Marine Construction & Welding

NA21003

Autumn 2020

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Structural Components

Girders and Transverses

Members of higher scantlings are referred to as girders and transverses.

Girders run along the length of a ship providing longitudinal strength

Transverses run along the breadth of a ship and contribute to transverse strength and provide support to longitudinals.

Structural Components

❑ **Centre girder:**

It runs along the centre line of the ship as a vertical flat plate in the double bottom

Extent: Aft collision bulkhead to the forward collision bulkhead. divides the double bottom into water tight port and starboard tanks.

❑ **Side girder:**

Vertical flat plates within double bottom running along the length of the ship

It runs from one plate floor to the next and is welded to it.
Side girders are generally not water tight, with lightening holes to reduce weight and provide passage to fluid.

Structural Components

❑ **Hatch-side girder:**

Runs continuously along the length of the ship piercing through the subdivision bulkheads

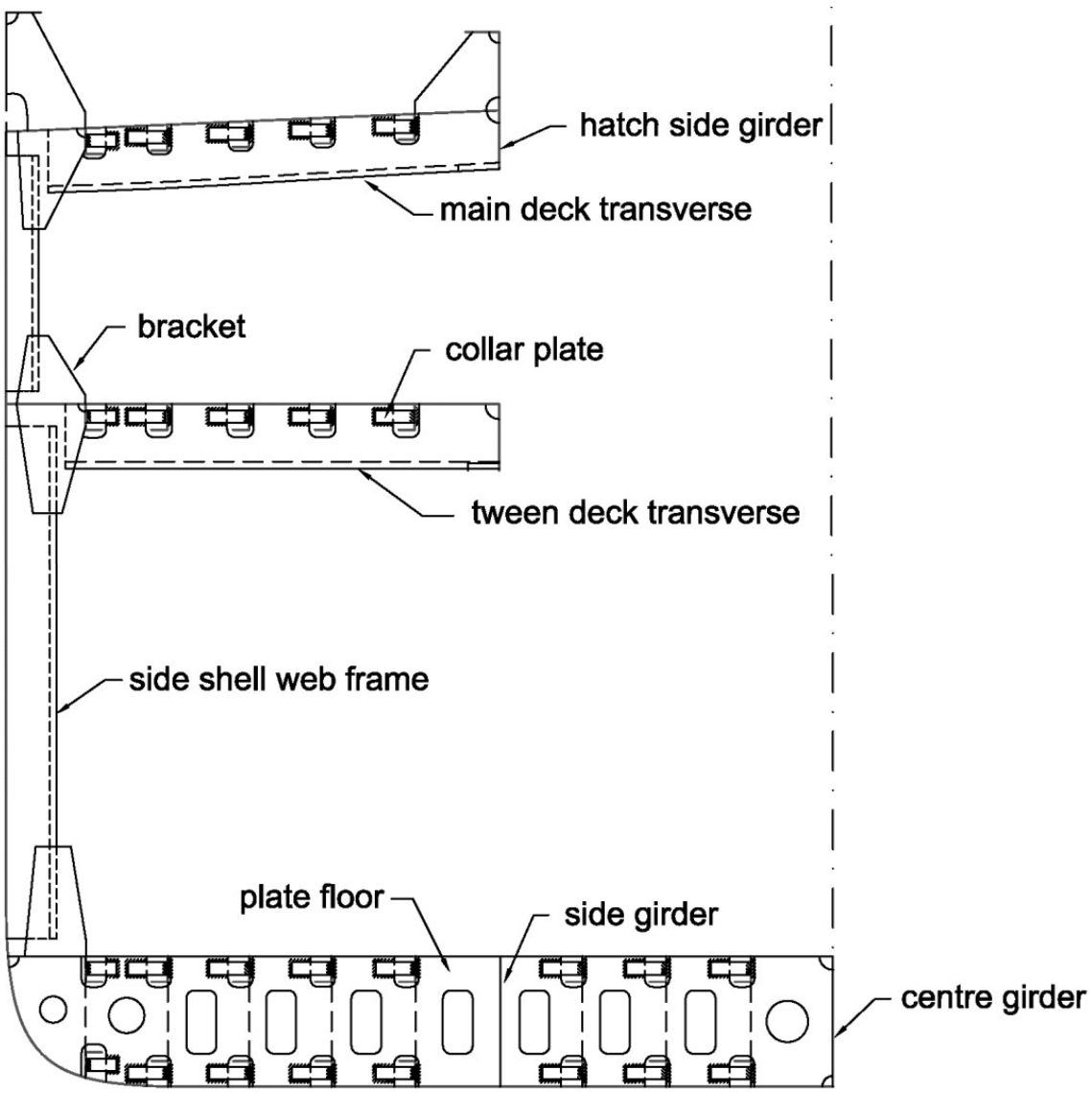
Primary function: compensate for loss in longitudinal strength due to large hatch opening in the deck.

❑ **Hatch-end beam:**

Transverse members at forward and aft ends of hatch, and welded to the hatch-side girder

Primary function: compensate for loss in transverse strength due to large hatch opening in the deck.

Structural Components



Structural Components

❑ **Deck Transverse:**

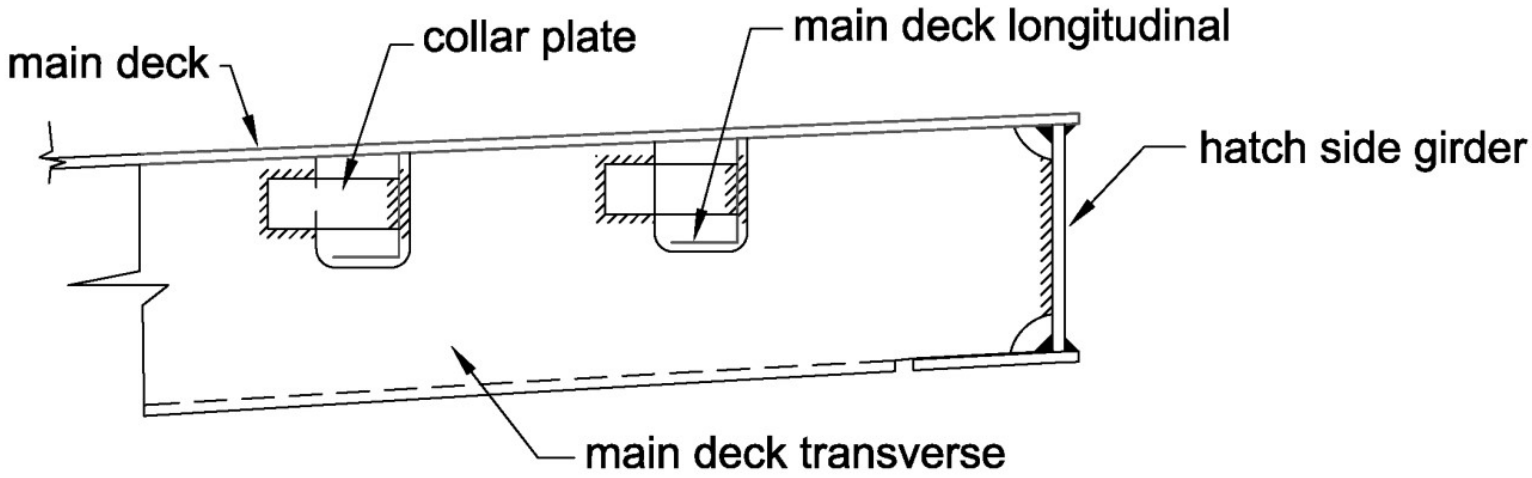
Transverse members of higher scantlings compared to the deck longitudinals.

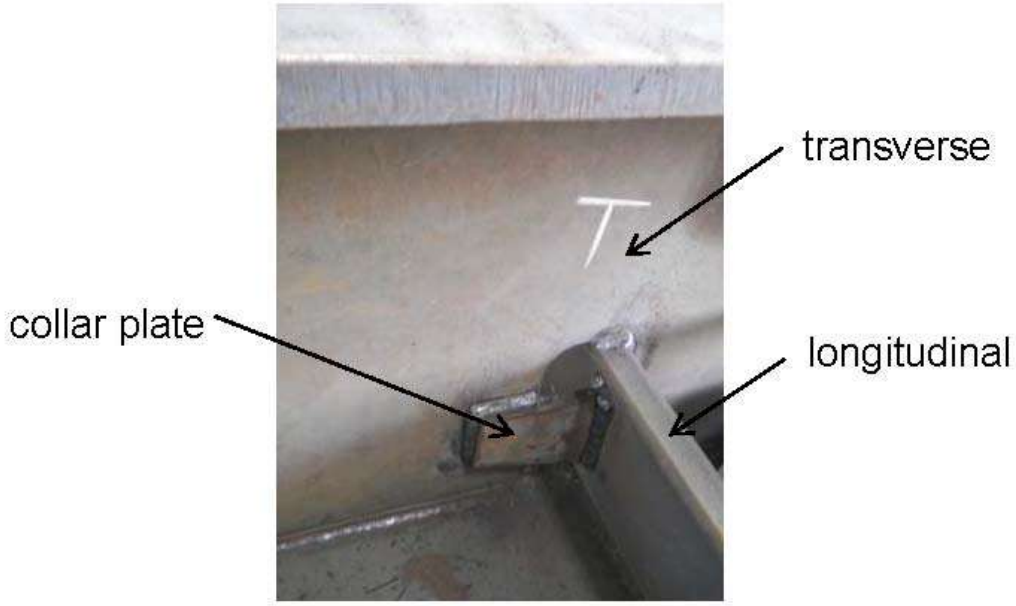
In longitudinal framing system transverses provide for transverse strength and also support the longitudinals.

