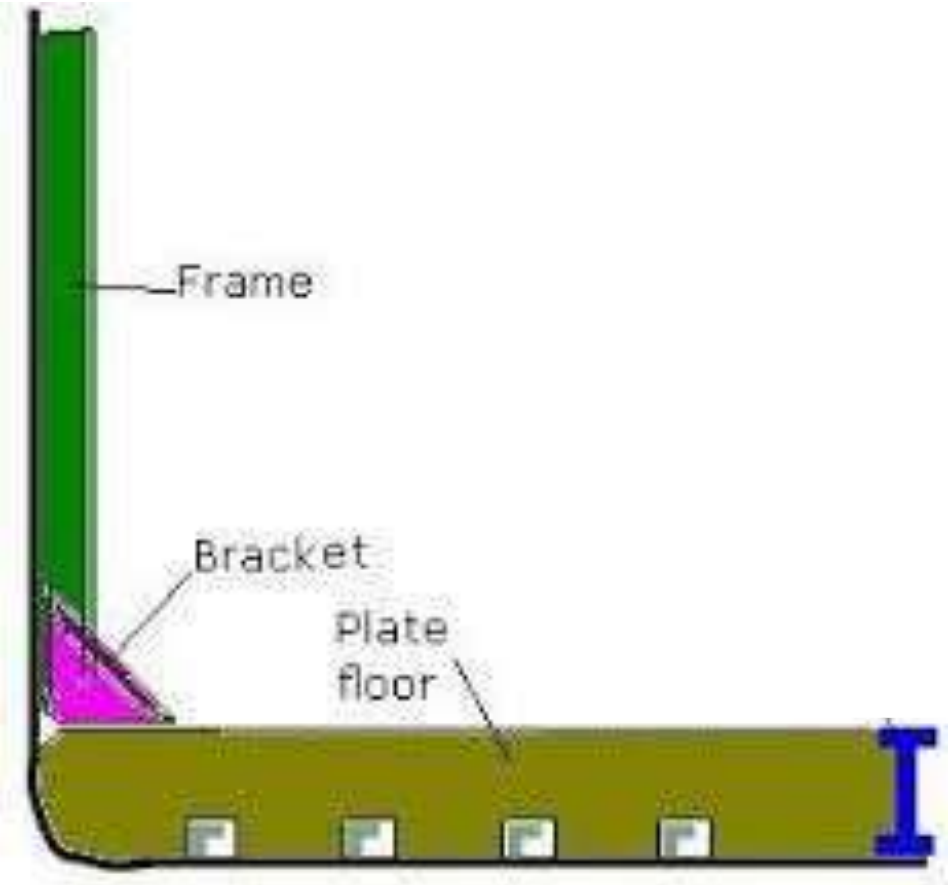
# Strengthening Structure : Stiffener Type

- Based on size (dimensions)
- **Floor**
- A transverse stiffening member …a vertical platelike structure between the outer and inner bottom plating
- From the centre girder to the turn of bilge.
- Provide support and strength to outer and inner bottom plating.



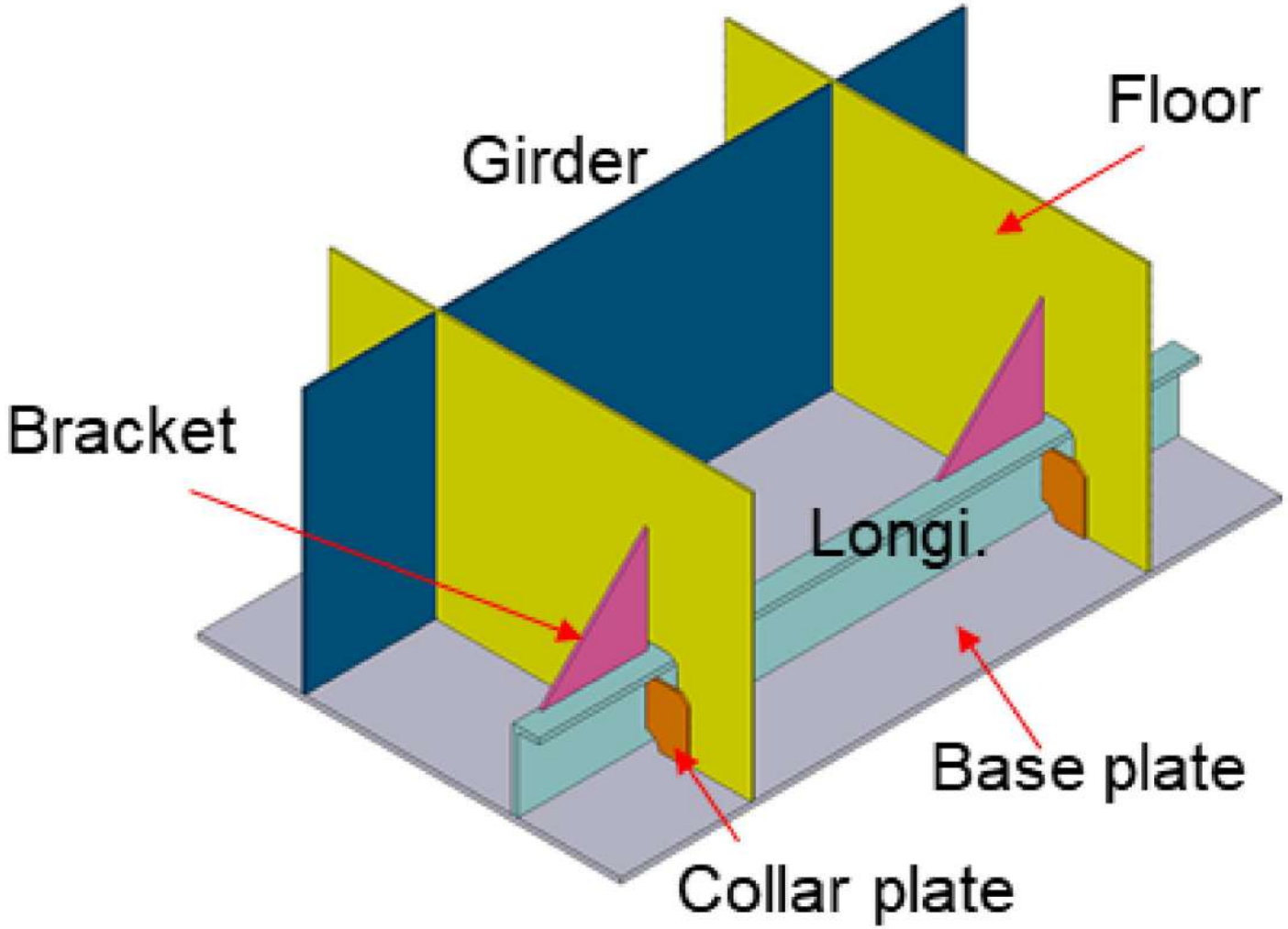
# Strengthening Structure : Misc Structures

- Bracket
- Typically a triangular plate structure
- prevent sideways deformation or lateral-torsional buckling in the supporting components of structures.
- Generally provided at the connection between two supporting structural members.
- A Bracket that connects a deck transverse to a side frame is also called a Knee



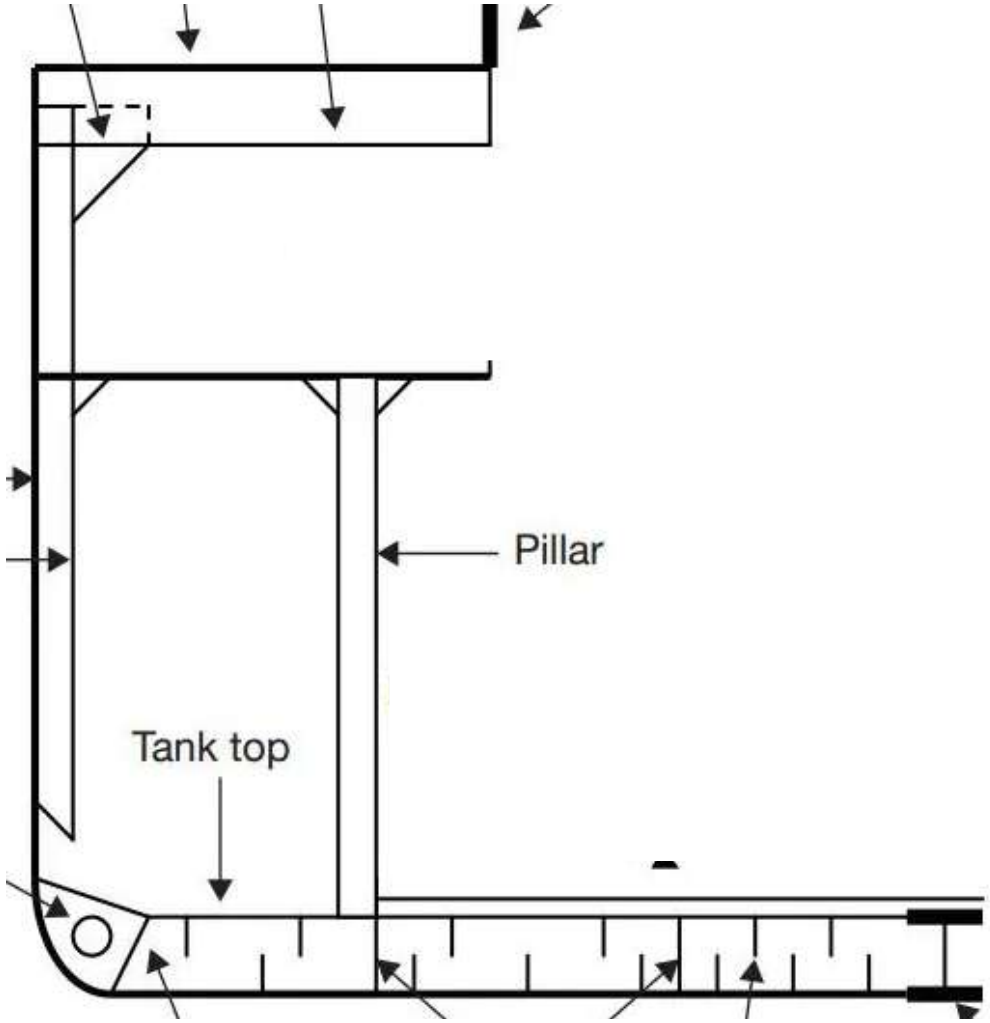
# Strengthening Structure : Misc Structures

- Bracket



# Strengthening Structure : Misc Structures

- Pillar / Stanchion
- Vertical structure
- Generally cylindrical in shape.
- To carry the load on the decks vertically down to the ship's bottom structure where these loads are supported by the upward buoyant forces.



