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DESIGN OF 30,000 DWT AND 53,000 DWT BULK CARRIERS USING ADVANCED COMPUTER DESIGN SOFTWARES

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Abstract

The design of a bulk carrier ship hull is done either by using B.S.R.A results or Taylor s series by conventional methods which may results in some inaccuracies in the design. Two bulk carriers of 30,000 DWT and 53,000 DWT are designed using the computer aided design software and the results are shown the ship is designed using the modern computer design application software like Napa, Tribon and catia.

***Keywords**:* DWT, ComputerDesign, ship, Bulk Carrier.

Introduction

A bulk carrier, bulk freighter, or bulker is a merchant ship specially designed to transport unpackaged bulk cargo, such as grains, coal, ore, and cement in its cargo holds. Today, bulkers make up 40% of the world's merchant fleets and range in size from single-hold mini-bulkers to mammoth ore ships able to carry 400,000 metric tons of deadweight (DWT). Korea is the largest single builder of bulkers, and 82% of these ships were built in Asia. Bulkers are introduced to overcome the difficulties and special requirements of cargo experienced while carrying bulk material in general cargo ships, secondly the quantities are increased with time Bulk carriers make up 15% to 17% of the worlds merchant fleet used to carry material in bulks around the world. The hull of the ship is considered as the prime importance which was carried out from predetermined graphs and results like B.S.R.A results and Tylor series. Sometimes the designs end up with the inaccurate performance. Two bulk carriers 30,000 DWT and 50,000 DWT are designed using the conventional method by deriving the data from the existing ships and they are redrawn manually. This process in carried out at Hindustan shipyard limited(HSL) and Andhra university Marine engineering department .The design of the ships are made in two phases first by the conventional method and second by computer design software like NAPA,TRIBON,CATIA and AUTOCAD.

Fixing the Main Dimensions of the Ship

The main dimensions of the ship influence many of the ships characteristics such as stability, hold capacity, power requirements and its economic efficiency. So, they should be coordinated such that the ship satisfies the design conditions as well as the characteristics desired by the shipping companies with various combinations of dimensions. The economic factor is of prime importance in designing a ship. An owner requires a ship, which will give him the best possible returns for his initial investment and running costs. This means that the final design should be arrived at taking into account not only the present economic considerations, but also those likely to develop within the entire life of the ship. Basic design includes selection of ship dimensions, hull form, amount of power and type of engine, preliminary arrangement of hull and machinery, and major structural arrangement. Proper selections assure the attainment of the mission requirements such as cargo carrying capacity and dead weight. It includes checks and modifications for achievement of required cargo capacity, subdivision and stability standards, free board and tonnage measurement.

For the optimization of dimensions for economic efficiency, at the same time meeting the owners requirements I have adopted the following procedure. I would have taken the parent ship having the specified deadweight and speed. But to have an idea of dimensions for optimization I referred ‘Register of Ships’ compiled by classification society (LRS), which gives the particulars of ship’s built under their survey. These particulars include name of the ship, its year and place of built, LOA, LBP, B, D, T, Speed, Deadweight, NRT, GRT, number of holds, super structure details, main engine details etc.

s.no	*Principle Dimension*	*30.000 Dwt ship*	*53,000 Dwt ship*
1.	Length between perpendiculars (LBP)	166.83 m	206 m
2.	Moulded Breadth	26 m	30 m
3.	Moulded Depth	14.86 m	17.7 m
4.	Moulded Draught	11.37 m	13.1 m
5.	Block Coefficient (C_b)	0.81	0.82
6.	Midshipsection coefficient(C_M)	0.99	0.99
7.	Waterplane Area Coefficient(C_w)	0.88	0.89
8.	Longitudinal prismatic coefficient(C_{pl})	0.81	0.83
9.	Vertical Prismatic Coefficient (C_{pv})	0.92	0.92
10.	Displacement at Moulded draft	42040.5	67938.5
11.	Speed	14 knots	15 knots

Freeboard Calculations

Freeboard may be broadly defined as the height that the sides of a floating vessel project above the water. The maximum waterline to which a ship can be loaded is governed by the Plimsoll mark, which is permanently marked on the vessel's sides at midships. The freeboard deck means the uppermost complete deck having permanent means of closing all openings in that deck..The ships with very small openings are known as type "A" ships and with very large openings are known as type "B" ships. Bulk carriers will have large openings come under type B ships and the

s.no	*Ship type*	*Freeboard Height*
1.	30,000 type B ship	3.25 m
2	53,000 type B ship	4.62 m

