Marine Construction & Welding

NA21003

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Structural Strength Considerations

For Ships

Strength Considerations

Structural design of ships is based on the following strength considerations to withstand the service loads:

- Longitudinal strength.
- Transverse strength.
- Torsional strength.
- Local strength.

Longitudinal Strength

Ocean going vessels : L/B ~ 3 to 6 (slender structure)

Longitudinal strength is of prime importance.

Higher ship length results in higher bending moment

Structural members resisting longitudinal bending contribute towards longitudinal strength.

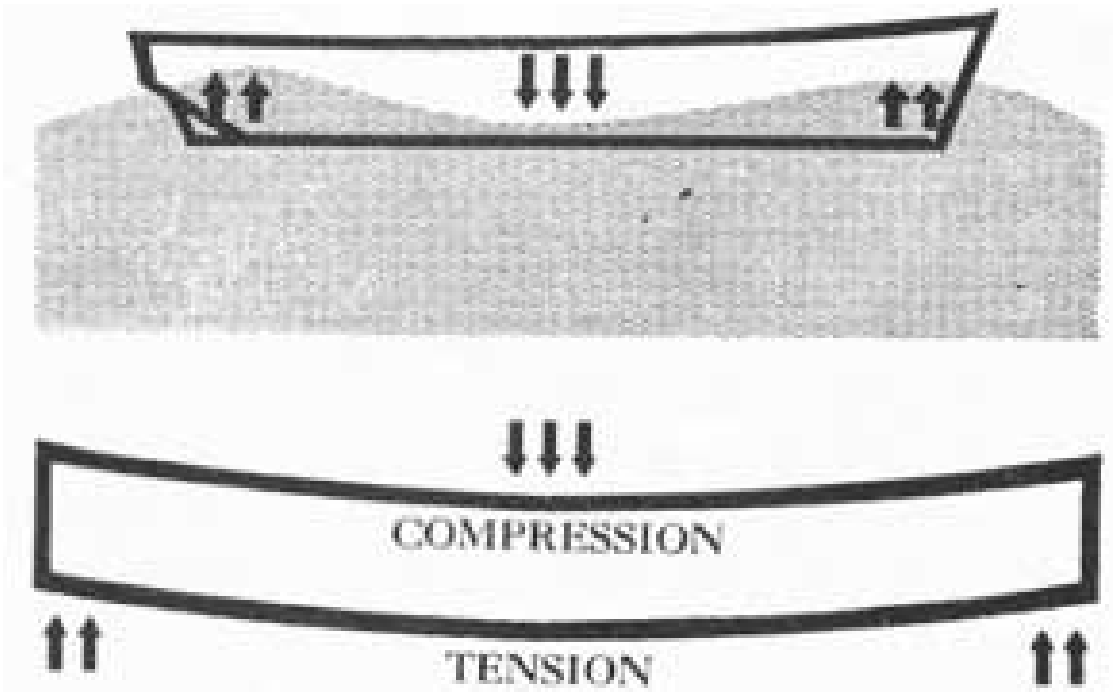
Minimum length to effectively contribute towards longitudinal strength:

15% of the LBP

Longitudinal Strength

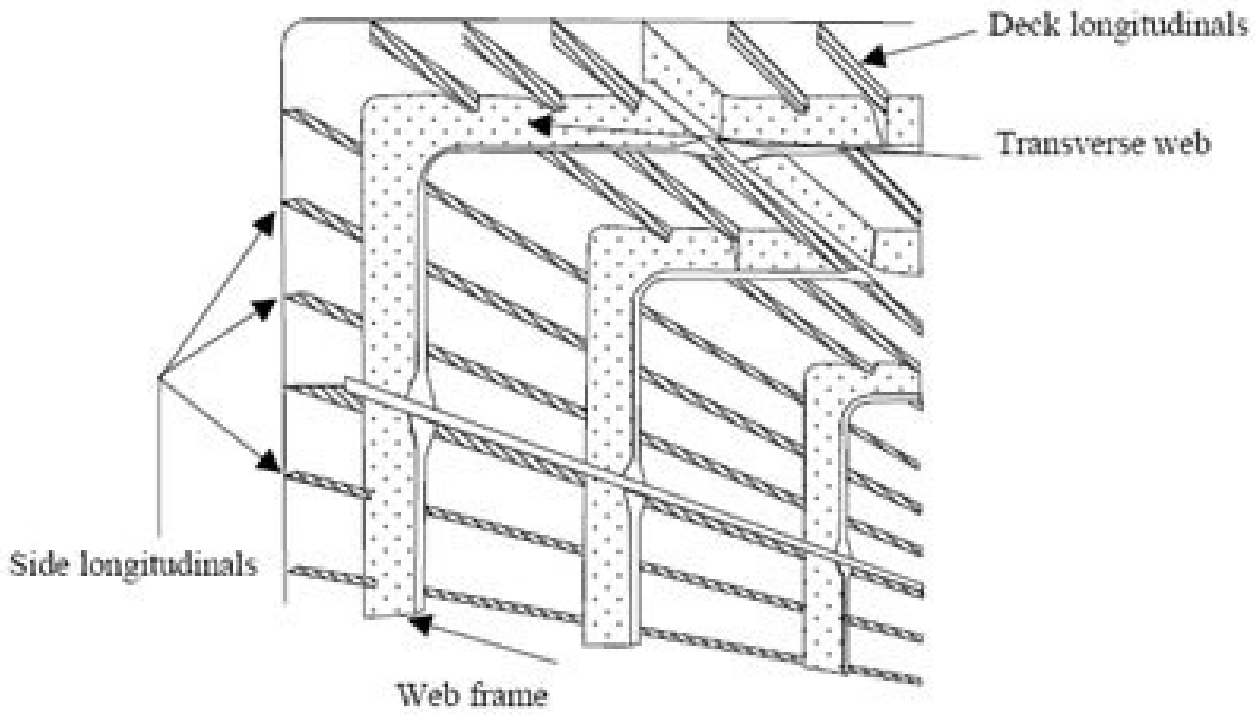
Tensile and Compressive stresses to develop in the hull girder.

Maximum stress on deck and the keel plates as they are farthest from the neutral axis.



Longitudinal Members

- Main deck plate
- Deck longitudinal
- Inner and outer side shell
- Bottom shell
- Bottom shell longitudinal
- Central girder
- Side girder
- Longitudinal bulkhead etc.



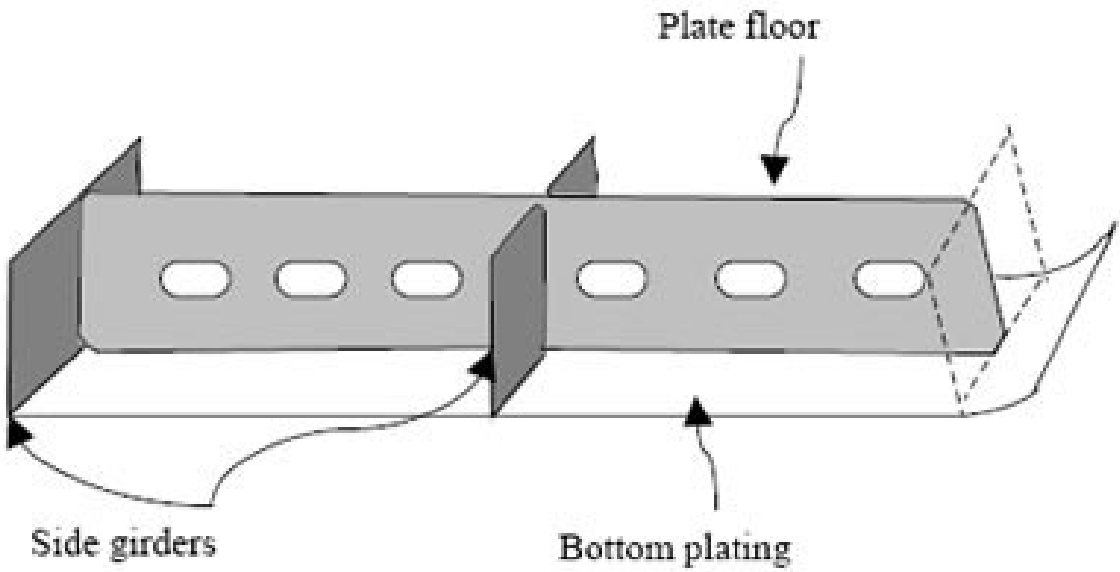
Transverse Strength

Transverse loading on ship hull may arise due to oblique waves

May cause deformation in transverse direction known as ‘Raking’ is transverse strength is not sufficient.