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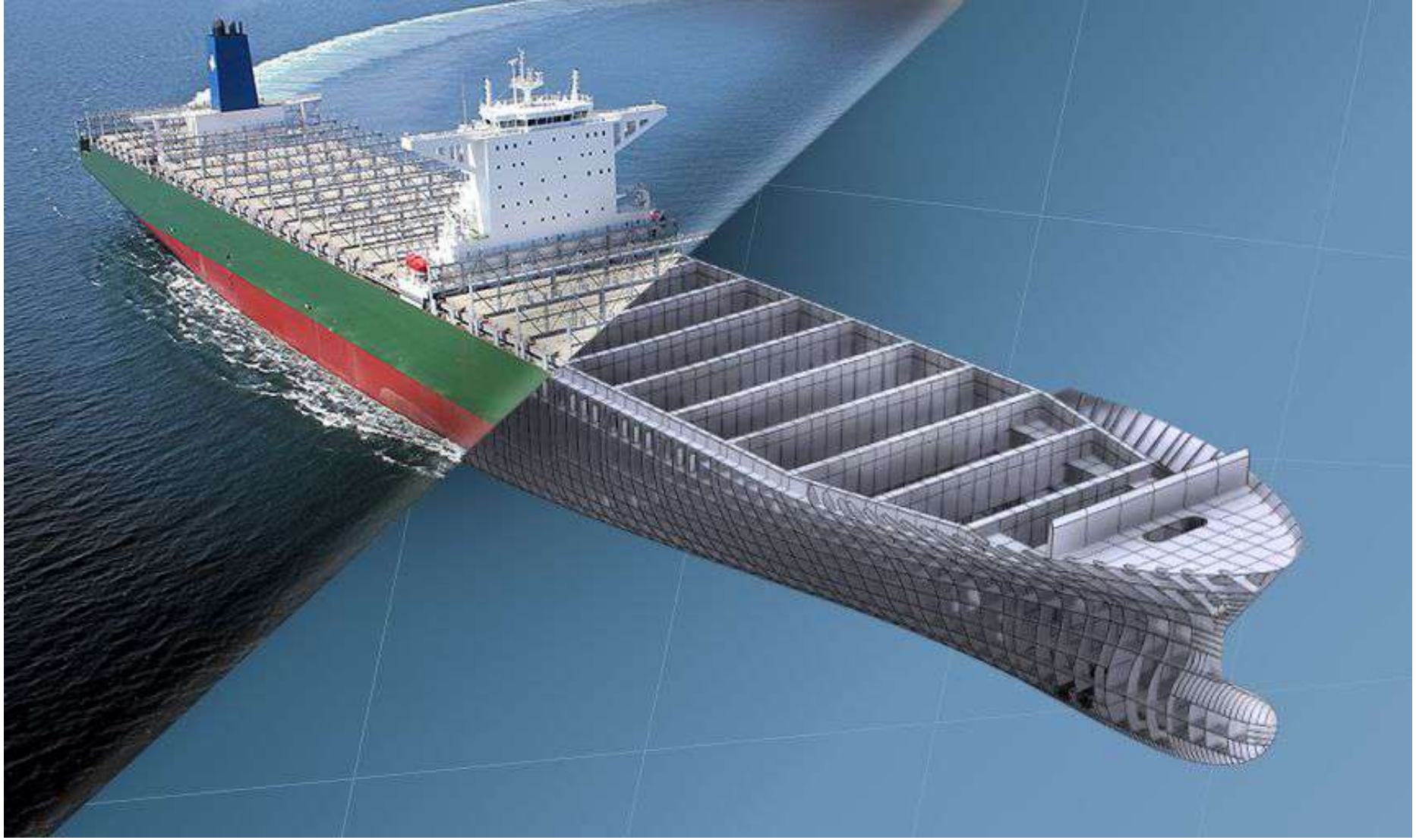

# Introduction to Naval Architecture

## II SEM –Module 4

# Syllabus

4. **Module IV**

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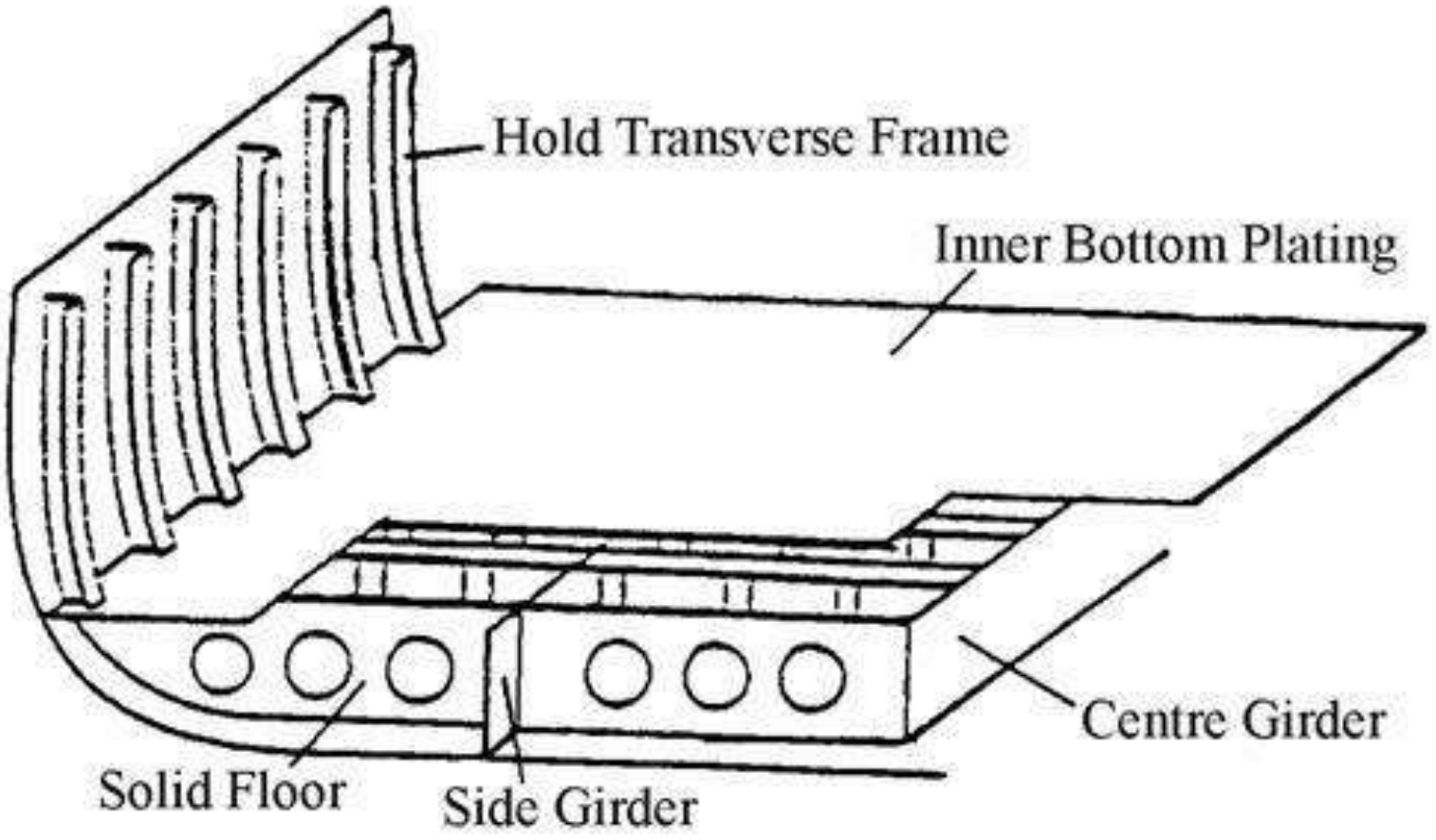
  - Special Structure / Fittings

# Ship Structure – Based on Location

- Bottom Structure
- Side Structure
- Deck Structure
- Fore End Structure
- Aft End Structure