A collar plate is welded at the intersection to make a rigid connection

Design strategy: The free span of a longitudinal becomes equal to the spacing between two adjacent transverses.

Structural Components





Intersection of deck longitudinal and deck transverse

Structural Components

❑ **Stringers:**

Stiffening members of higher scantlings- fabricated T sections or perforated stiffened plates.

Used to provide additional strength to side shell in fore peak structure against local loads

Structural Components

Floors:

Vertical transverse members in the double bottom

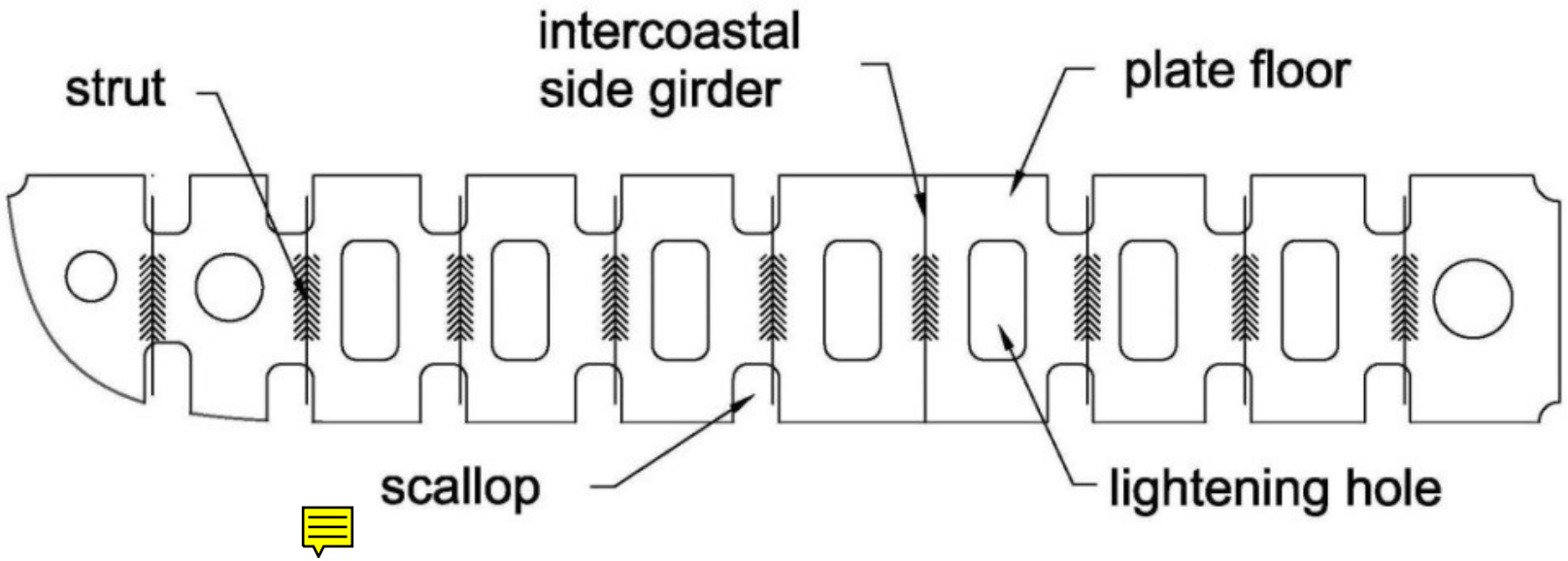
- Plate floor
- Water tight floor
- Bracket floor

Structural Components

- **Plate floor/ Solid floor:**

Flat plate panels providing transverse strength to the hull structure.

They are strengthened using stiffeners known as struts welded to the floor plating.

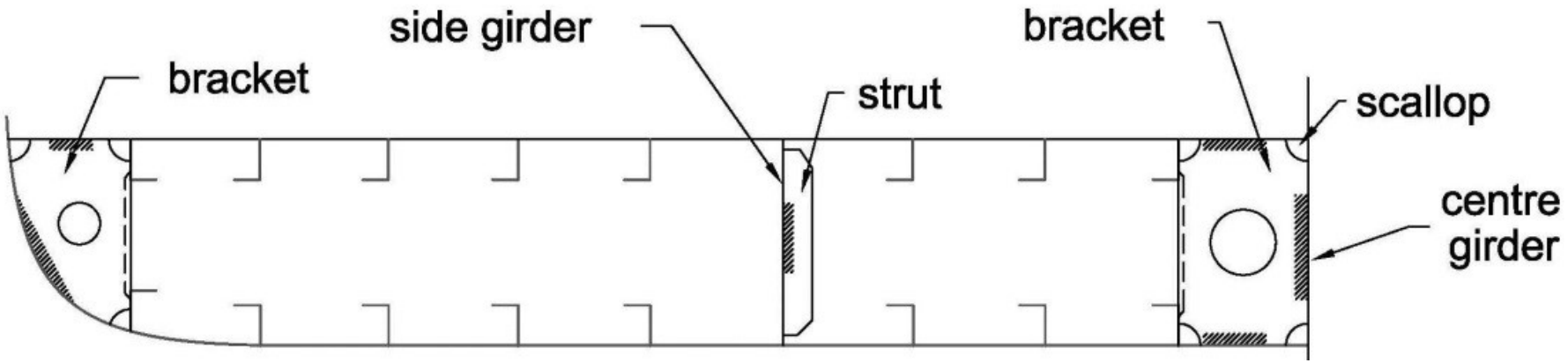


Structural Components

- **Bracket floor:**

It comprises of two pieces of plate brackets:

- One connecting the centre girder to the bottom shell and inner bottom longitudinals
- Other one at the bilge end connecting the pair of longitudinals



Structural Components

- **Watertight floor:**

Placed below the transverse subdivision bulkheads and in places where the double bottom space is used for tankage purposes.

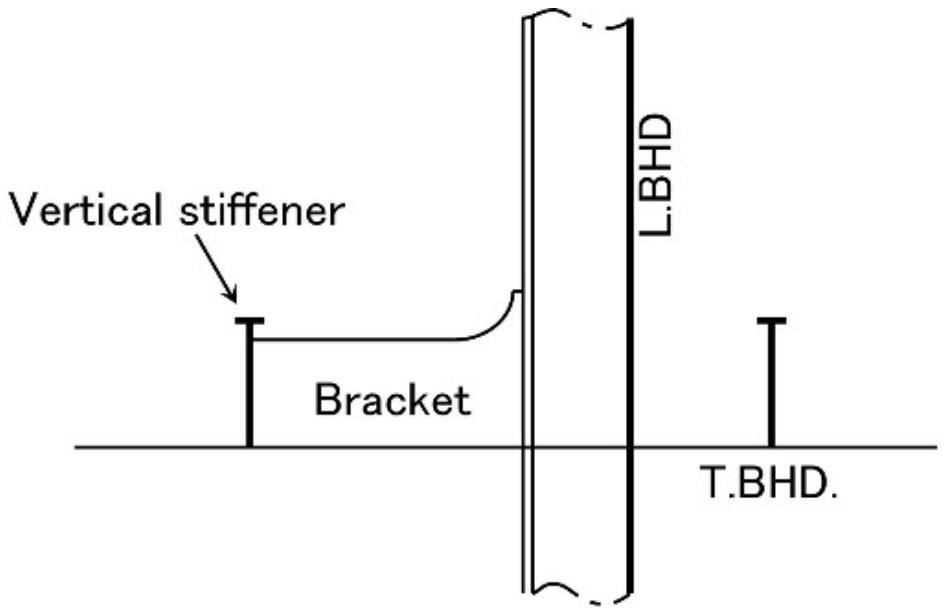
No lightening holes present, and the scallops are sealed using collar plates

Structural Components

❑ Brackets:

They are classified as a secondary structural members which contribute indirectly to the overall strength.

They help in providing structural continuity and local strengthening.