Transverse Members

- Main deck plate
- Deck transverses
- Deck beams
- Continuous lower deck plate
- Lower deck transverses
- Subdivision transverse water tight bulkhead
- Side shell frames and web frames
- Plate Floors and water tight floors



Torsional Strength

In addition to bending, the transverse forces over the hull result in torsional moments.

These moments may be caused by both static or dynamic forces acting on the ship hull.

Torsional Strength

Torsional strength important particularly in the case of **container ships:** Deck openings large in comparison to the breadth of the vessels

Additional torsional strength

- Providing box girder
- Double walled, i.e. cellular construction

Local Strength

Local strength requirement assumes significance in the areas where the hull structure is subjected to localized loading:

- Support bearings of propeller shaft
- Support structure for rudder stock
- Engine room base
- Derrick and crane foundation on the deck
- Forward end structure subjected to slamming load
- Forward most deck plating subjected to load due to shipping in of green waters, etc.

Local Strength

Provide additional stiffening members:

- Stringers in the side shell
- Centre line wash bulkhead in the ford end construction,
- Beams in the forward part of deck plating,
- Plate floors at every frame space in engine room,
- Increased scantlings and additional stiffeners in way of seatings of deck machineries, etc.

Structural Arrangement

Structural arrangement the strength to weight ratio aspect must be kept into mind.

A good design will provide for high strength to weight ratio, e.g. frame spacing should be so chosen that for the required strength the weight of the structure works out to be minimum.

If the functional requirement permits then the framing system should be such which gives better buckling strength.

Structural Arrangement

Structural Arrangement

A ship under construction in a shipyard

Framing System

Stiffened plate panels (prefabricated)

- flat
- curved

Hull structure built as an assembly of stiffened pate panels.

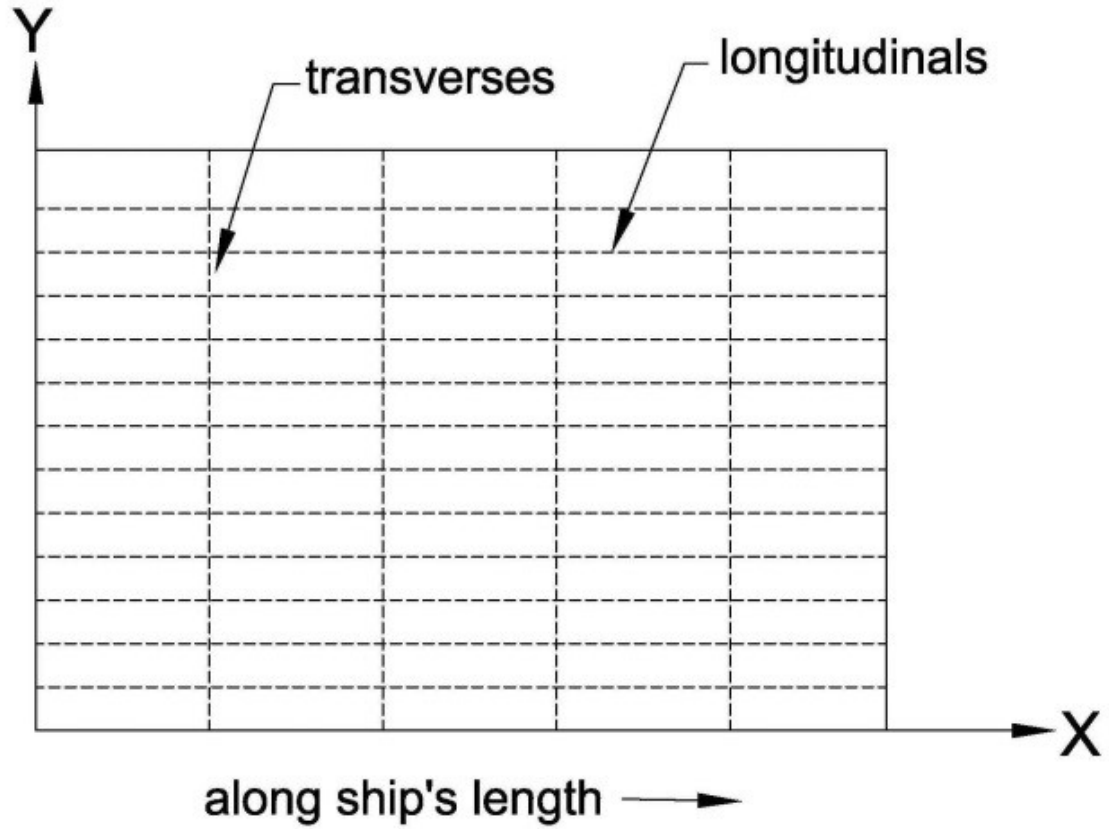
Stiffeners in orthogonal direction (longitudinal and transverse direction)

