



Chapter 9

Basics of Fishing Vessel Design

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1.0 Introduction

The designer prepares the design to meet the requirement of the owner who normally is a fisherman. The vessel designed and built should be economical for the owner. The owner's main requirements are the following.

2.0 Criteria for selection of vessel design

Type of fishing and equipment to be fitted on the deck: One most important criteria to be considered during the initial stages of boat design is the method of fishing to be done using the boat. The fishing method decides the arrangements to be made in the boat. In the case of a stern trawler, the trawl winch will be placed in the aft of the wheel house. The wheel house of a stern trawler is placed in the mid ship on the main deck. The trawl gallows are to be fitted in the aft end of the main deck. The derrick needs to be placed just aft of the wheel house. This arrangement will suit the stern trawling activities. The fish hold is positioned forward of the engine room. This arrangement will balance the weight of the boat. The main engine, winch and other machinery will be placed suitably for meeting these requirements. This general arrangement will vary for a purse seiner or tuna Long liner. A purse seiner will not have the gallows, trawl winch and derrick. Majority of the purse seiners operate the net manually. The net is spread on the forward deck and occupies complete deck space in the forward. Some of the vessels have started fitting a purse winch in the aft of the wheel house. The fish hold position is same as the trawler. The long liner will be

fitted with a main line spooler on the forward deck in the port side and the line setter will be fitted in aft of the deck. The fish hold position remains in the forward. Gallows and derrick are not required for the long liners.

Material: Different materials are used for the construction of fishing vessels. The most popular materials used are steel, wood and fiber glass reinforced plastic. Aluminium, ferro cement and FRP laminated plywood are also used. The selection of material depends on the size of the boat and type of fishing. Small sized beach landing boats are constructed with FRP, wood and plywood whereas larger sized deep sea going purse seiners and trawlers are built in steel. Dimensions of the boat.

Capacity and method of fish storage: The capacity of fish hold and storage method are important in deciding the size of the boat. Vessels with insulated fish hold and freezing facility will have large size. The generators for running the refrigeration systems are to be placed in separate space. This requires additional space.

Speed of vessel: The speed of vessel is an important parameter since this decides the engine power. High horsepower means high expenditure on fuel and the cost operation of the boat will increase. Higher horse power requires higher storage space for fuel.

Endurance, fresh water and ice capacity: For boats with long endurance the storage capacity of fresh water, diesel and ice will be higher. This will increase the size and weight of the boat.

Draft of the vessel: The draft which is the depth of the vessel below water level is an important factor in fixing the dimensions of the boat. Some harbours and lagoons in islands such as Lakshadweep, the water depth available is restricted. The boats to be operated from these places are to be designed with low draft.

Freeboard: The freeboard of long liners and hand liners are to be minimum so that the line fishing can be conducted easily from these boats.

Hull shape: A very important factor which decides the stability, speed, sea kindliness and fuel consumption is the hull geometry. A bulbous bow fitted in the forward portion below the waterline will increase the speed of the vessel. But this has to be designed and constructed properly. The bilge keel fitted just below the water level in the mid ship area reduces the rolling of the boat.

Other facilities such as accommodation, toilet and galley: At present the crew are sleeping in the wheel house of the boat. There is no toilet and galley facility even in the deep sea going fishing vessels. Additional space will have to be provided for accommodation, galley and toilet.

Selection of machinery and equipment: The choice of main engine, reduction gear box, winch, refrigeration system and other items shall be in such a way that spare parts are available locally and the service of the manufacturer or their representative is available locally.

Safety requirements: Necessary fire controlling appliances, life saving appliance and Light and sound signals are to be included in the design of the boat.

Rules and regulations: The rules and registration regulations play an important role in the selection of main dimensions of the boat. For example, the vessels which are having a registered length of 20 meters and above are to be designed in accordance with the rules of classification society and registered with mercantile Department. This will increase the cost of construction of the boat. Moreover the operational expenditure will also increase for such vessels.

3.0 Classification of boat construction

There are two classes of boat construction based on design.

- ▶ Boats built based on the design developed from the experience of carpenters
- ▶ Construction based on standard design procedure

3.1 Boats built based on the design developed from the experience of fabricators:

Existing and proven design of a boat will be picked by the builder. Sometimes they follow the same design or apply minor modifications to meet the requirements of the owner and build a new vessel. The next person will modify this one and end up with a third variety. Like this the fourth and fifth boat will be entirely different from the parent boat. They normally complete the construction and take the trials. After trials if the product is found to be performing well, it is called a successful boat. But this method becomes a very expensive experiment.