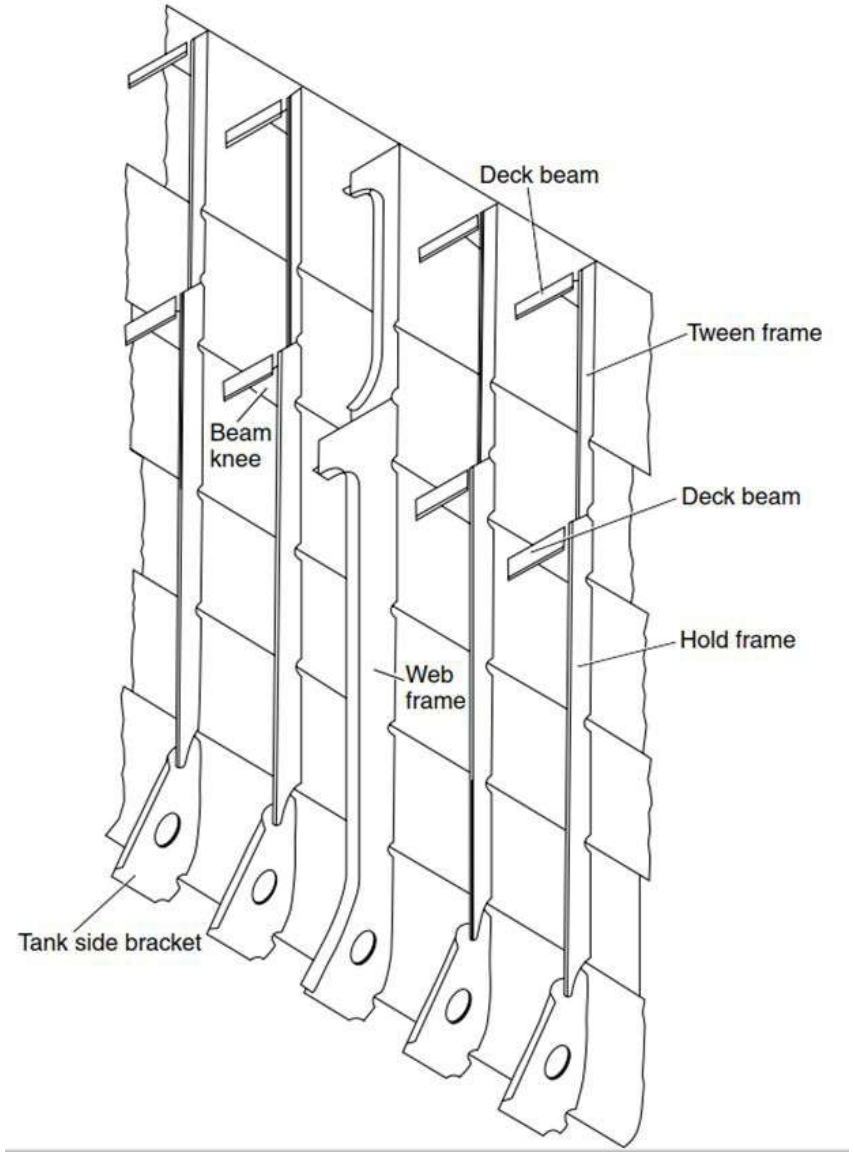
# Ship Structure – Bottom Structure

- The structure extending from the outer bottom shell plating to the inner bottom (along the depth of the ship) and from the centreline to the turn of the bilge where the side shell commences.



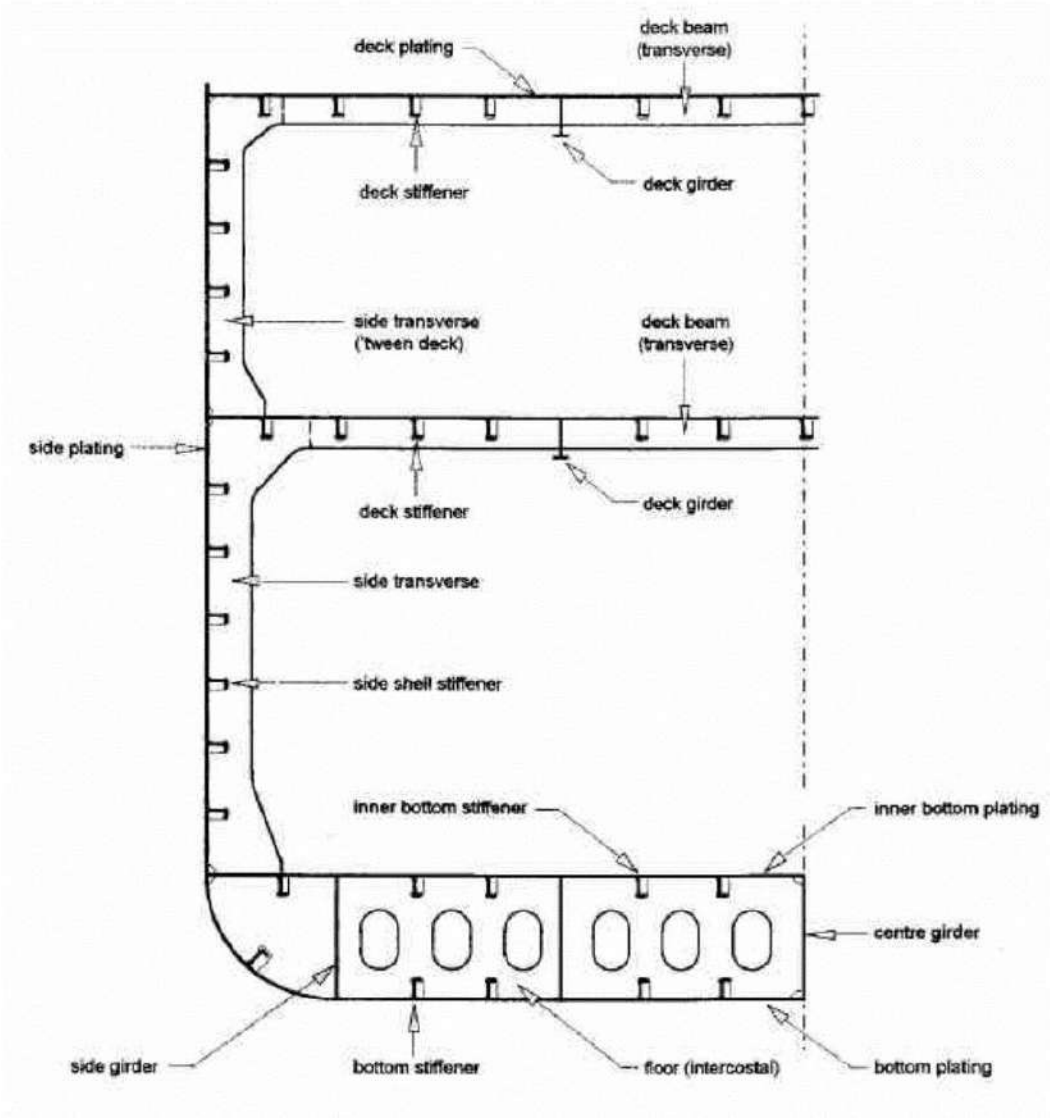
# Ship Structure – Side Structure

- The structure extending from the turn of the bilge to the weather deck (or main deck)



# Ship Structure – Deck Structure

- The deck structure comprises of the deck plating and its strengthening members between the side shell structure on port and starboard side.



# Ship Structure – Fore End Structure

- The entire structure ahead of the forward most bulkhead (called collision bulkhead) is called the fore end structure. It is heavily stiffened to withstand extreme loads of slamming, panting and even collision.
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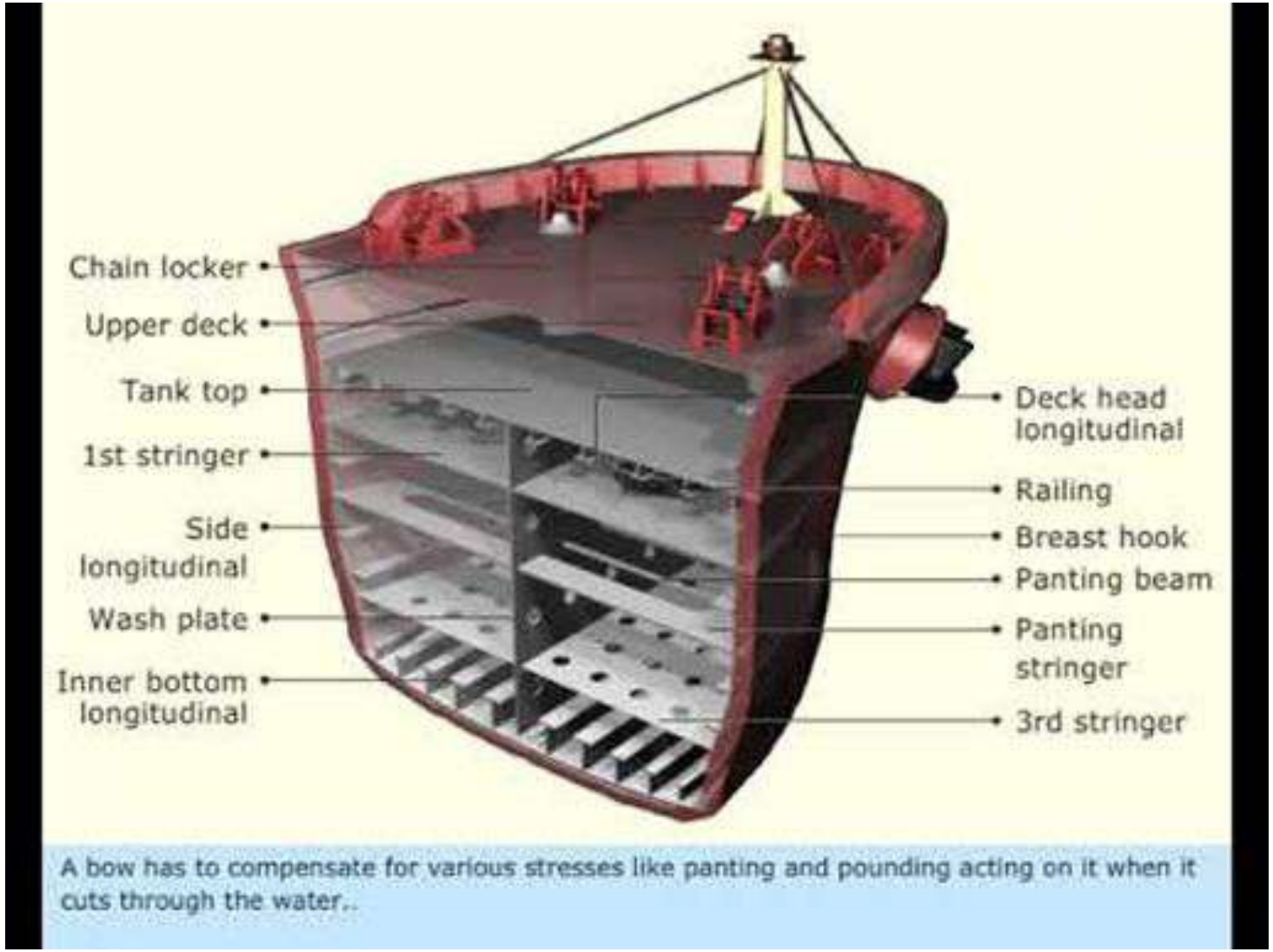