Longitudinal stiffeners and girders: Along the length of ship

Transverse stiffeners and frames: Perpendicular to the length

Longitudinal Framing System

Longitudinal members often referred to as primary stiffeners are closely spaced and the transverse members (secondary stiffeners) are widely spaced



Longitudinal Framing System

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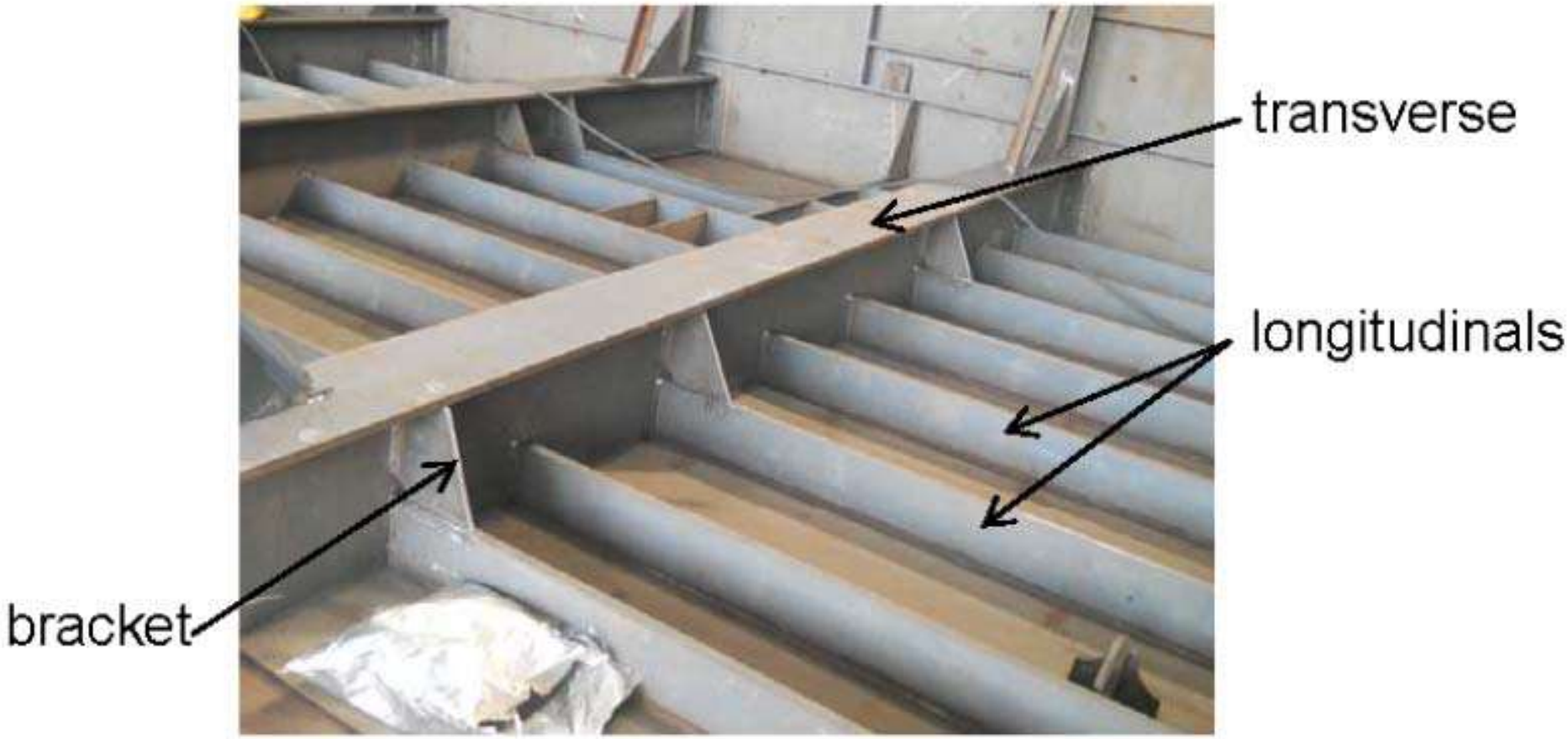
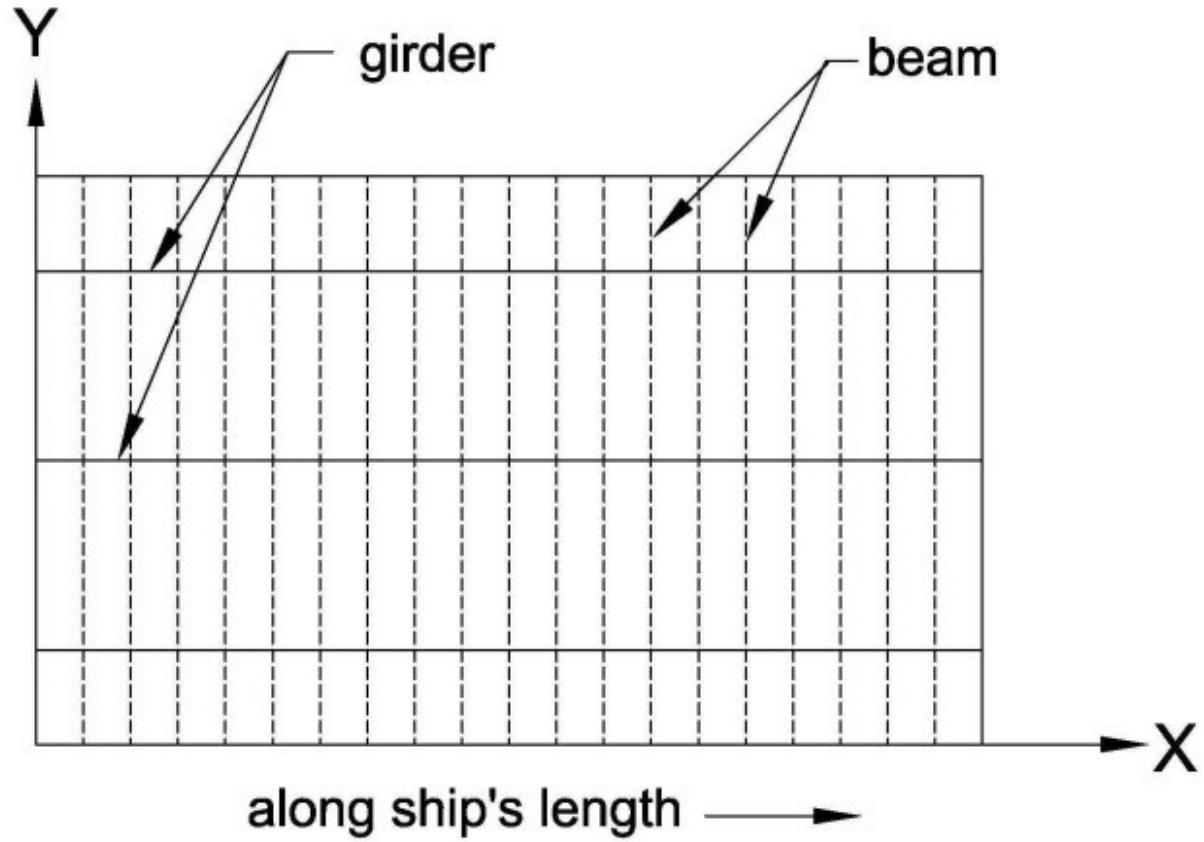