Modifying a boat which is already built is a very difficult task and expensive and extra time and efforts will have to be spent. This becomes very dangerous when the stability requirements are not met. There are several occasions when the trial design and constructions ending up as poor performing vessel. The whole investment and time goes as a waste. The modifications become very expensive. For example a boat was constructed with larger breadth. After construction it was realized that the speed is less. This ended in many difficulties such as the vessel reaching the fishing ground late compared to other boats and could not make very good catch. The boat crew was not interested in working on a slow boat. The fuel cost went up. There was nobody to buy this vessel. On another occasion, it was found that an overpowered engine with 400 hp was fitted on a boat designed for 180 hp. The hull structure could not withstand the high vibrations and the hull was broken.

In most of the cases it can be noticed that there are no watertight partitions called bulkheads in a boat constructed in this fashion. Watertight partitions are made mandatory in marine crafts for the safety from flooding. The water generated from melting of the ice can leak to the engine room and lead to high corrosion. The water leak from engine room to the fish storage area can contaminate the fish as this water may contain oil. Hence, it is risky to follow this method.

3.2 Construction based on standard design procedure

The standard design procedure follows a spiral form. The basic steps involved in the design of a fishing boat are the following.

- ▶ Analyse some of the existing boats with the same or similar parameters and arrive at preliminary dimensions and power.
- ▶ Make a preliminary General Arrangement plan to meet the required capacities for diesel, water, fish storage, provision, crew requirements and power.
- ▶ Calculate the total requirement of material, machinery, equipment, etc
- ▶ Calculate the total cost.
- ▶ The preliminary assessment of stability is also to be done.
- ▶ When the requirements of the owner are met for the above cost, the final design will be prepared.
- ▶ Go to the previous stages whenever any of the above requirements is not met. Then carry out the modification and proceed from that step.

4.0 Detailed design

The following steps are to be followed for completing the design of any vessel.

- ▶ Prepare the hull form or the lines plan: This is to arrive at the hull geometry. The plan, side view and sections will be drawn. The detailed view of the boat hull at different sections will be available in this.
- ▶ Calculate the hydrostatic particulars of the vessel: From the above lines plan the displacement, metacentric height, position of center of gravity will be calculated.
- ▶ Make the Bonjean curves. The section areas and moments of hull at different sections will be calculated and plotted. A typical Bonjean curve of a vessel is given in Figure. 1.

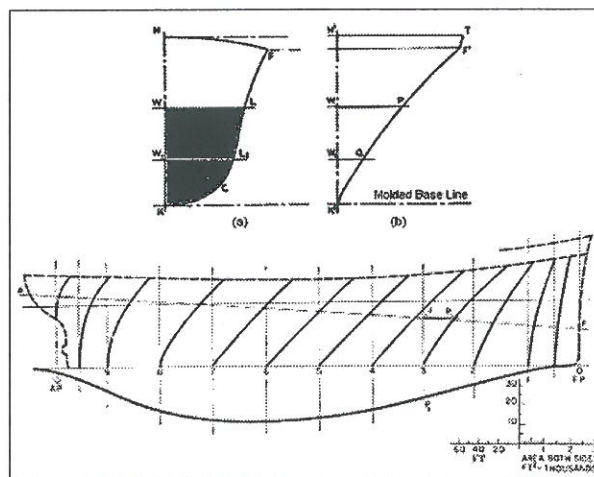


Fig.1 Bonjean curves

- ▶ Calculate the stability at this stage for a check: From the hydrostatic values the initial calculation of stability can be done. Any shortage in stability can be corrected at this stage and the design can be corrected.
- ▶ Make the initial General Arrangement plan: Once the stability and capacity requirements are satisfied the initial general arrangement drawing can be made.
- ▶ Adopt a class rule and calculate the scantlings: In this step, the structural design of the boat will be done. The thickness of the plates and the scantlings of the sections will be finalized.
- ▶ Prepare the Longitudinal structural plan: This plan will give the details of the different structures in the boat. The thickness of the plates at keel, bulkhead, transom and deck will be shown in this. The size of the transverse and longitudinal frames, bulkhead stiffeners and deck can be obtained from this plan.
- ▶ Make the structural plan for all frames: According to this design the frames will be constructed. Each frame is to be designed individually so that the builder can construct all the frames with the help of this design.
- ▶ Calculate the structural weight of the boat.
- ▶ Finalise the power and machinery for the vessel. Based on the resistance and powering calculations the power requirement of the boat can be fixed. The power required for the winch can be either taken from the Power Take Off (PTO) from the main engine or separately from a generator. The hydraulic power required for windlass, winch or steering purpose can be taken from the main engine or from a generator.
- ▶ Design of propulsion system: The diameter and length of the propeller shaft, the diameter and pitch of the propeller and the diameter and thickness of the bush at the ends will be determined.
- ▶ Design of steering system: The area of the rudder, the detailed design of the rudder stock and the bush will be decided in this step.
- ▶ Design the fish hold: Based on the capacity requirement, the fish hold will be designed. The size of the partitions and thickness of the insulating material are to be finalised here.
- ▶ Design of the fish hold: The fish hold with the details of the partitions, stiffeners and the insulating materials are to be given in details in this plan. In the case of refrigerated holds the specification of the refrigeration unit is to be given in detail.
- ▶ Estimate the final weight: At this stage the total weight of the boat can be determined. This will include the weight of the hull, deck, machinery, equipment, insulation, propulsion and steering units and all other items onboard.
- ▶ Finalise the general arrangement plan. Such a plan is given in Fig. 2.
- ▶ Modify the design incorporating changes in the structural plan, for any stability problem: The preliminary stability can be ascertained at this stage.