Ship Construction Workflow

Plates & Profiles → Sub assemblies → Assemblies → Units → Blocks → Ship

Ship Construction Workflow

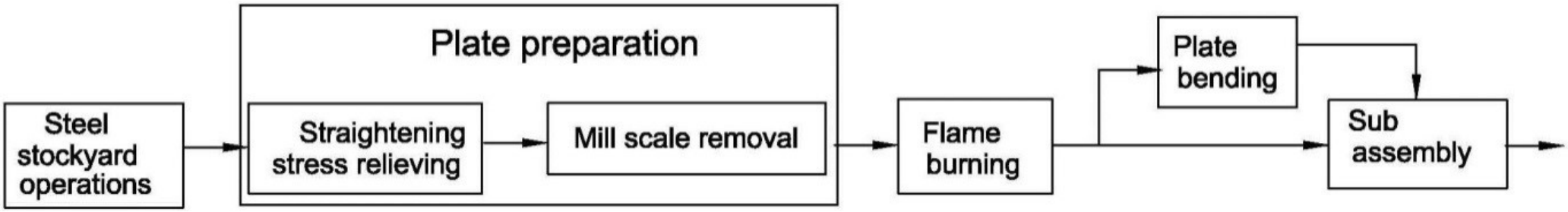
Shipbuilding is essentially an **assembly industry**

The products of first stage of assembly are referred to here as subassemblies.

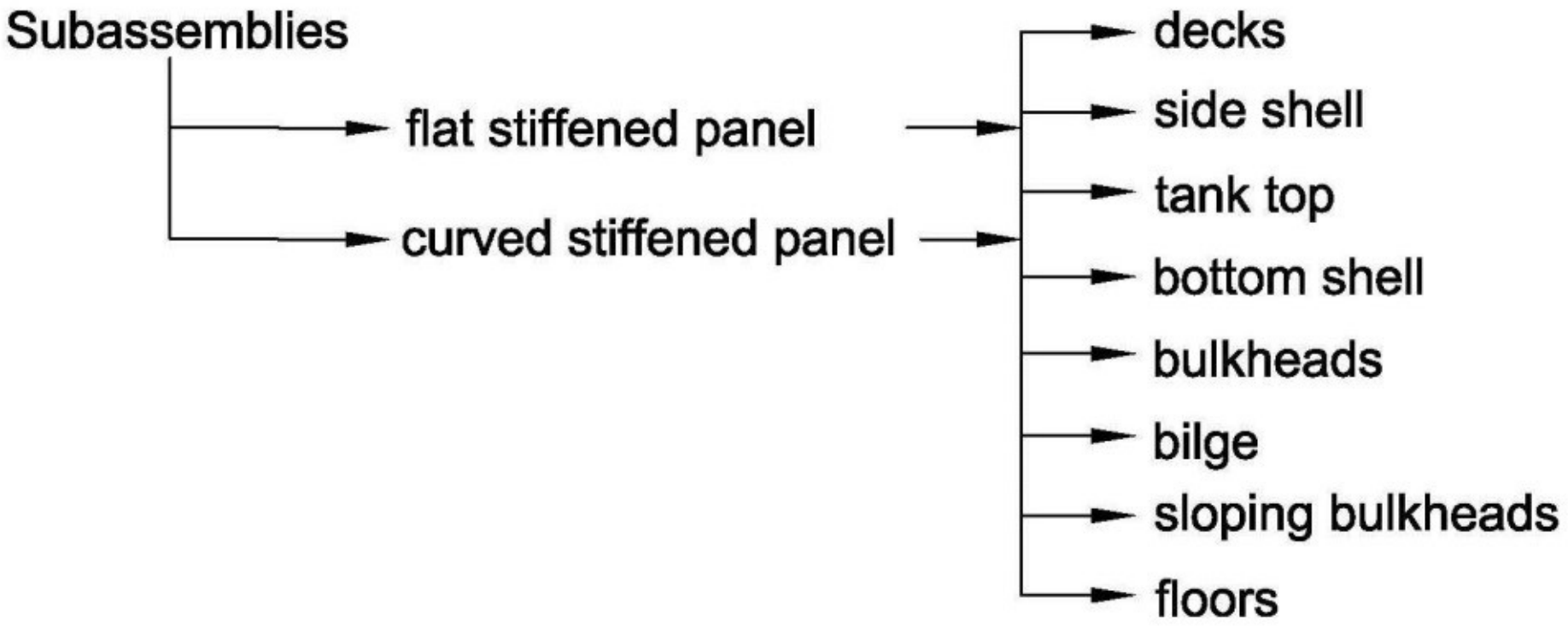
The subassemblies put together yields assemblies and subsequently units, blocks and finally the complete ship.

Ship Construction Workflow

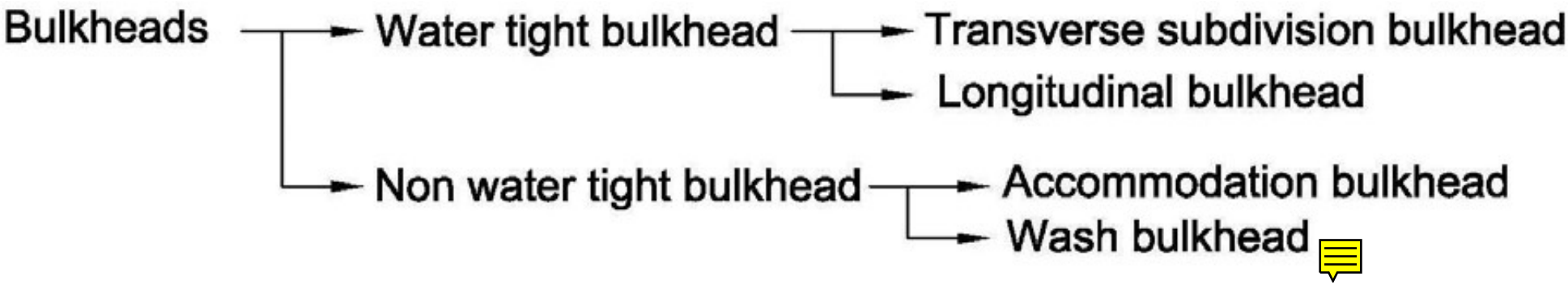
Production activities from the steel stockyard to the stage of fabrication of subassemblies:



Structural subassemblies



Bulkheads


Bulkheads
Water tight bulkhead
Transverse subdivision bulkhead
Longitudinal bulkhead
Non water tight bulkhead
Accommodation bulkhead
Wash bulkhead

Bulkheads

The basic functions of **transverse watertight bulkheads** are:

- Divide the ship into several watertight compartments.
- In case of flooding of a compartment, bulkhead prevents progressive flooding. They are designed to take the hydrostatic load in case of flooding.
- Provide support to the longitudinals running continuously piercing through the bulkheads.
- Provide sufficient transverse strength to the hull structure
- Confine any fire breaking out in any cargo hold to that hold

Bulkheads

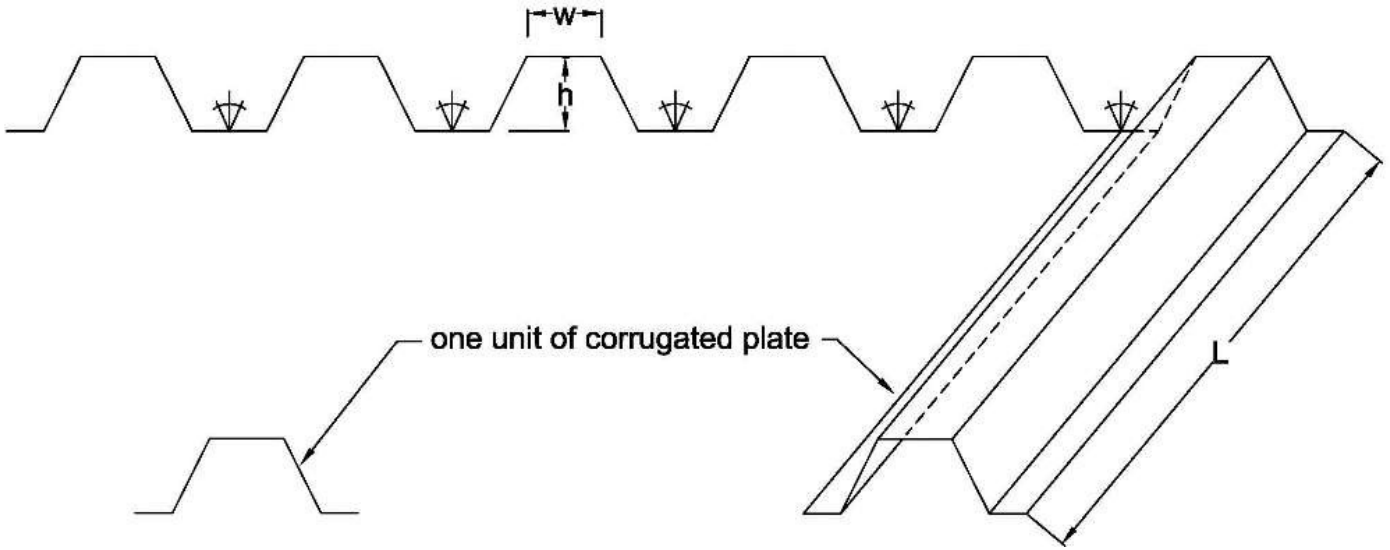
Transverse watertight bulkheads may be

- Flat stiffened or,
- Corrugated

Corrugated bulkhead:

Plate is corrugated to achieve the desired stiffness.