Finalization of hull form using B.S.R A results

While designing the ships, we should know about the main dimensions- length, breadth, depth, draught, block coefficient and the longitudinal position of centre of buoyancy. The lines have influence on the following characteristics:

1. Resistance increase in seaway
2. Manoeuvrability
3. Course- keeping ability
4. Roll damping
5. Sea-keeping ability
6. Size of under deck volume

There are several methods used for designing the hull form like Taylor's series and B.S.R.A results which are a set of graphs which define the structure of the ship at different stations. The main parameters such as dimensions - length, breadth, draught, are to be arrived at coefficients of form and the longitudinal position of centre of buoyancy. The geometry of ship has influence on the following characteristics so the design of the hull is derived from the B.S.R.A Results. Length between Perpendiculars is divided into 10 equal parts with ordinate stations. More stations are taken at the ends to define the curvature of a ship more accurately. The sectional area up to moulded draft can be dr4awn by taking the sectional areas on Y-axis and ordinate stations on X-axis. The ordinates for sectional area curve are given as the ratio of sectional area to midship section at various stations from ordinates Sectional areas are calculated More stations are taken at the ends to define the curvature of a ship more accurately. The sectional axis. The ordinates for sectional area curve are given as the ratio of sectional area to midship section at various stations from ordinates lifted from B.S.R.A. results at the C_B 0.81 and 0.82of the ship under design

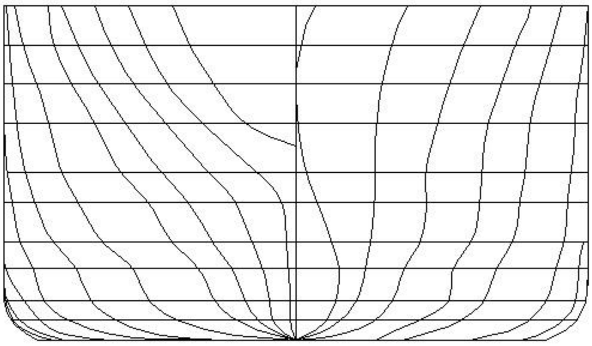
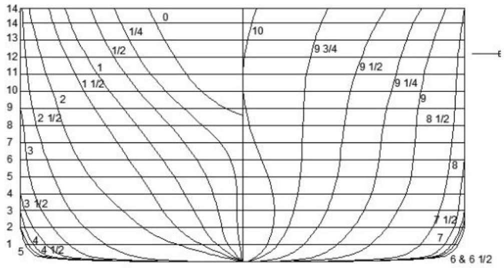


Fig1 showing the body plan of 30,000 and 53,000 DWT drawn from B.S.R.A Results

The above body plan is inaccurate as it observed which may cause résistance increase in the seaway, maneuverability, course keeping capability, roll damping and hydrostatic characteristics. In order to overcome these problems the above drawing points were transferred to TRIBON or NAPA and the results in the shapes are as follows



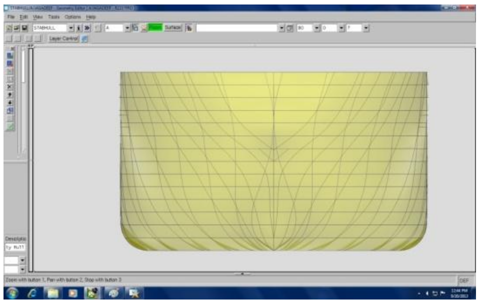


Fig 2 the Body plan of the 30,000 and 53,000 DWT after fairing in TRIBON/NAPA

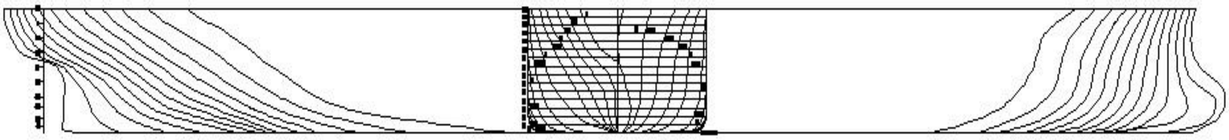


Fig 3 Sheer plan of the ship Hull

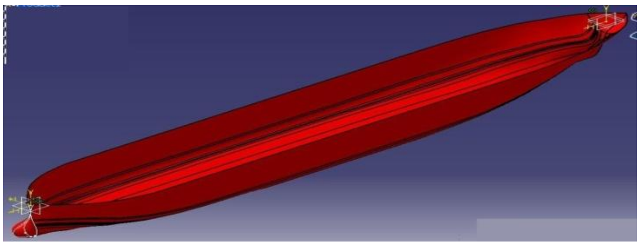
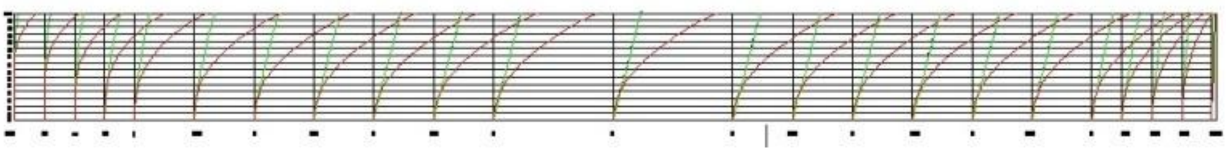