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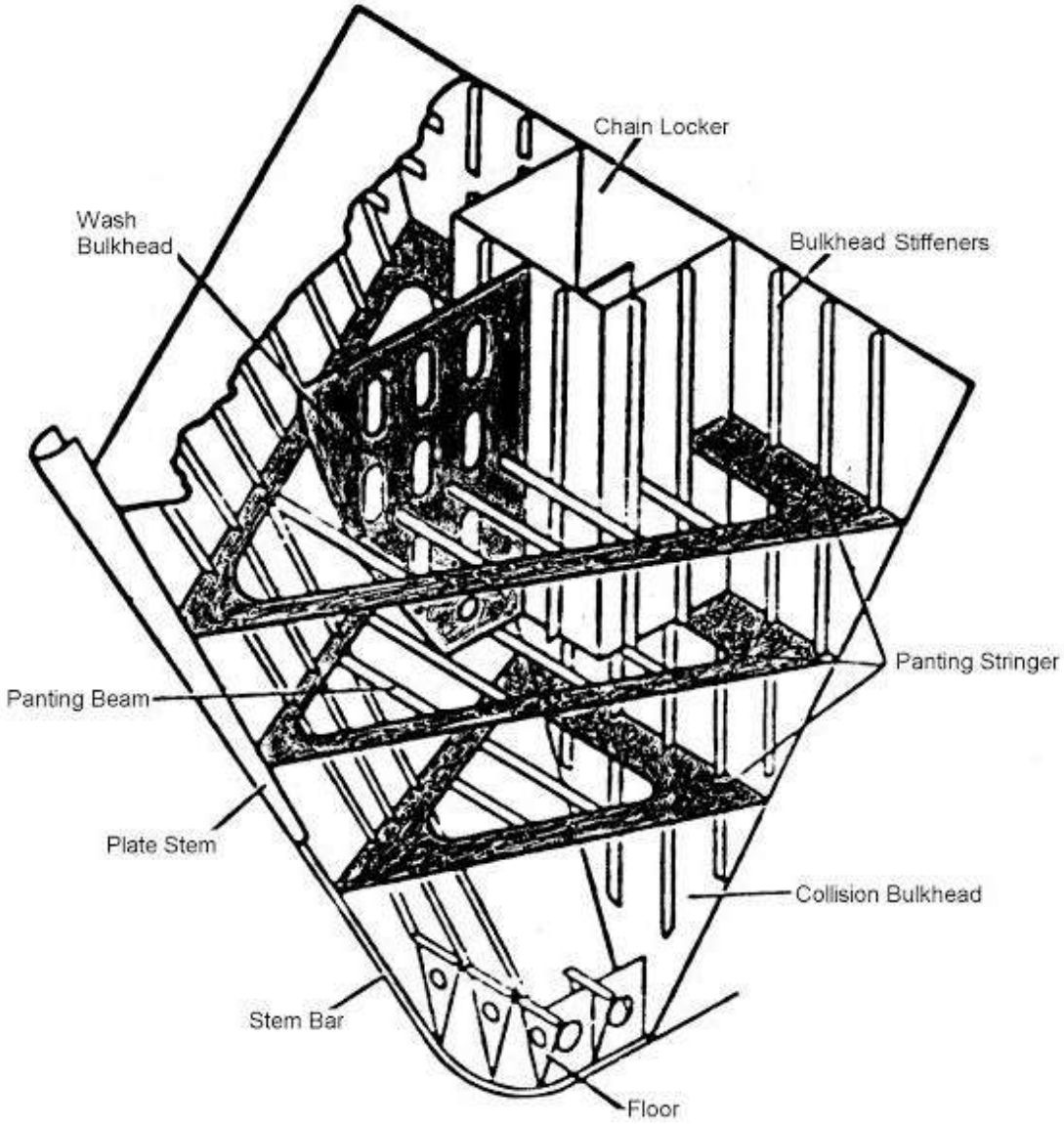
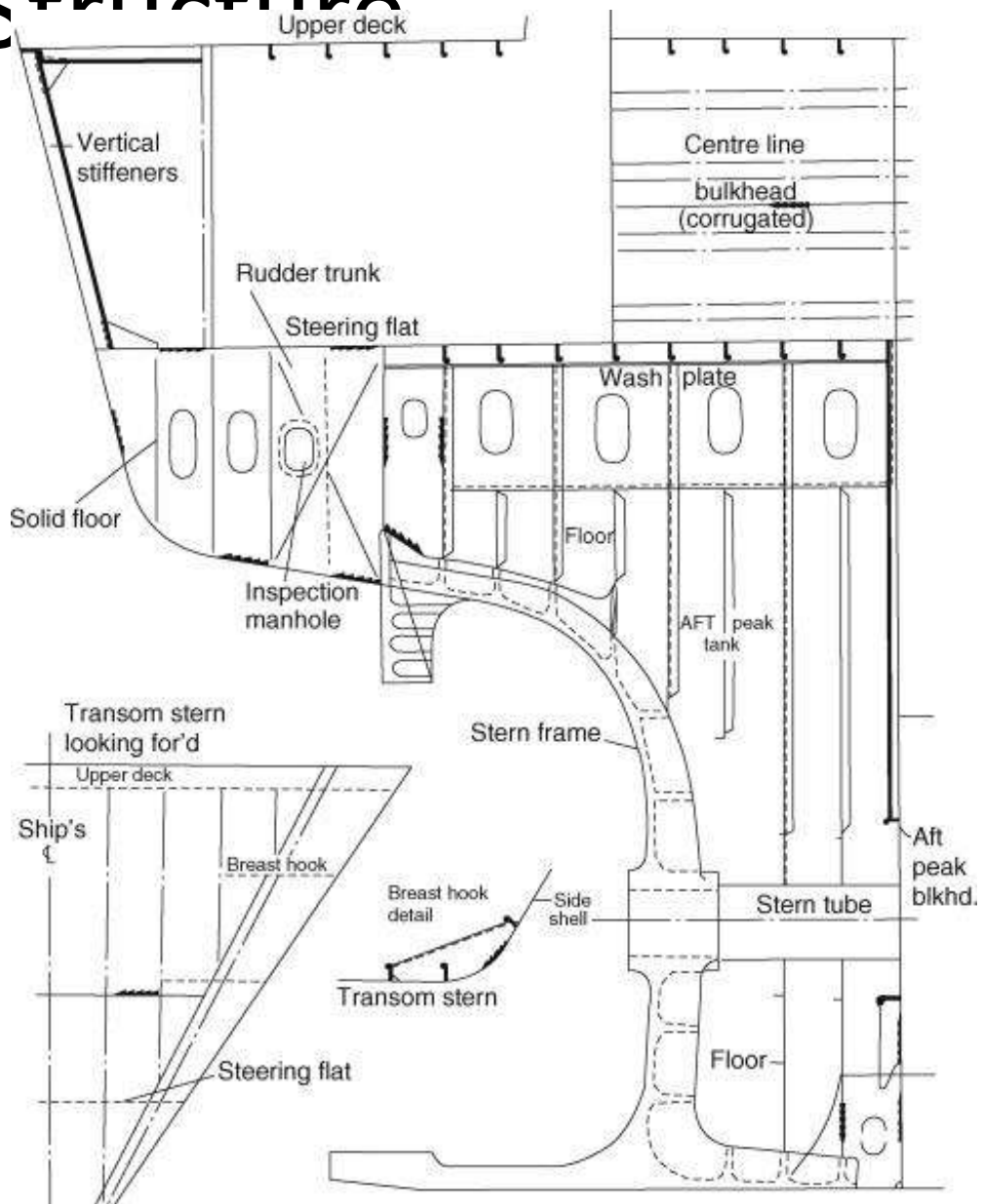


# Ship Structure – Aft End Structure

- It is the structure aft of the aft most bulkhead (called the aft peak bulkhead). This structure is also heavily stiffened as it is subject to heavy vibration loads, induced by propeller, rudder and shaft