Geometry of the corrugation is decided based on required section modulus



Bulkheads

Longitudinal watertight bulkheads are used in oil tankers or bulk liquid cargo carriers

Purpose:

To reduce free surface effect, and sloshing of liquids in partially filled tanks with ship motions

Bulkheads

Non water tight bulkheads

- Partition bulkheads in the accommodation region
- Wash bulkhead in the fore end construction

Openings called lightening holes may be provided to reduce structural weight

Can be of flat stiffened plate or corrugated construction.

Decks

❑ Decks

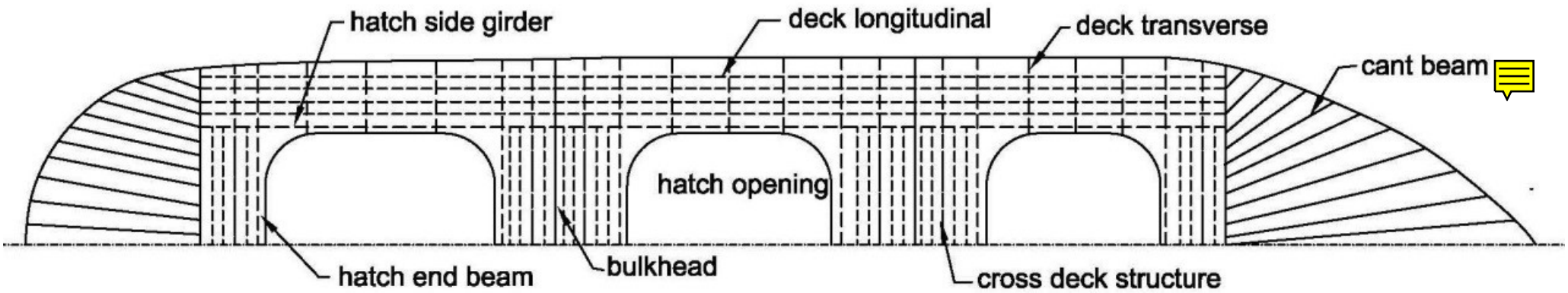
Main deck: The uppermost continuous deck of a ship, also called weather deck as it is exposed to the weather.

Bulkhead deck: The continuous deck to which the transverse subdivision bulkheads extend.

Depending on functional requirement, a ship may not have any lower deck or can have a single lower deck or multiple lower decks.

Bulk carriers, oil tankers, container ships do not have lower deck.
There will be at least one lower deck (tween deck) in general cargo ship.

Decks



Structural arrangement of a deck with hatch opening

Side Shell

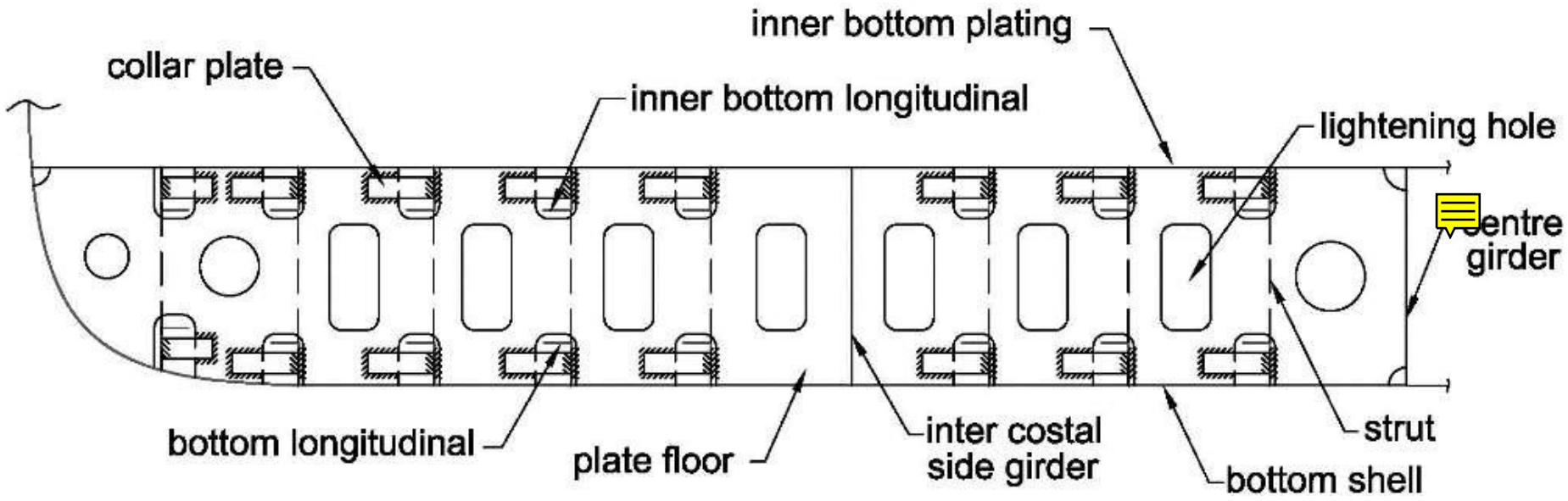
Forms the side boundary of the cargo hold and the engine room.

Depending on the type of cargo as well as structural strength requirement, it may be of single shell construction or cellular, i.e. double wall construction.

Bottom shell

The bottom shell is the bottom most plating of the hull girder. The central plating of the bottom shell plate is the so-called keel plate.

The bottom shell is longitudinally stiffened and the bottom shell longitudinals are supported by the floors in the double bottom.



Inner bottom plating

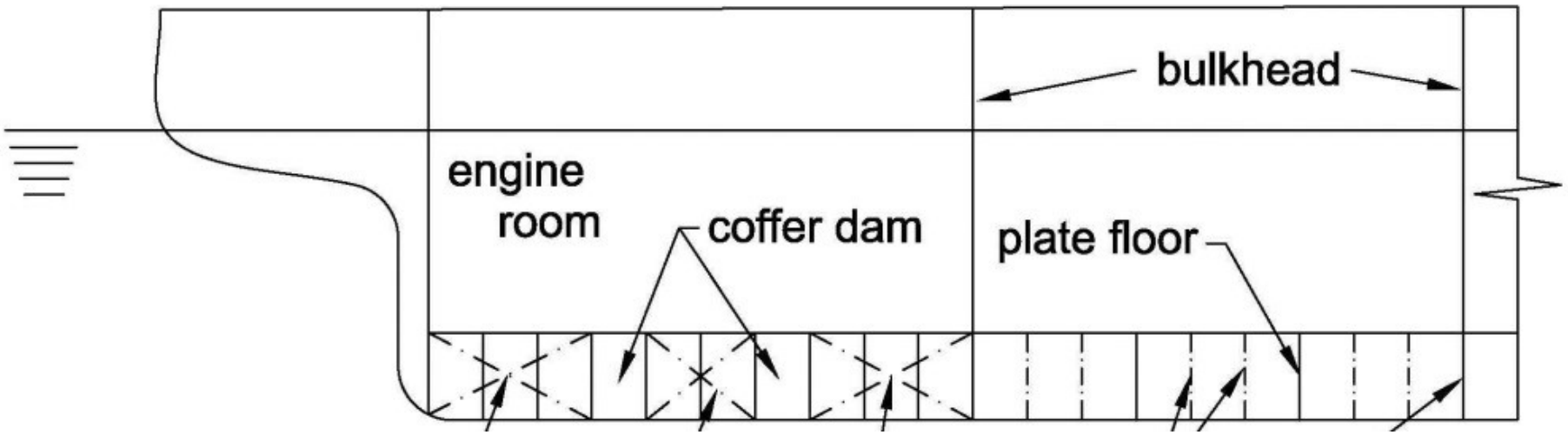
As per Safety of Life at Sea (SOLAS) requirement, all ocean going ships are required to have double bottom, i.e. outer bottom and inner bottom.