Fig 4 Hull Form of the Ship after generating the surface

Sectional Areas and Vertical Moments

The cross-sectional area of each ordinate station shown in the body plan up to the waterline in question is determined which is input into the calculation of the volume of displacement; this set of curves is known as the *Bonjean curves*. A typical plot of the Bonjean curves is shown in Figure. When plotted against ship length, the immersed areas at the ordinate stations form a *sectional area curve*, whose shape represents the "fullness" or "fineness" of the ship form, an important consideration in ship resistance and powering. To find out the volume of the displacement and LCB at a trimmed water line at which the ship is floating due to distribution of cargo or when the ship is floating on even keel In sub division of ships from the safety point of view so that when the ship is flooded due to accident or damaged the ship will not sink beyond the margin line. In strength calculations to find out the buoyancy when the ship is floating in waves.In launching calculations.



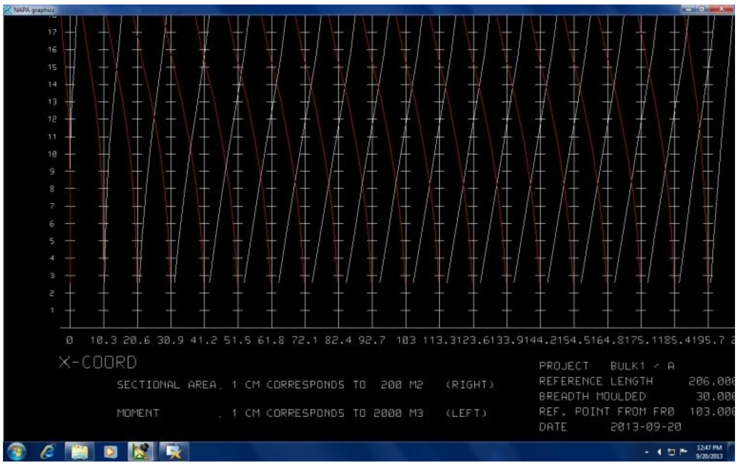


Fig 5 Sectional area curves obtained from Tribon

Hydrostatic characteristics of ships

Throughout the life a ship changes its weight and disposition of cargo, its draft, trim and freeboard. The density of water in which ship floats varies. Ship's stability also changes. It its condition at any stated set of circumstances to be estimated, its condition in a precise state must be known so that the effect of changes from that state can be calculated. This precise condition is known as the design condition. For this, changes from the design and properties of underwater form are calculated for a complete range of water lines. This information is known as hydrostatic data and are plotted against drafts. Drafts are spaced equally generally one meter apart. These curves are shown on displacement sheet. The following properties are plotted against draft to form hydrostatic curves.