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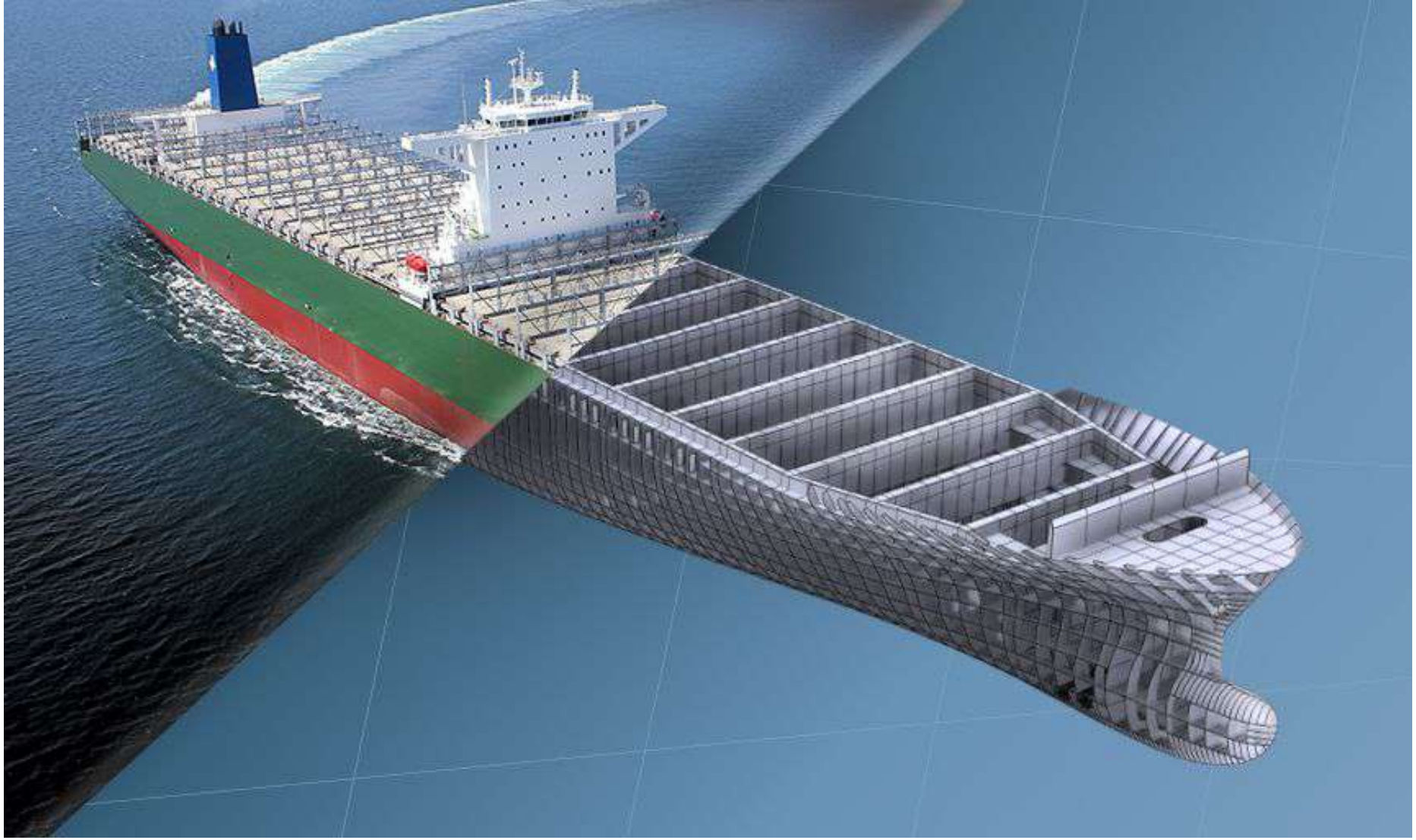


# Introduction to Naval Architecture

## II SEM –Module 4

# Syllabus

4. **Module IV**

   **Introduction to ship structures**

   The ship and her structural members - shipbuilding materials (properties, compositions), Bottom structure, shell plating and framing, decks, hatches and hatch covers, Superstructures, bulkheads, tanks, holds, fore and aft structure, stern and rudder.

# Ship Structure – Categorisation

- Main parts of ship's structure can be categorized based on the following different criteria

  - Type / Shape
  - Location
  - Participation in Load bearing
  - Special Structure / Underwater Fittings

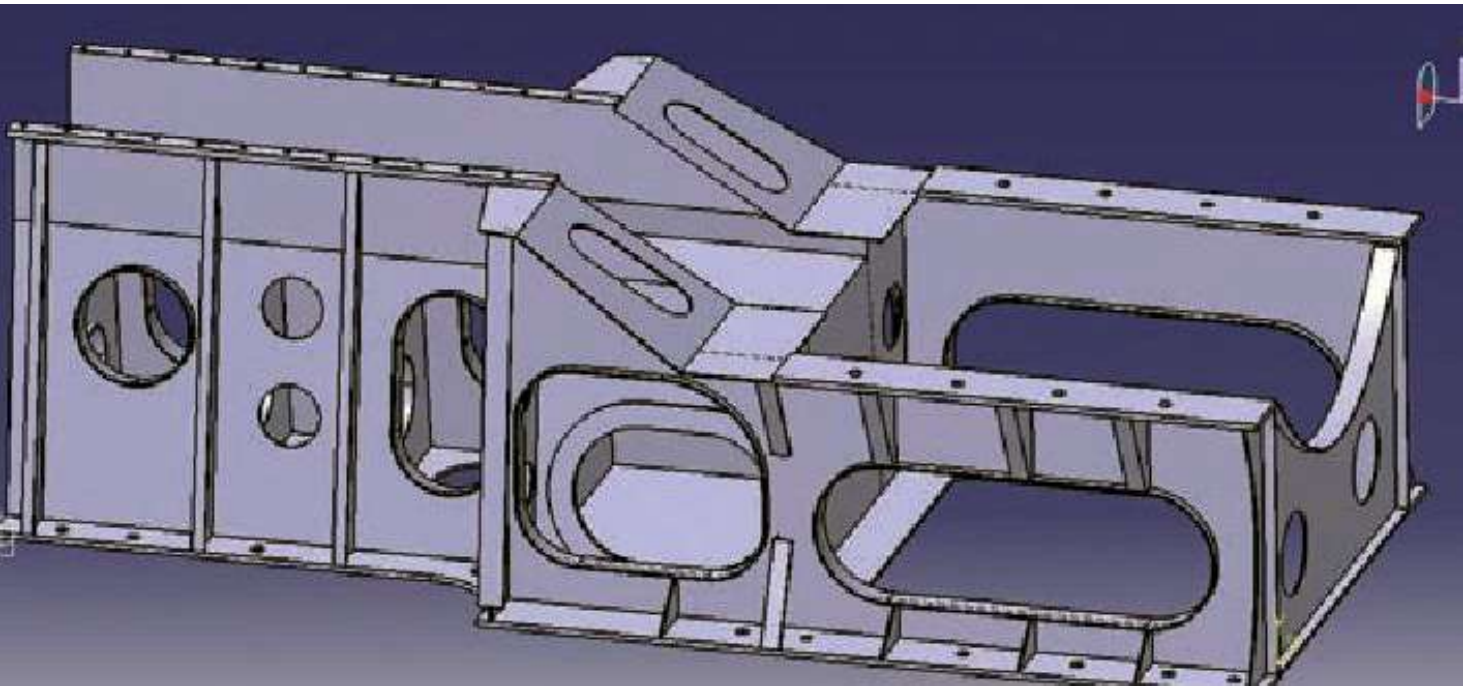
# Ship Structure – Special Structure / Underwater Fittings

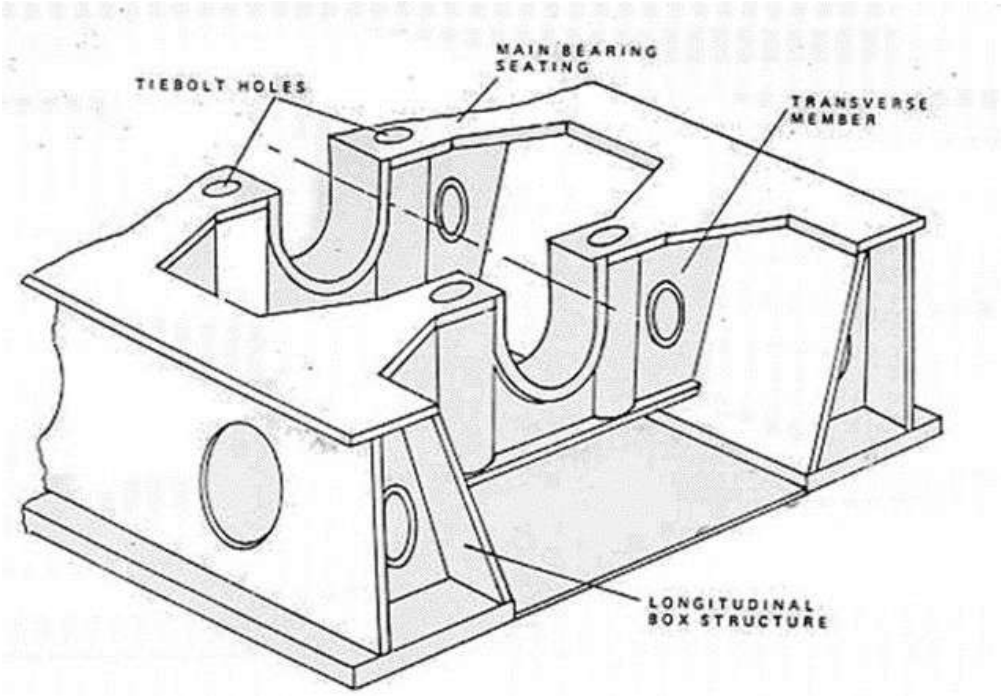
- Refers to
  - Special structures serving a particular purpose providing strength / support
    - Superstructure
    - Machinery foundation
    - Mast Structure
  - Welded or Cast underwater fittings
    - Rudder
    - Stabilisers
    - Shaft Bracket
    - Bilge Keel