Structural Assemblies

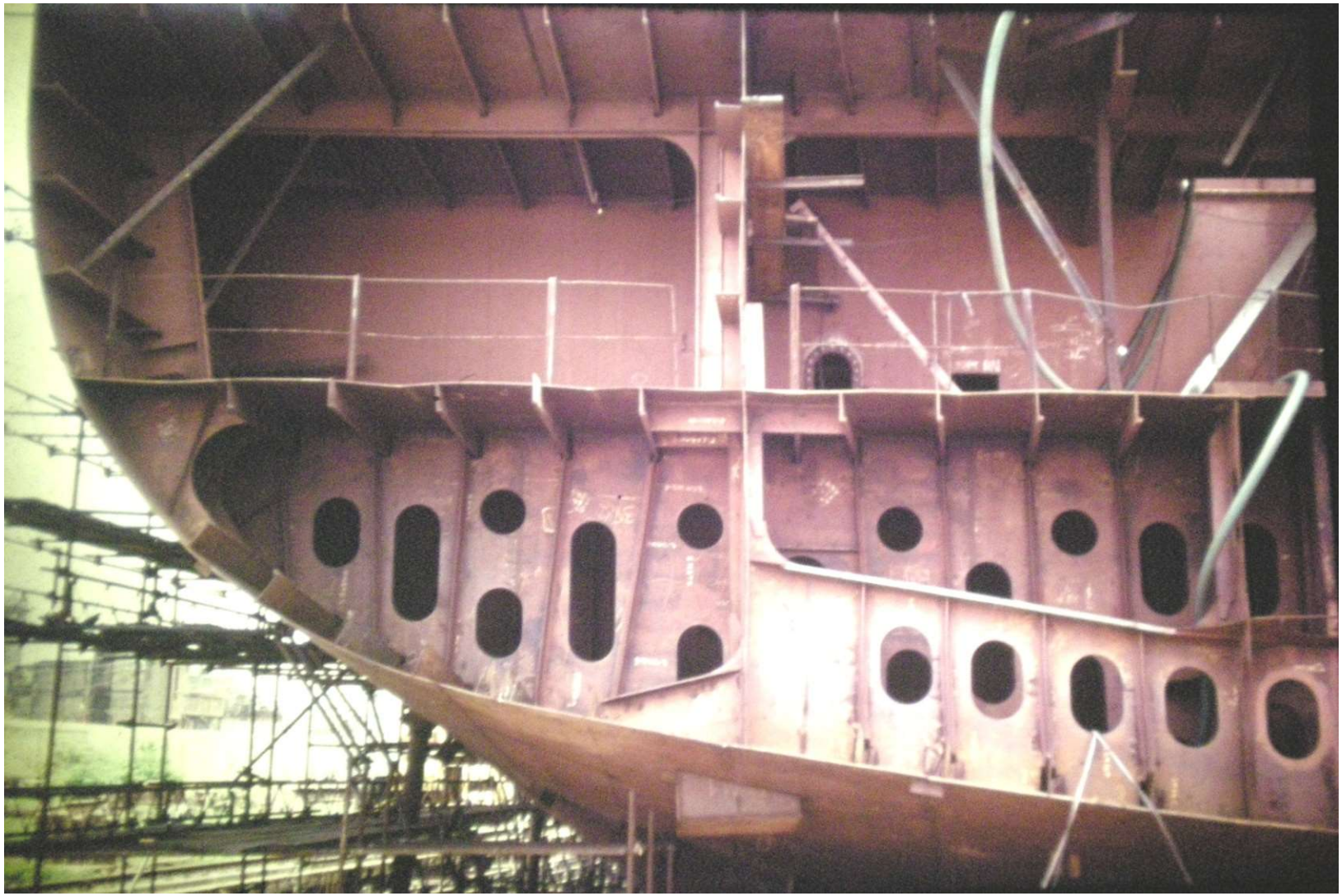
Double Bottom

The double bottom space cannot be used for carrying cargo. It is either empty or used mainly for carrying water ballast.

Longitudinal framing system is in general adopted in the double bottom.



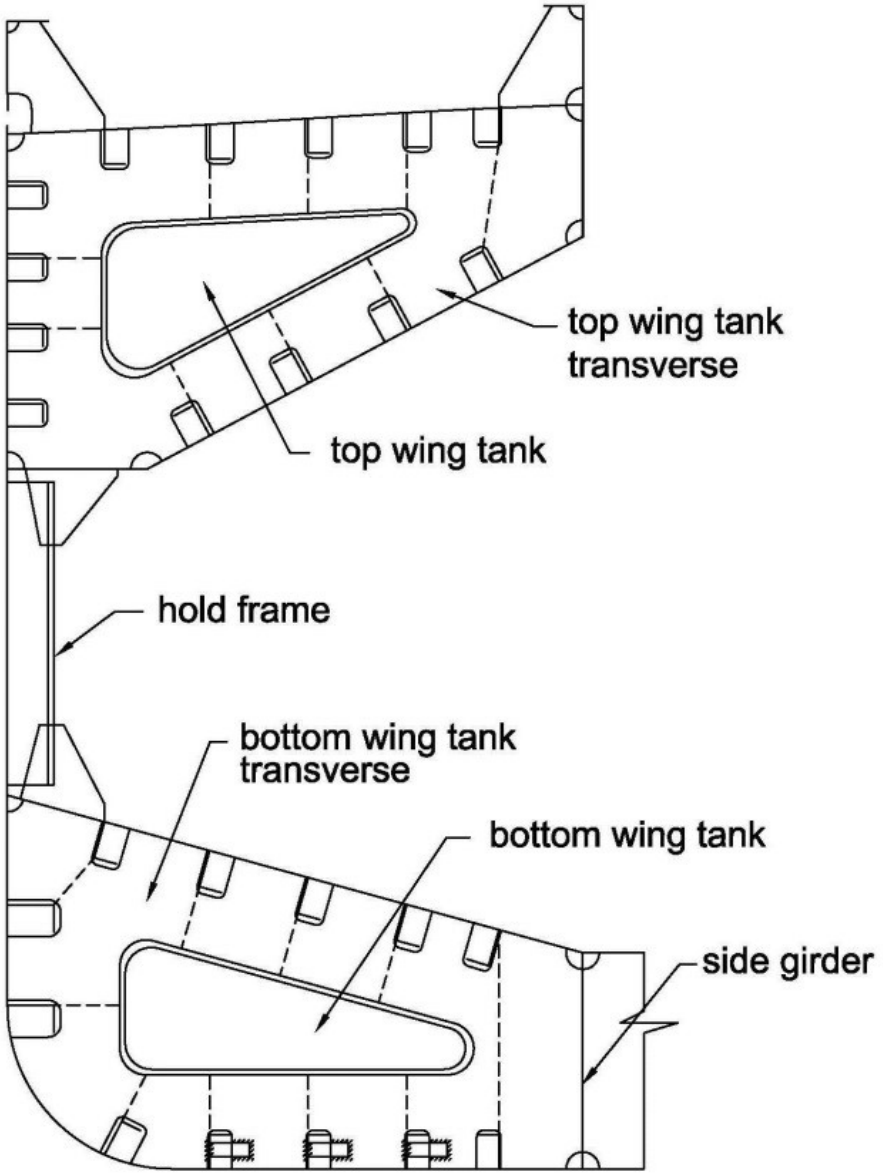
Double Bottom



Wing Tank

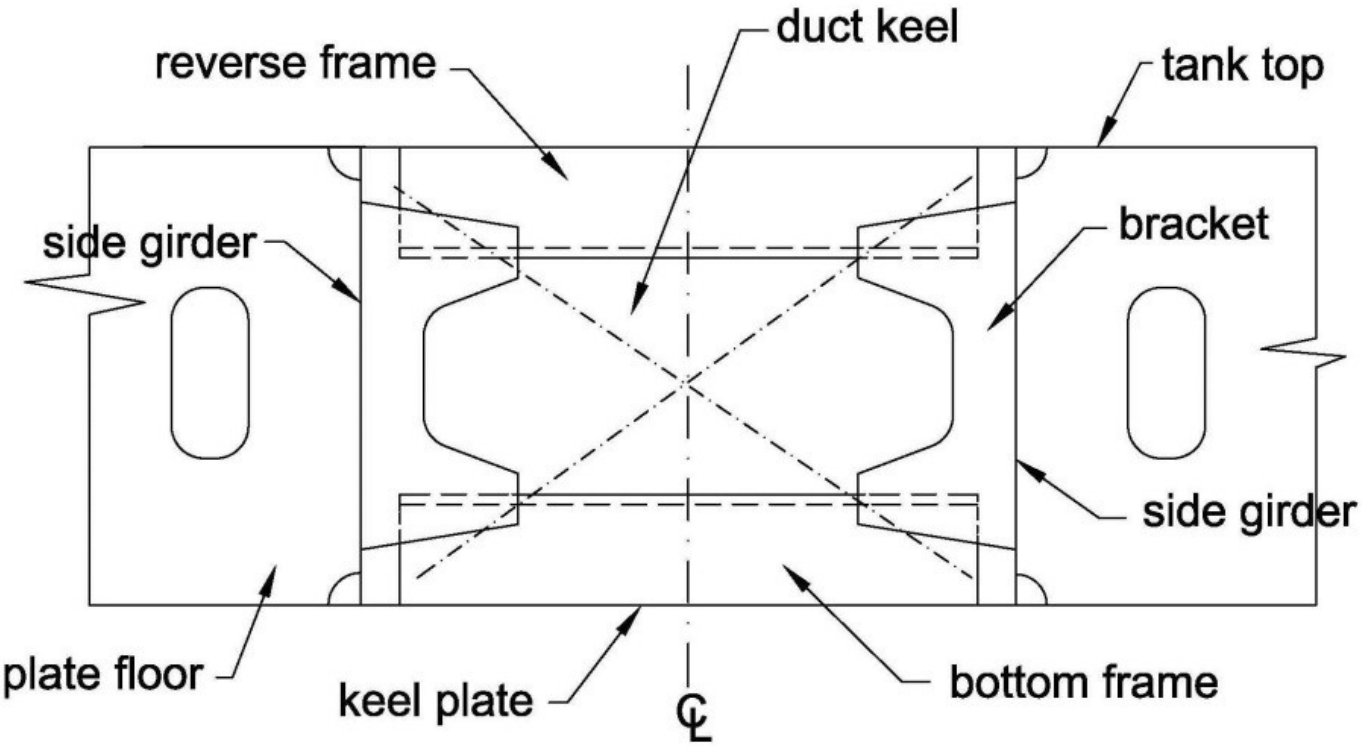
Provided at the top and bottom side of the cargo holds of bulk carrier for cargo stowage and unloading.