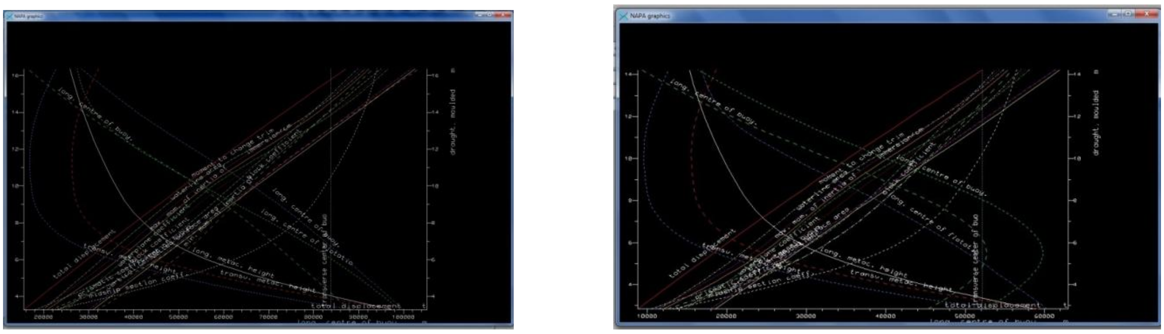


Fig 6 Hydrostatic curves of 30,000 and 53,00 Dwt Bulk Carriers

Resistance calculations

The total resistance coefficient When a ship is moving with velocity V, the effect of this forward motion is to generate dynamic pressures on the hull which modify the original normal static pressure and if the forces arising from this modified pressure system resolved in the force and aft direction there is a resultant which opposes the motion of the ship through the water. If the forces are resolved in the transverse direction the resultant is zero because of symmetry of the ship form.When the ship is in motion, another set of forces also influence the motion of the ship. Generally all fluids possess to a great extent the property known as viscosity and therefore when a surface such as the immersed surface of the ship moves thorough the water, tangential forces are generated which when summed up produce a resultant opposing the motion of the ship. The two sets of forces both normal and tangential produce resultants, which act in a direction opposite to the motion of the ship. This total force is the resistance of the ship. The ship is actually moving in two fluid medium with different densities. While the lower part of the hull is moving in water and the upper part is moving through air. Due to air also some resistance occurs and this type of resistance is dependent only on velocity of air. However the total resistance of the ship is split into frictional resistance and residuary resistance, appendage resistance and air resistance. Frictional resistance contributes 80% to 85% of the total. In the following resistance calculations are made on the basis of Guldhammer and Harvard method.

The total resistance coefficient of the ship

$$C_T = \frac{R_T}{\frac{1}{2}\rho S V^2}$$

no	*Resistance coefficients*	*30,000 DWT*	*53000 DWT*
1	Frictional resistance coefficient C_F	1.45	1.42
2	Residual resistance coefficient C_R	0.722	0.790
3	Incremental resistance coefficient C_A	0.040	0.040
4	Air resistance coefficient	0.070	0.070
5	Steering Resistance coefficient (C_{AS})	0.040	0.40
6	$C_T = C_F + C_R + C_A$	2.65 $*10^{-3}$	2.31 $*10^{-3}$

Propeller Design

A ship experiences resisting forces from the water and air which must be overcome by a force called thrust. The thrust is supplied by some thrust-producing-mechanism. The earlier thrust producing mechanisms were oars (manual power), sails (wind power), jet pumps, paddle wheels and latest modern mechanism is propeller. This process is known as propulsion. The thrust is produced by rotation of the propeller, which in turn activates the surrounding water. The rotation of the propeller is achieved earlier by steam engines or presently i.e. Engines, Diesel electric drive, turbines or nuclear power. Internal combustion engines are presently used for propulsion of the merchant navy. In selecting propelling machinery for a given vessel, many factors must be taken into consideration, such as the weight, the space occupies, cost, reliability, flexibility and cost of fuel consumed etc. For selecting the main propulsive engine, power required is calculated as below from effective power arrived at from resistance calculations. (Guldhammer and Harvald method)

no	*Resistance coefficients*	*30,000 DWT*	*53000 DWT*
1	DIAMETER D_P	6.46 m	7.99 m
2	PITCH (P)	4.79 m	5.96 m
3	BLADE AREA RATIO (B.A.R)	$= \frac{\Pi}{4} D_P^2 = \frac{\Pi}{4}\ 6.46\ ^2 = 32.77$	$= \frac{\Pi}{4} D_P^2 = \frac{\Pi}{4}\ 7.99\ ^2 = 50.14\ m^2$
4	DISC AREA A_0	$= B.A.R \times A_0 = 0.40 \times 32.77$	$= B.A.R \times A_0 = 0.48 \times 50.14$
5	EXPANDED BLADE AREA	13.11	18.2
6	PROPELLER R.P.M. (N)	99 rev / min	82 rev / min
7	NUMBER OF BLADES	4	4

General Arrangement

The General arrangement of a ship can be defined as the assignment of spaces for all required functions and equipment, properly coordinated for location and access. The general arrangement represents a summary and integration of information from other divisions and specialties in ship design, intended to provide for all the necessary functions of the ship in the most efficient and economical way.

The efficient operation of a ship depends on the proper arrangement of each separate spaces and provision of effective inter relationships between these spaces. General arrangement must be functionally and economically developed with respect to factors that affect construction and operation costs especially the manpower required to run the ship.

The first step in solving the general arrangement problems of a cargo ship is locating the main spaces and their boundaries within the ship hull and superstructure.