# Ship Structure – Superstructure

- Structure above main deck of ship

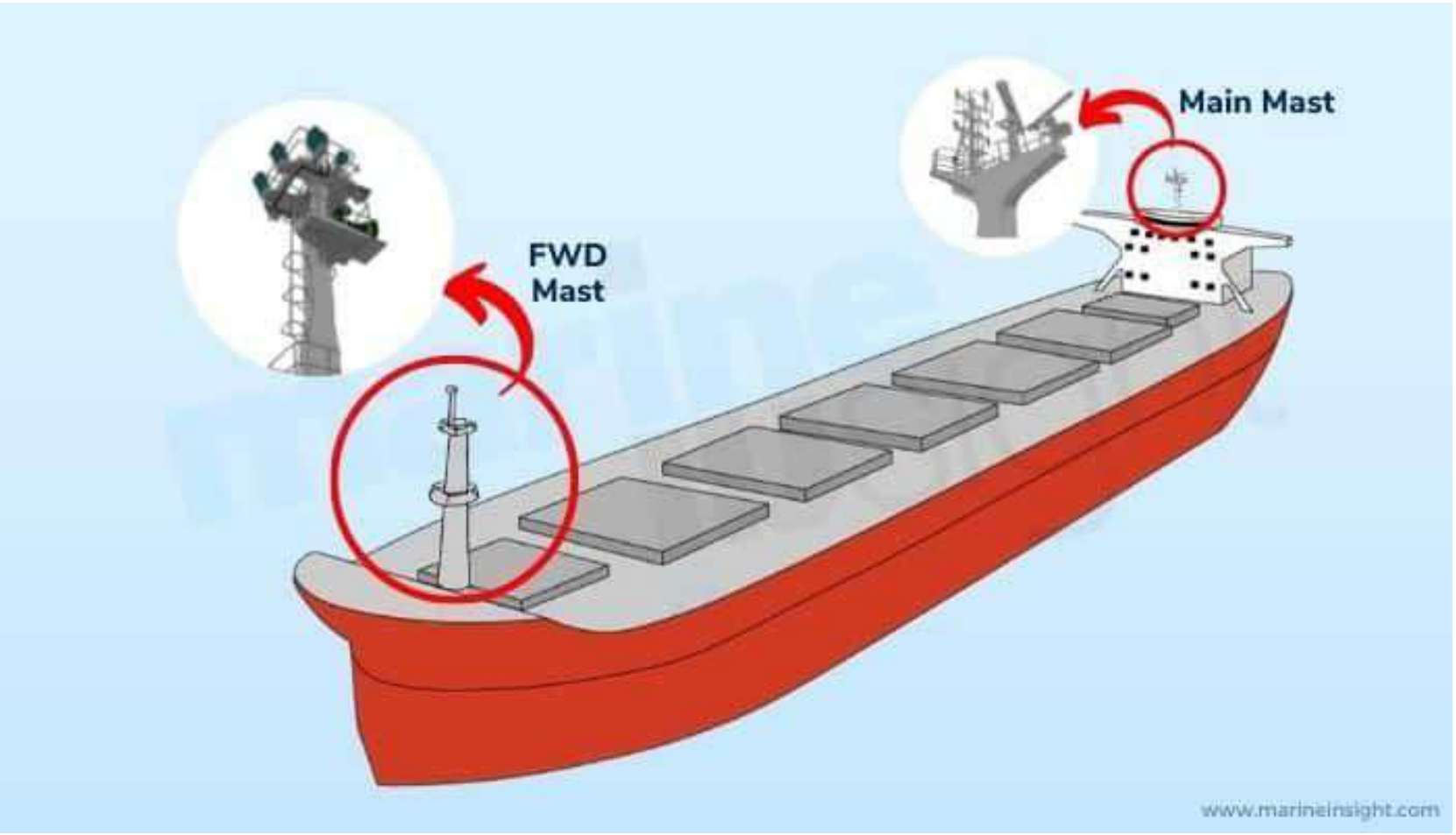

# Ship Structure – Engine / Machinery Foundation



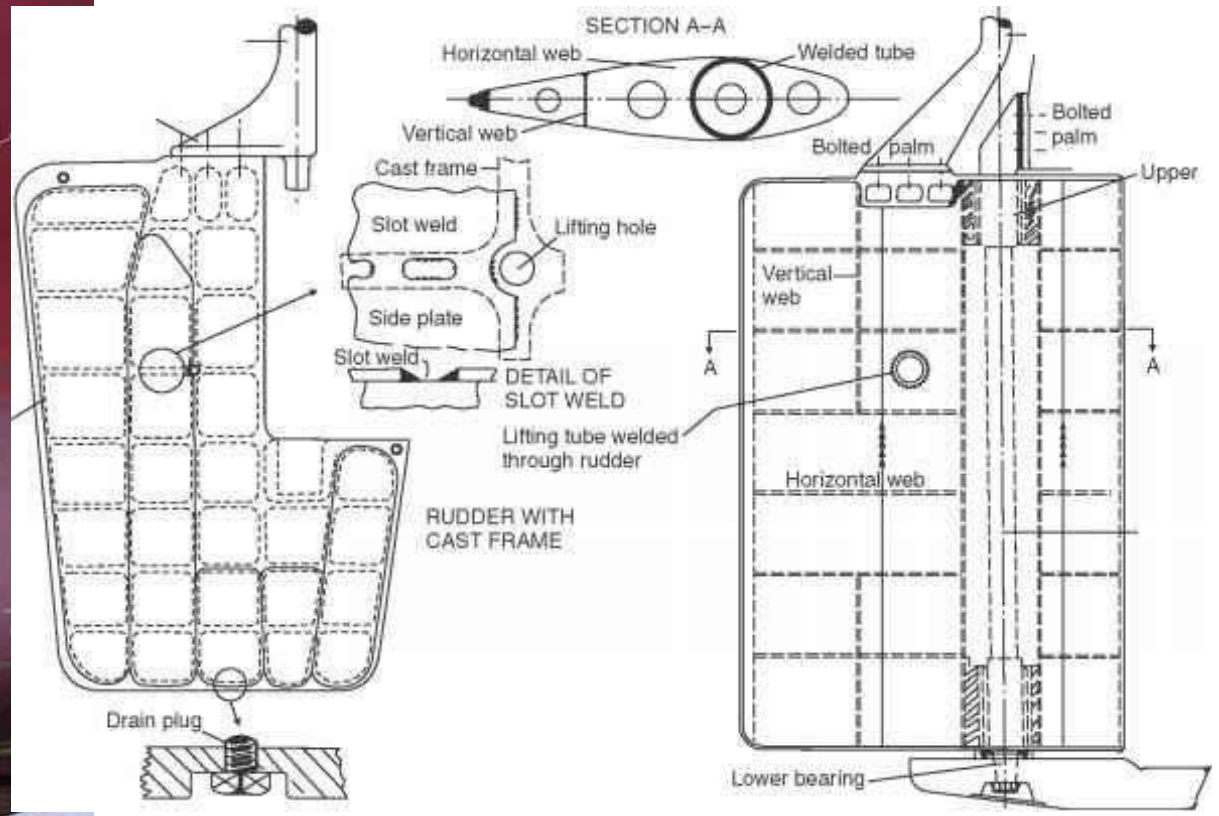



Engine bedplate of a crosshead engine
(steel parts welded together)