They remain empty or are used to carry some liquids like ballast water, fresh water, etc.



Duct Keel

A structural arrangement within the double bottom in which centre girder is replaced by two side girders forming a tunnel along the length of a ship.



Duct Keel

Duct keel has several advantages:

- These two water tight side girders make a protected closed duct
- The duct can be used for laying pipes, electrical cables, etc.
- The maintenance of these pipes and cables becomes easier.
- Any leakage in a pipeline will not contaminate with any other liquid.
- It provides for a stronger support for the ship structure for putting the ship on keel blocks.
- It provides for higher longitudinal strength.

Fore end

Loads to be considered:

- Green water loading on deck
- Local loading on deck due to the heavy anchor windlass
- Slamming load on the side shells due to pitching/heaving motions of the ship
- Forces due to by anchoring operations
- Impact load- accidental head-on collision of fore end structure.

Fore end

Forecastle deck is sometimes provided in ocean-going ships

Purpose:

- To have considerably higher freeboard to prevent shipping in of green waters

- Increased deck area to accommodate anchor windlass or other deck equipment

- A storage space between main deck and forecastle deck for mooring ropes, other deck rigging items, etc.

Fore end

Bow stem:

The upper part of bow stem above design waterline is made up of radiused plate.

At lower parts, a round bar is used and the side shell plates are terminated tangentially on this round bar and welded. This is called stem bar.

Chain locker:

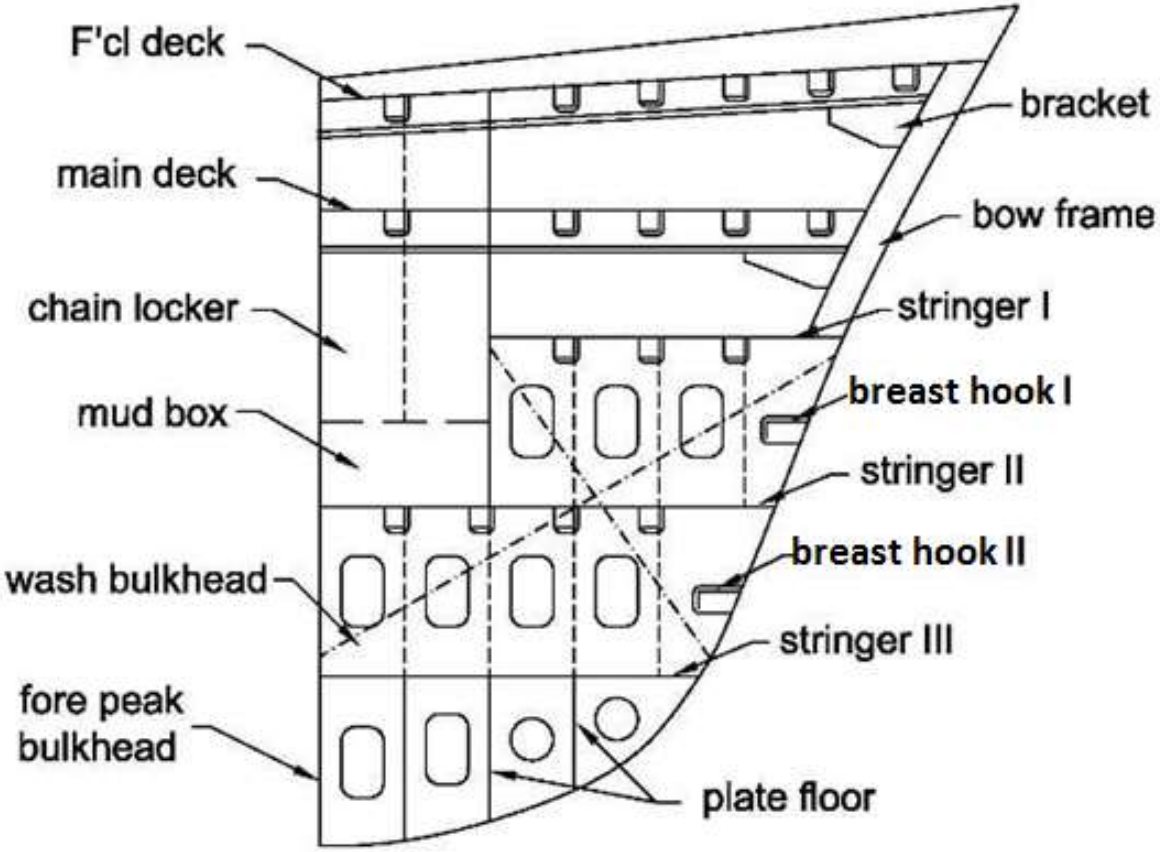
A storing place for the anchor chain cable

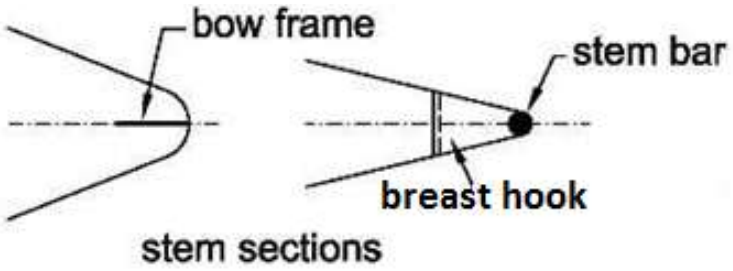
Located forward of the collision bulkhead. The dimensions are decided based on the size and length of the anchor chain cable.

Bulbous bow:

A bulbous bow is an extension of the hull just below the waterline. They can be of various shapes and sizes.

Fore end


F'cl deck
main deck
chain locker
mud box
wash bulkhead
fore peak bulkhead
bracket
bow frame
stringer I
breast hook I
stringer II
breast hook II
stringer III
plate floor


bow frame
stem bar
breast hook
stem sections

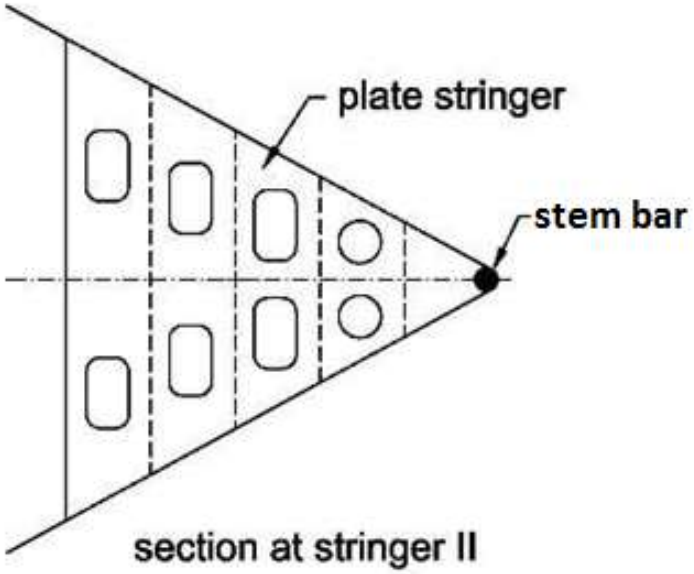


plate stringer
stem bar
section at stringer II

Bulbous bow

A bulbous bow modifies the water flow causing reduction of wave resistance.

The usefulness of a bulb is generally limited to the interval **0.238 ≤ Fn ≤ 0.563**, Fn being the Froude number.

Generally at low speeds the effect of the bulb is negative. With increasing Froude Number, its effect becomes positive and increases up to a maximum value.