These spaces are:

1. Cargo spaces
2. Machinery spaces.
3. Crew, passenger and associated spaces.
4. Tanks (Double bottom fore peak, after peak etc)
5. Miscellaneous

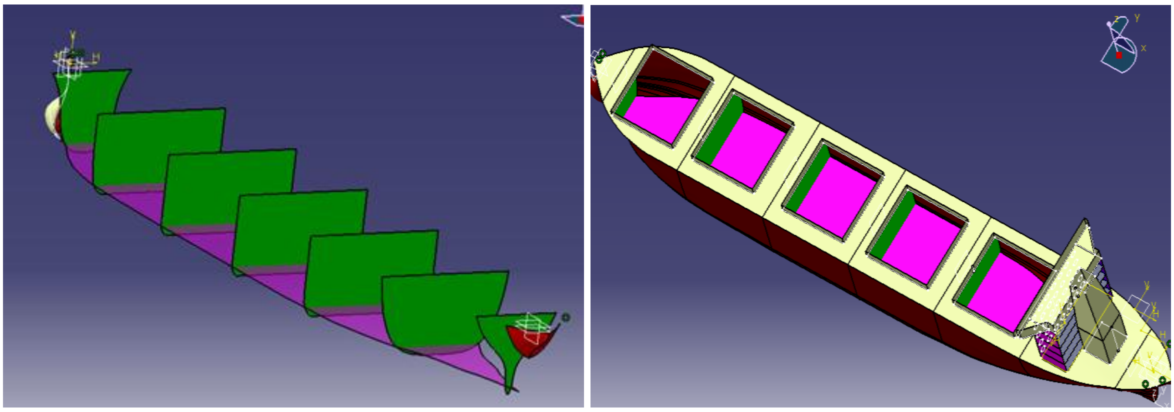


Fig7 showing 8 number of bulk heads and 5 cargo holds of the ships on the ship

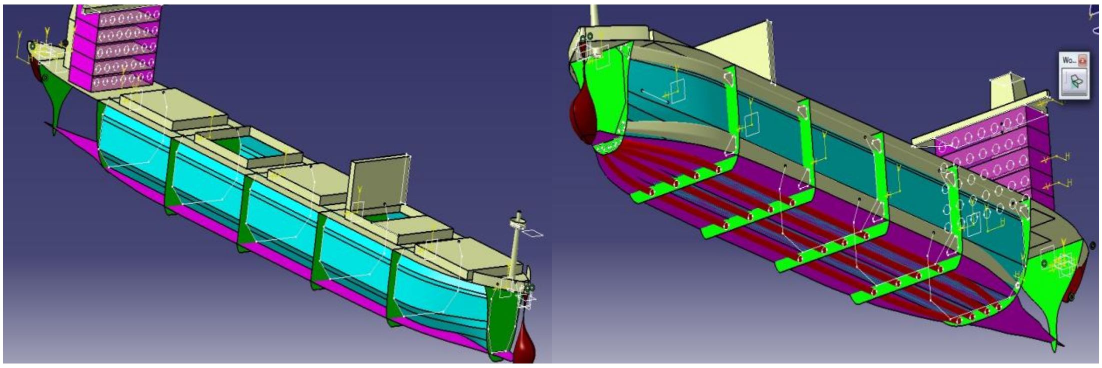


Fig8 showing the spaces allocated for engine room accommodation and double bottom tanks

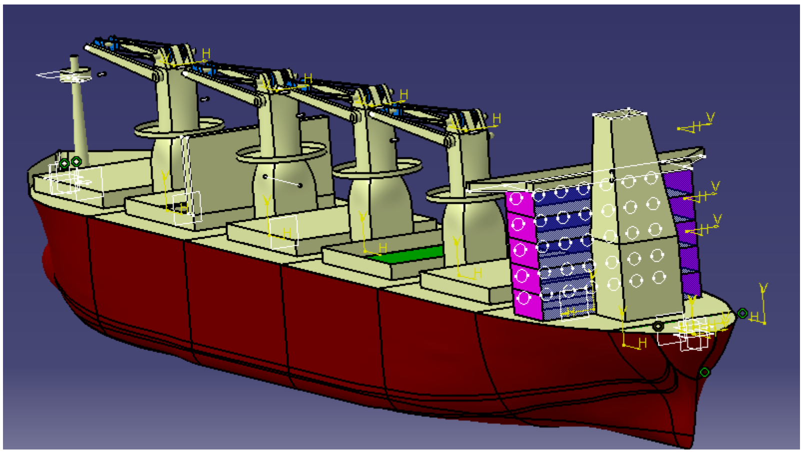


Fig8 The final form of the ship after Designing

Conclusion

We would finally conclude that the above ship designs using computer software not only gives accurate values but also reduces resistances in the sea.

Acknowledgment

We would like to thank marine engineering department professors Prof., T.V.K Bhanu Prakash Prof. V.V.S Prasad for their guidance and hindusthan shipyard limited for their support to design the ships in the advanced software.

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