# Ship Structure – Mast



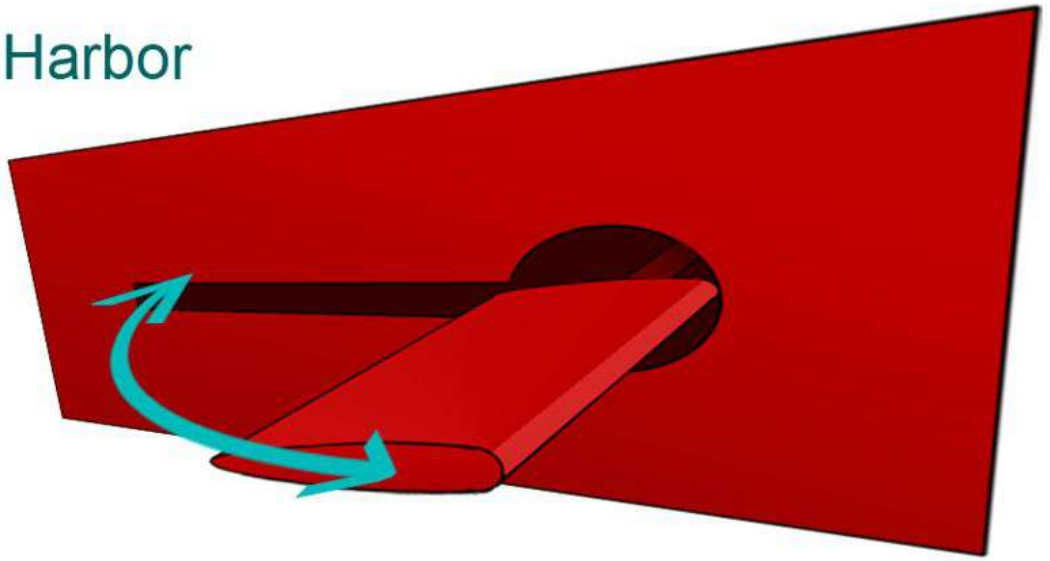

# Ship Structure – Rudder



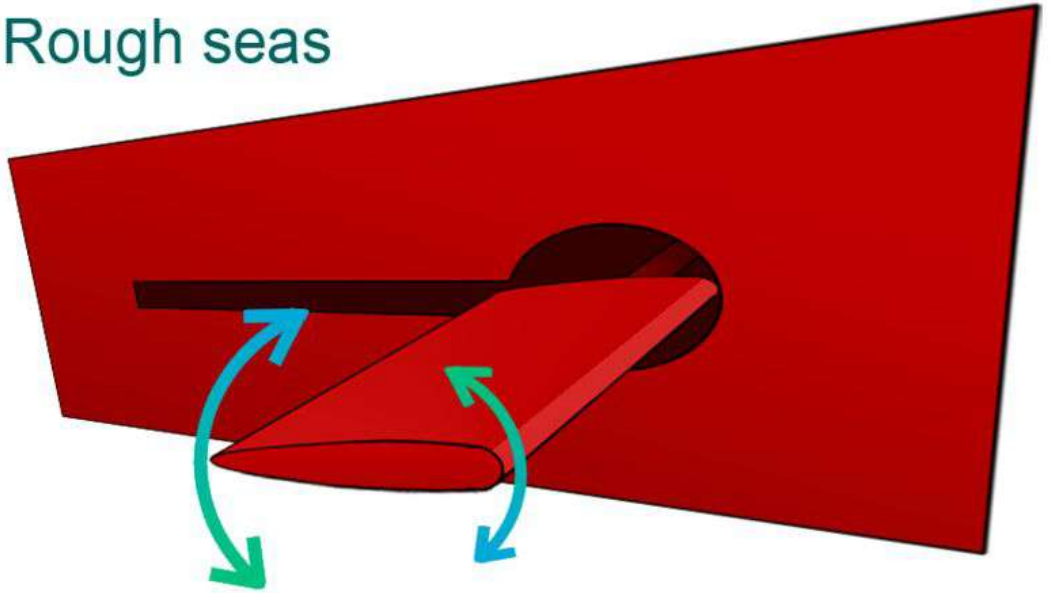
# Ship Structure – Stabilisers

Fin Stabilizer

Harbor

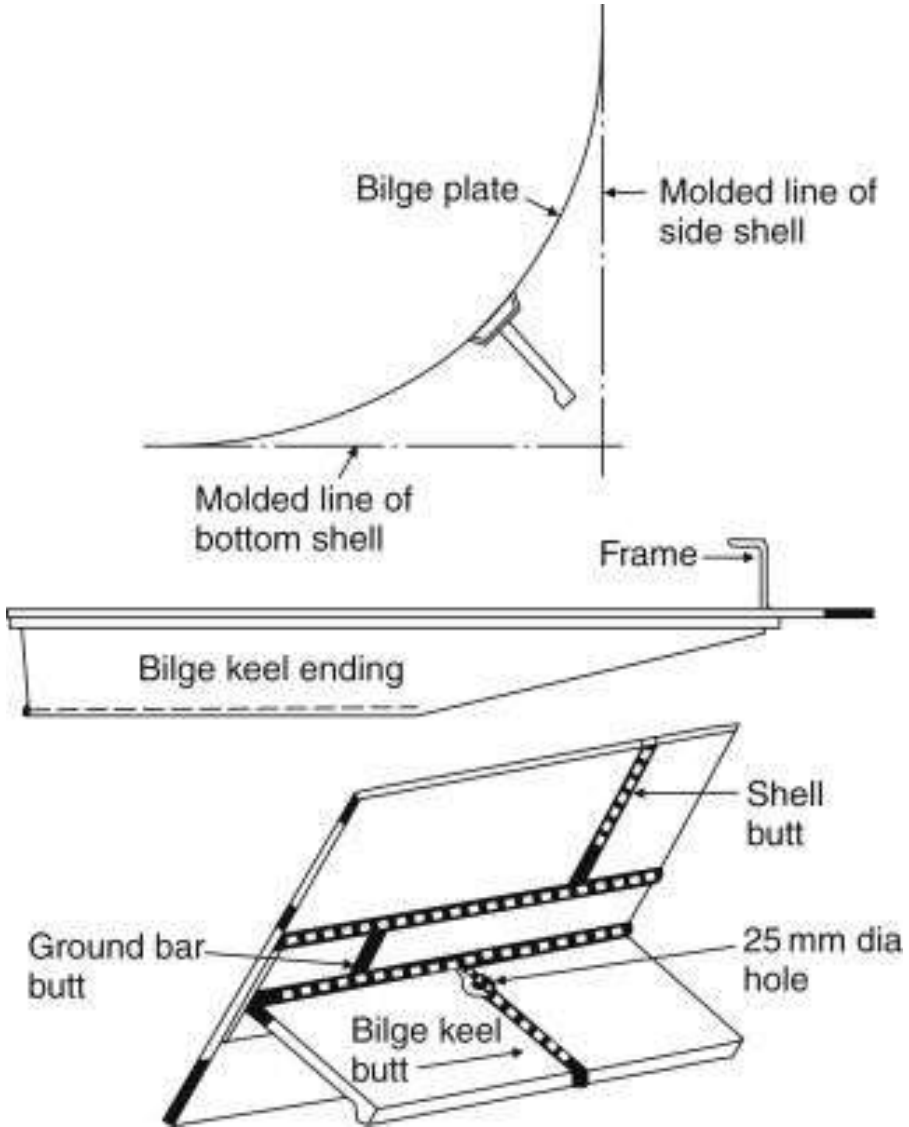


Rough seas



# Ship Structure – Shaft Bracket

# Ship Structure – Bilge Keel




# END

- In case of any doubts you may contact me at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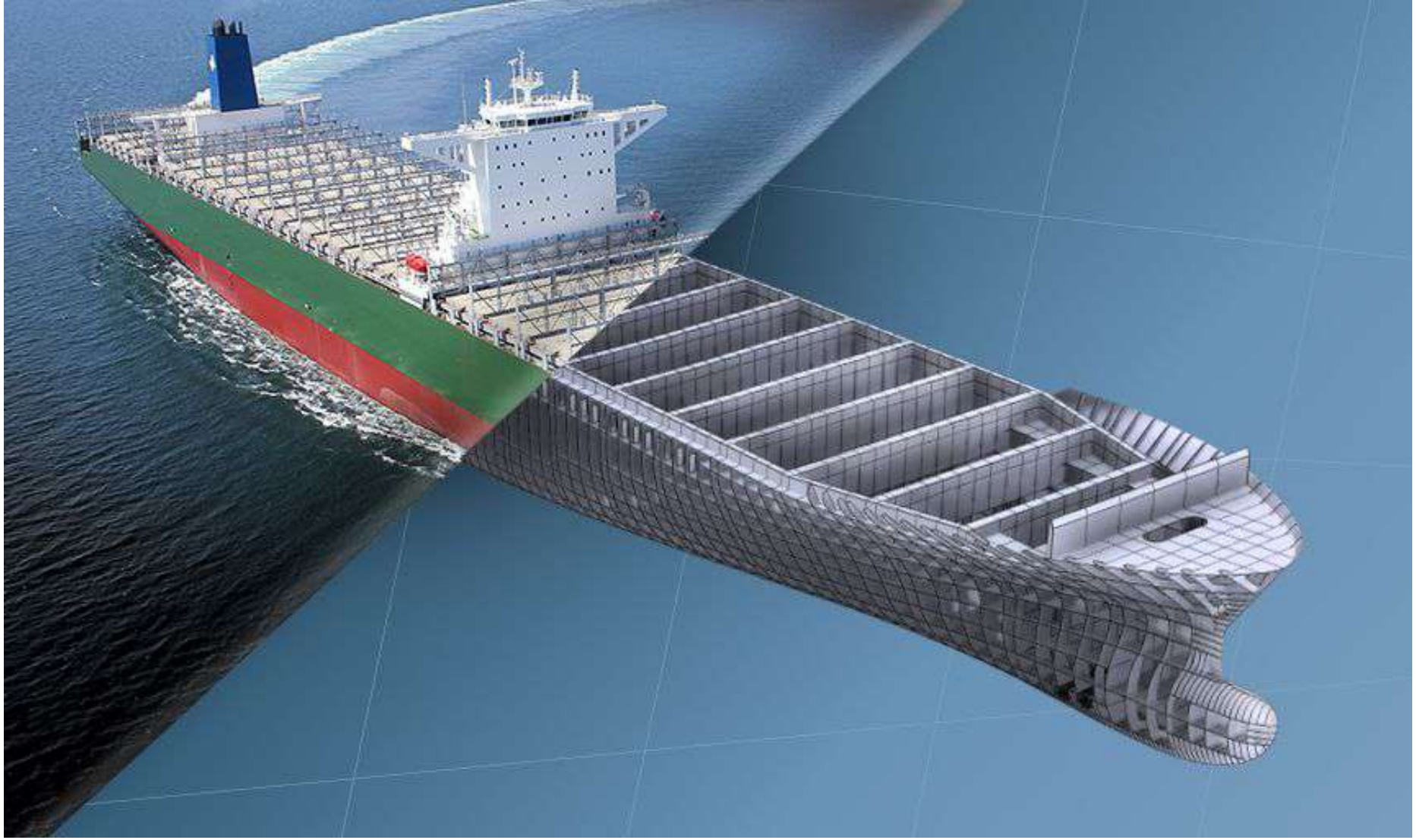


# Introduction to Naval Architecture

## II SEM –Module 5

# Syllabus

4. **Module IV**

**Introduction to ship structures**

The ship and her structural members - shipbuilding materials (properties, compositions), Bottom structure, shell plating and framing, decks, hatches and hatch covers, Superstructures, bulkheads, tanks, holds, fore and aft structure, stern and rudder.