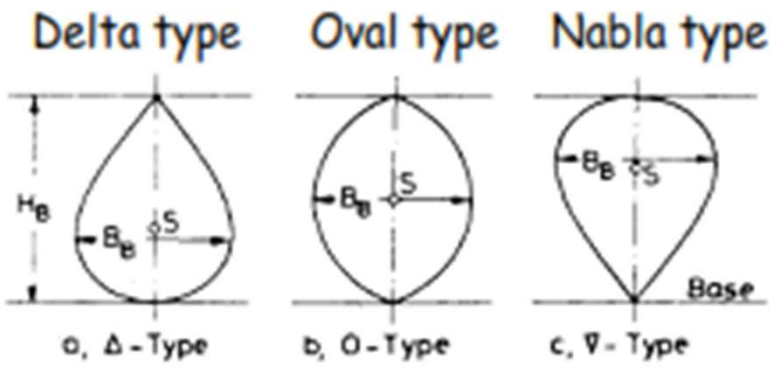
Advantages

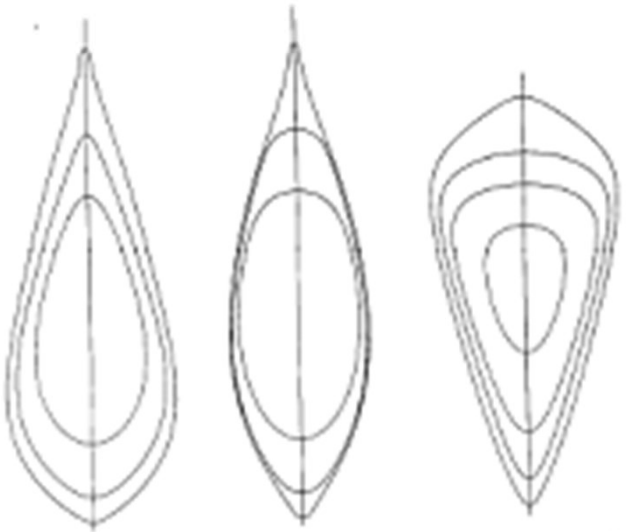
- Reduces the bow wave*
- Acts as a robust bumper in the event of a collision
- Allows installation of bow thrusters at the foremost position, making it more efficient.
- It provides for a larger reserve of flotation or a larger ballast capacity forward
- May reduce pitching of the vessel

Bulbous bow

Bulbous bow with bow thruster

Bulbous bow





- **Addition Bulb**
- **Implicit bulb**

Stern


MIDDLETOWN


SVEND MÆRSK
RIBE
MAERSK
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Cruiser Stern

Cruiser Stern:

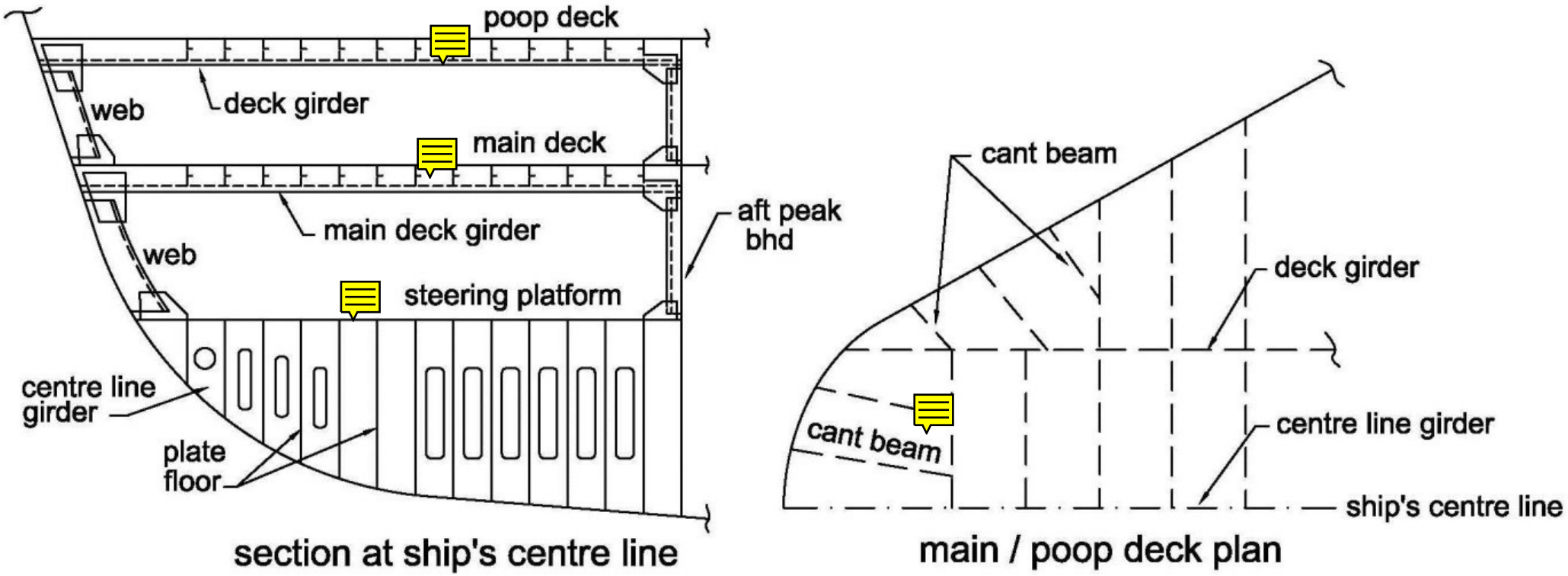
Has an upward curved profile from the after perpendicular to the main deck or poop deck.

Traditionally the most favoured option for ocean going vessels.

Aesthetically more pleasant profile and hydrodynamically efficient.

The overhang makes it vulnerable to slamming forces. It is necessary to have adequate stiffening of the stern section.

Cruiser Stern



Transom Stern

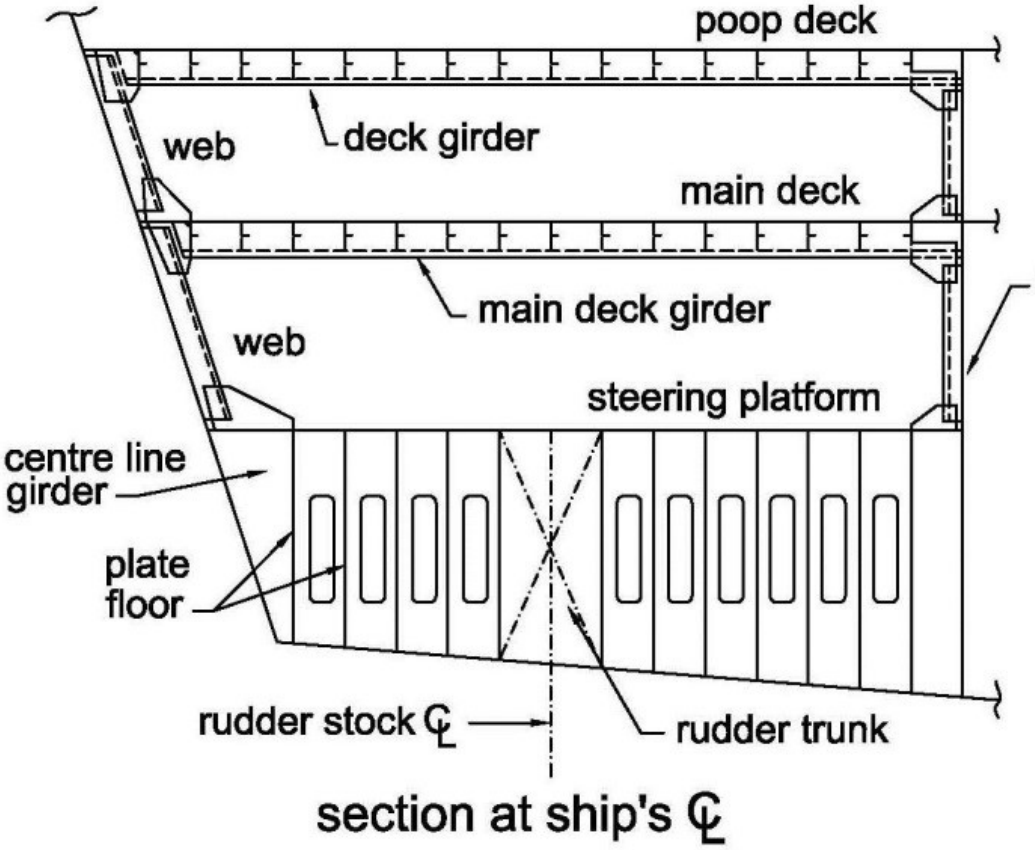
Transom Stern:

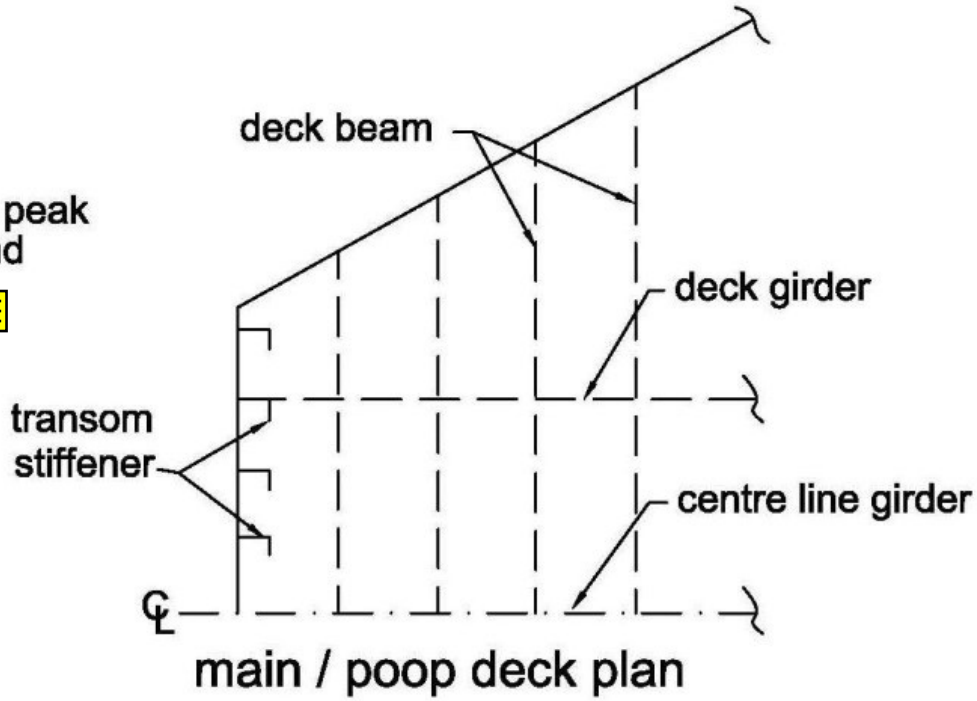
Transom stern is flat, thus it offers the advantage of construction as well as higher deck space.