- Make the final design with detailed construction plan of each joint of the hull and deck of the boat.

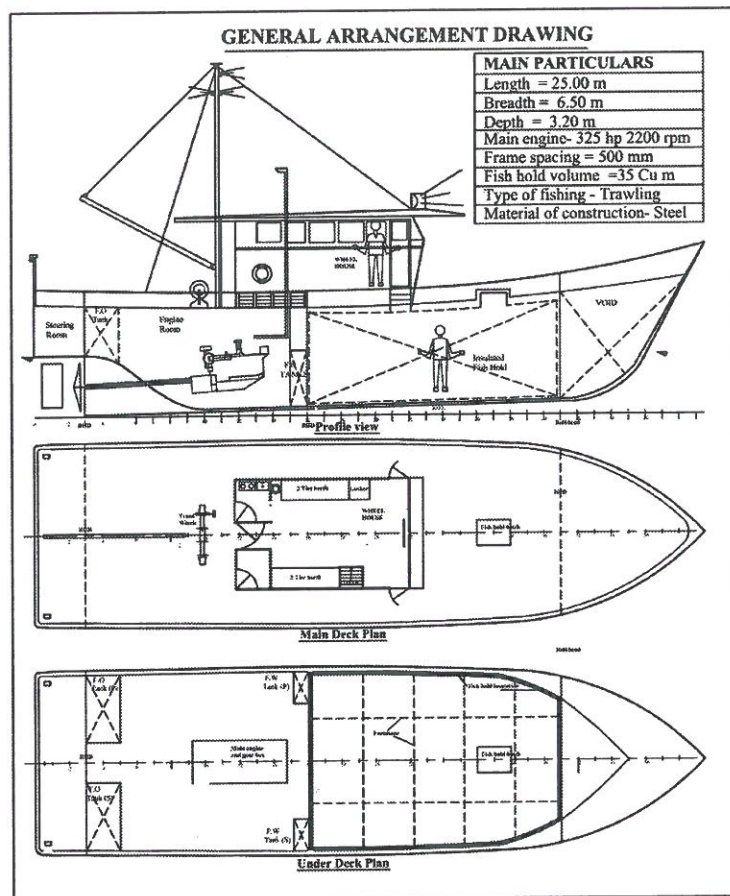


Fig.2 . General Arrangement drawing of a Trawler

During construction, proper care has to be given for the joints. This aspect is very important in keeping the water tightness of the boat. For wooden constructions, only well-seasoned wood without any sap wood shall be used. In the case of steel boats, only marine plates shall be used for the construction. The fiberglass boat is constructed in a continuous process and the hull is made in a single mould or two parts. These parts of the boat hull are joined water tightly. During the design stage sufficient care has to be given for the design of the joints. The type of welding, length of weld and the quality of the welding rod are to be specified during the design in the steel boat construction. The wooden joints are to be with sufficient strength and tightness. In the case of FRP boats sufficient overlapping of the glass mat is to be provided, especially in the keel and deck joints.

5.0 Construction and supervision

The construction of the vessel is to be supervised and monitored by a qualified person so

that strict adherence to the design requirements can be ensured. The utilization of space in a vessel is very important. Since every small space available in the boat is to be utilized economically so that owner is benefited by that.

6.0 Quality of materials and machinery

The quality of raw materials, welding rod, fiber glass, resin, wood, machines, pumps, winch and other items can be ensured with the help of the selection by an experienced person and installation under the guidance of this person. This will help in the proper and economical maintenance of the boat.

The detailed structural design will be based on the scantling rules by any of the International Association of Classification Societies. The Classification rules specify the mechanical properties of the steel plates and sections to be used for marine crafts. Indian Register of Shipping (IRS) is such an Indian agency. During construction there can be again some minor modifications or compromises within the limit of the rules to suit the availability of plates, sections, machinery and equipment.

7.0 Stability of boats

After the construction, the inclining experiment will be conducted in calm water in a protected area of the port. This test will give the position of the center of gravity of the vessel. The stability of the vessel can be calculated with the help of hydrostatic particulars and righting lever at different loading conditions. The calculation of stability and preparation of trim and stability booklet is important for all sea going fishing vessels.

8.0 Conclusion

The design of a boat requires careful consideration of input parameters so that the output will be a good boat. The systematic approach with the help of calculations will result in a stable vessel with fuel efficiency.

9.0 Further reading

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