# Miscellaneous Deck Structure / Fittings

- Hatches
- Hatch Covers

# Hatches and Hatch Covers

- What is a Hatch
  - Opening on a deck provided for access to lower decks

- What is a Hatch Cover
  - Cover provided for a hatch to provide
    - safety to personnel
    - weather protection to cargo / personnel
    - Watertight sealing of deck

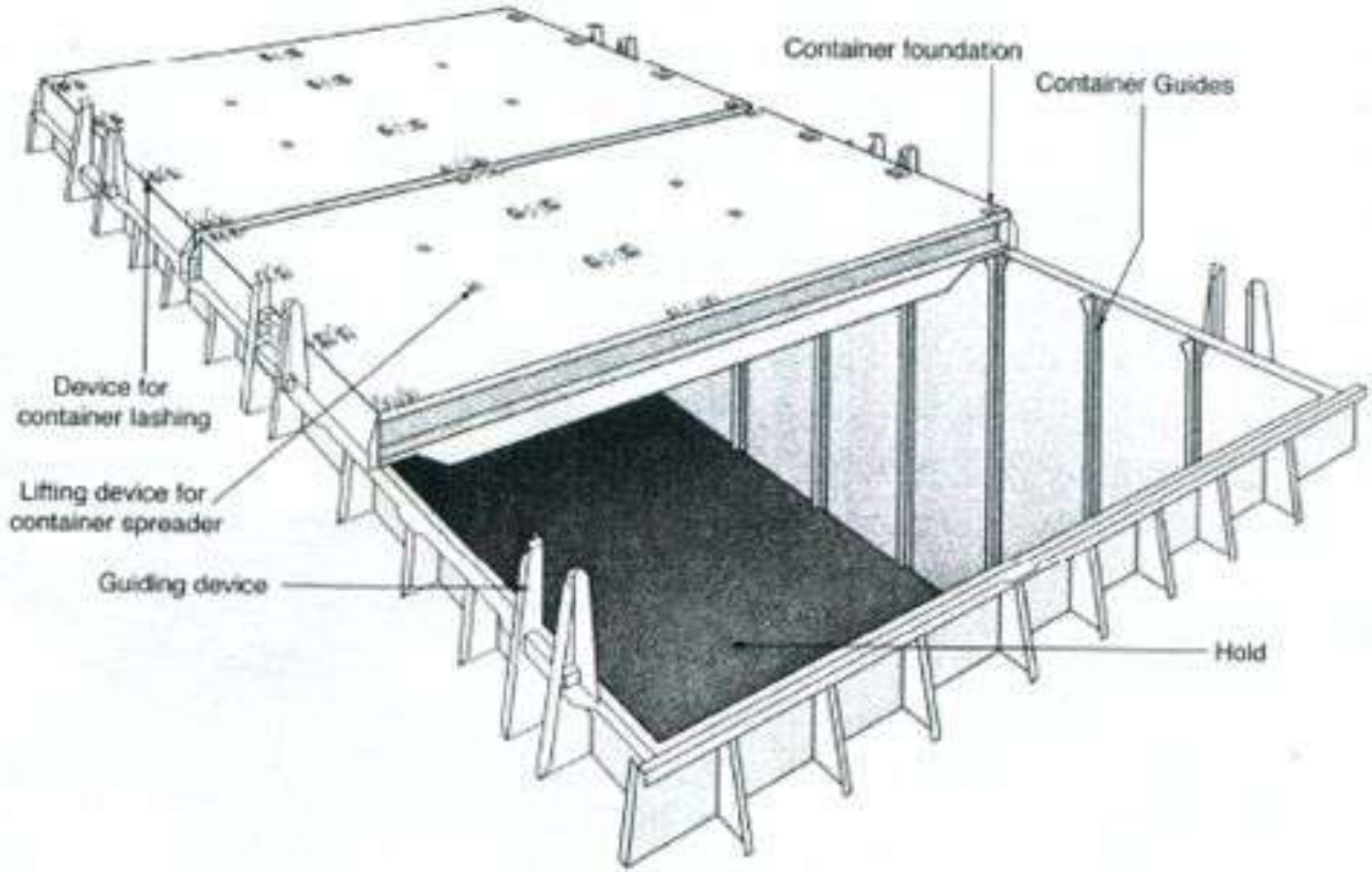
# Hatches

- Types of Hatches
  - Cargo Hatch
  - Deck Hatch

- Vessels with Cargo Hatches
  - Bulk Carriers (Ore, grain, coal, fertilisers etc.)
  - Break Bulk Carriers or General Cargo (crates, bags, boxes, drums, barrels etc.)
  - Container Ships
  - Fishing Vessels

- All vessels have Deck hatches

# Hatch Structure


Container foundation
Container Guides
Device for
container lashing
Lifting device for
container spreader
Guiding device
Hold


Hatch-coaming stays
Hatch-coaming

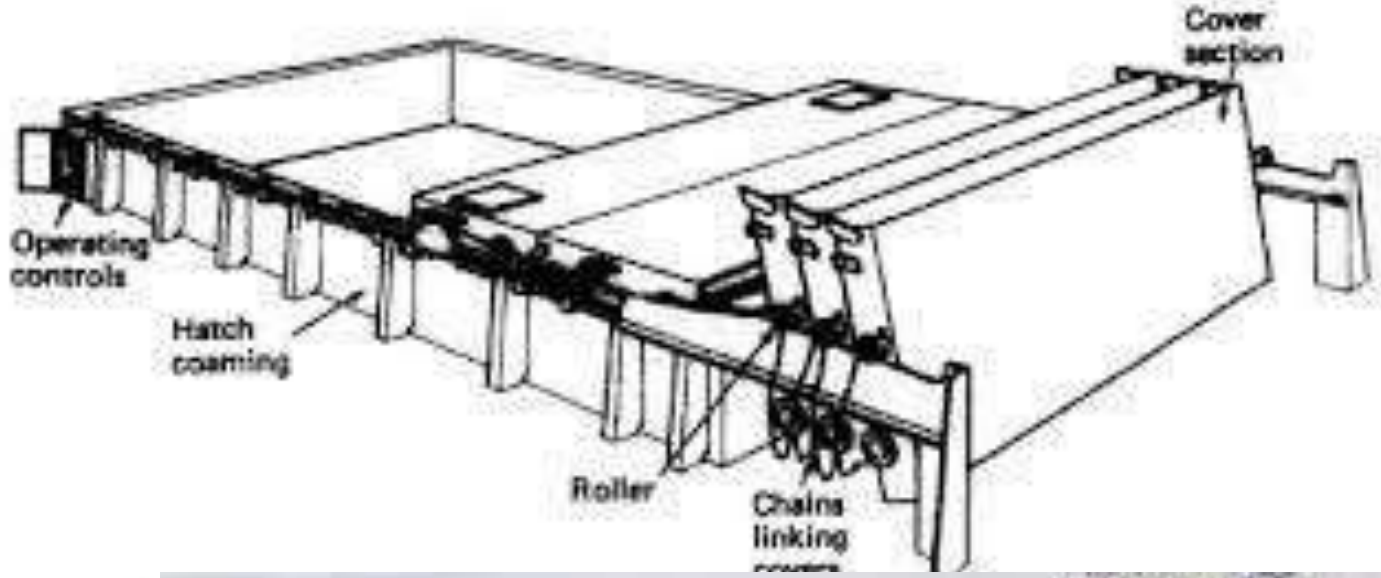
# Cargo Hatch Covers

- Types of Cargo Hatch Covers
  - Lifting type
  - Rolling type
    - Single Pull
      - Stacked Panel
      - Coiling
    - Side Rolling
      - Single Panel
      - Twin Panel
  - Folding type
    - Twin Panel
    - Multiple Panel
  - Stacking Type

- Lifting Type

Lifting Type: (Image credits: nauticexpo.com)

- Rolling Type (Single Pull)
  - Stacked Panel




- Rolling Type (Single Pull)
  - Coiling

- Rolling Type –
  - Side Rolling
    - Single Panel

- Rolling Type –
  - Side Rolling
    - Twin Panel


- Folding Type
  - Twin Panel

- Folding Type
  - Multiple Panel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- Stacking (Piggy back)

# Deck Hatch Covers

# Deck Hatch Covers -Types

- Opening Mechanism
- Locking Mechanism
- Openability
- Shape
- Coaming

# Deck Hatch Covers -Types

- Opening Mechanism
  - Manual
  - Hydraulic
  - Pneumatic
  - Spring loaded
  - Combination

# Deck Hatch Covers -Types

- Locking Mechanism
  - Wing Nut
  - Wheel
  - Dog Clips

# Deck Hatch Covers -Types

- Openability
  - Openable from both sides
  - Openable from one side only

# Deck Hatch Covers - Types

- Shape
  - Square
  - Rectangle
  - Circular
  - Oval


# Deck Hatch Covers -Types

- Coaming
  - With Coaming
  - Flush

# END

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