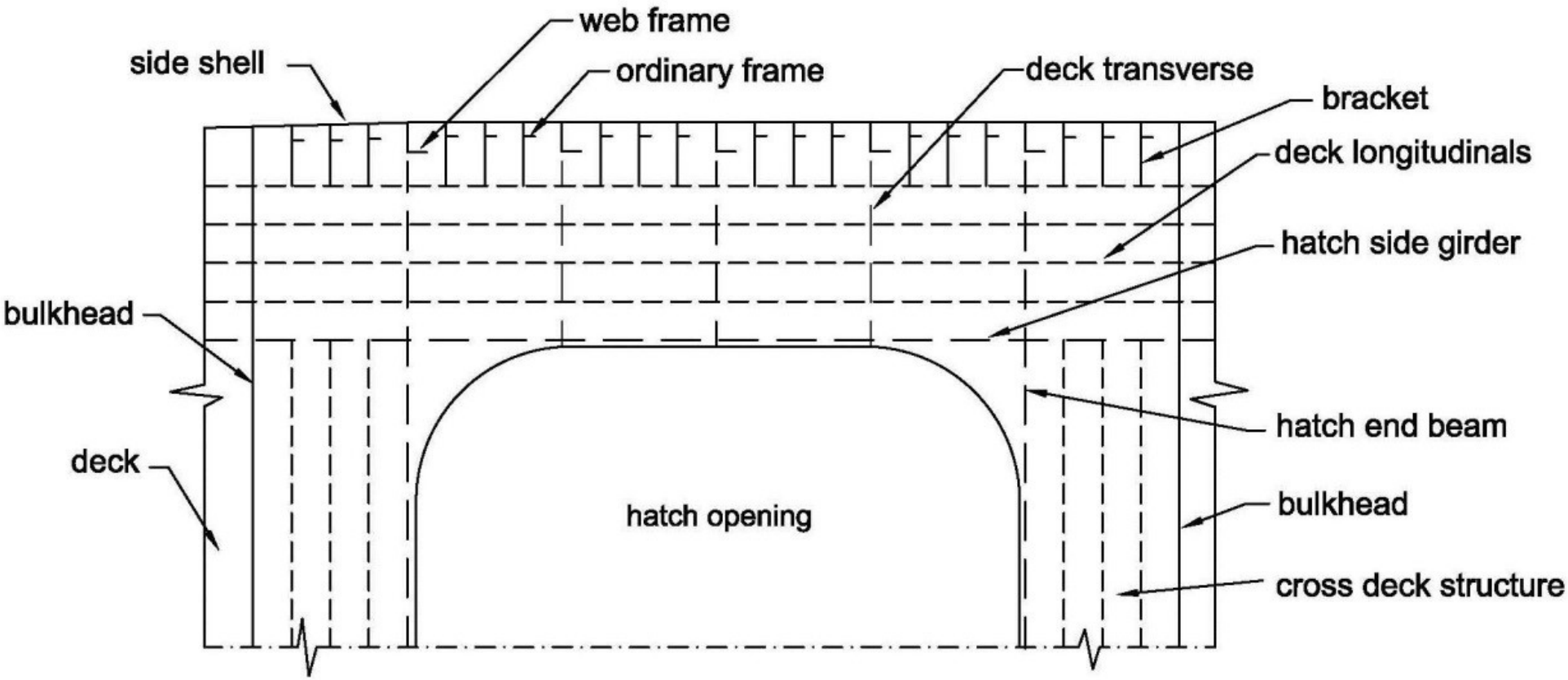
Transverse Framing System

The transverse frames or beams are the primary stiffeners. They are closely spaced with widely spaced longitudinal girders or stringers supporting them



Structural Arrangement

General cargo ship:



Structural Arrangement