The transom stern gives the effect of apparent increase in length of water plane providing hydrodynamic advantage.

Cant frames are not required and the transom plate is stiffened by vertical stiffeners

Transom Stern



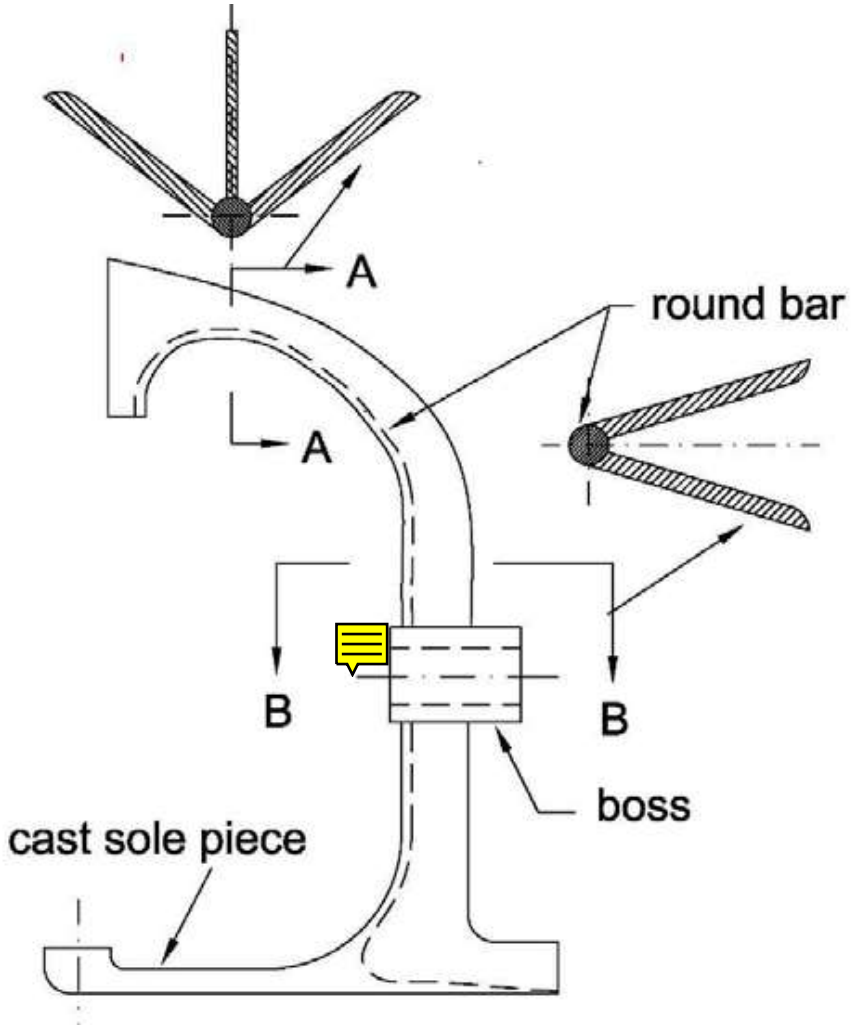


Stern Frame

The shape of the stern frame depends on the type of rudder being used.

The design depends primarily on the requirement of the propeller aperture to house the propeller.

Adequate clearance between the stern frame and the propeller blade tip required propeller excited hull vibration.



Rudder

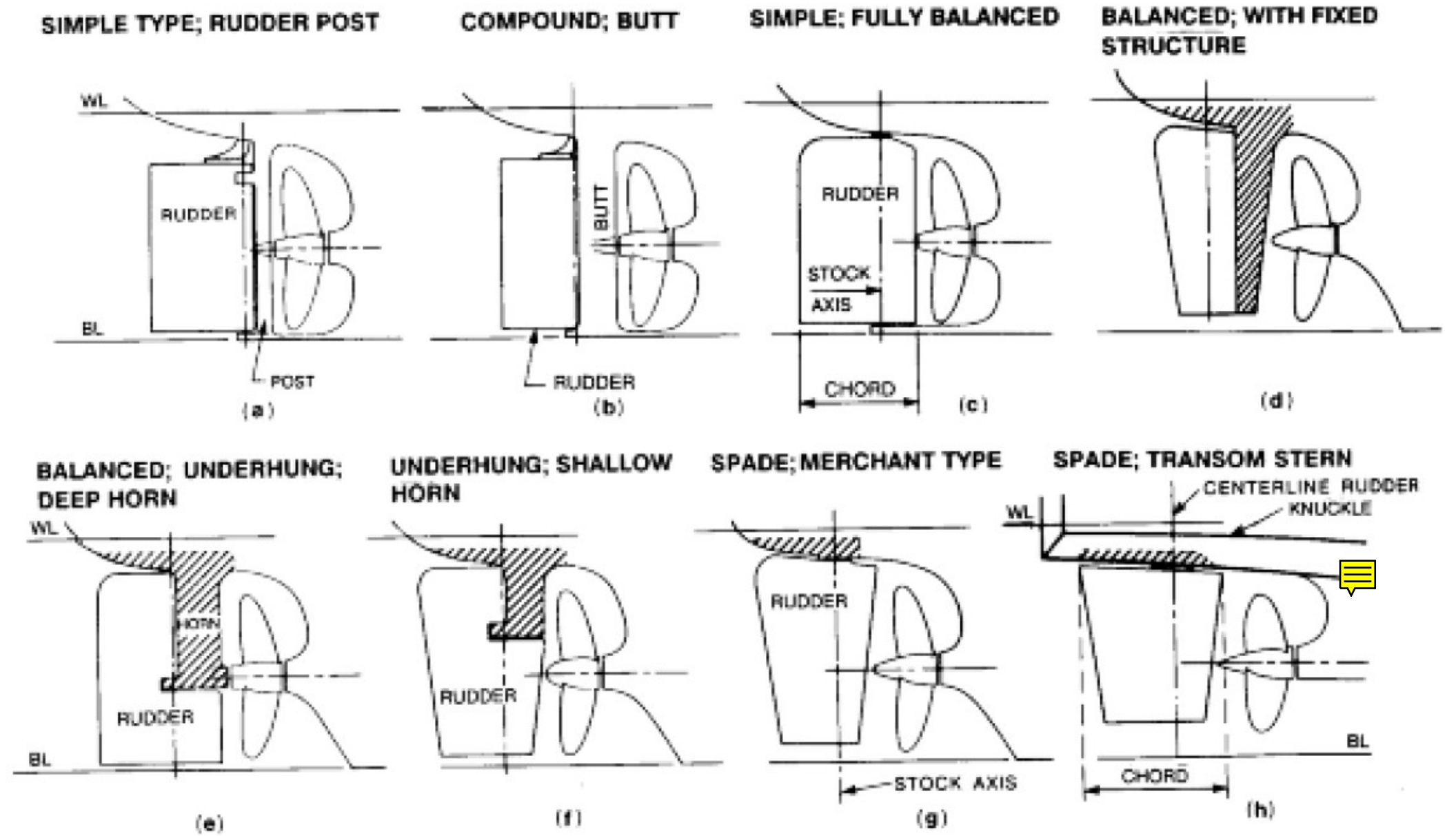
- Rudder is one of the very important items in a ship. It provides the ability to steer the ship to its destination.

- In smaller vessels simple stiffened flat plate rudder is used. In large vessels symmetrical aerofoil section is used.

- The shaft which holds the rudder is called rudder stock. It is made of cast or forged steel. Its design depends on the operational torque and bending moment.

Rudder

Rudder


SIMPLE TYPE; RUDDER POST
WL
RUDDER
BL
POST
(a)
COMPOUND; BUTT
BUTT
RUDDER
(b)
SIMPLE; FULLY BALANCED
RUDDER
STOCK
AXIS
CHORD
(c)
BALANCED; WITH FIXED STRUCTURE
(d)
BALANCED; UNDERHUNG; DEEP HORN
WL
HORN
RUDDER
BL
(e)
UNDERHUNG; SHALLOW HORN
RUDDER
(f)
SPADE; MERCHANT TYPE
RUDDER
STOCK AXIS
(g)
SPADE; TRANSOM STERN
CENTERLINE RUDDER
KNUCKLE
WL
BL
CHORD
(h)

Stern tube & ‘A bracket’

The propeller shaft is taken through a shaft tunnel, in which towards the propeller end the stern tube is located.

‘A brackets’ are used to support overhang of the propeller shaft.