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M/S Ingrid of Lake Victoria

The M/S Ingrid is a containership designed to transport 1000 tonnes of either coffee or sugar on a weekly basis. The shipments are supposed to go from Kemondo, Tanzania, to Mwanza, also in Tanzania and then proceed to Kisumu in Kenya. The most common type of container used is the TEU, (Twenty-foot Equivalent Unit). It can carry a maximum weight of 24 tonnes and the recommended loading volume is 1000 cft or 28 cbm. Sugar is commonly transported in 50-kilo bags, the density of sugar is 880 kilos/cbm and therefore 42 TEUs are needed not to exceed the container's maximum weight. Coffee beans that are shipped in 60-kilo bags have less than half the density of sugar, 400.5 kilos/cbm, and therefore require 90 TEUs.

The task here is to design a ship that will perform this transportation as efficiently as possible. The process started with the idea of a larger ship that could carry the entire cargo at once. It soon became clear however that the special requirements connected to building the ship in local docks spoke in favour of a smaller size. I consulted Mr. Göran Frisk at SOLVE to get a second opinion and also he thought that a smaller and faster ship seamed as a better alternative.

Once the route was decided to go from Kemondo to Kisumu via Mwanza, the distance was approximated to 510 nautical miles. After testing different combinations of length and breadth, speed, number of containers and ballast weight the ship was finally stable. The final measurements were a length of 88 meters, a width of feet 12 meters and a draft of feet 4.5 meters, this might not sound as much but she can carry up to 500 tonnes of goods. A table of ship data for MS Ingrid is depicted below. When the values from this table are used as input, the computerized tool Tribon shows that the centre of gravity can be raised to approximately 3.4 meters and that the metacentric height GM_0 can be lowered to 2 meters without making the ship unstable. It is also shown that the ship is stable for the draught of 2.25 meters corresponding to the displacement of 1100 tonnes. Tribon also estimates the shaft power to 1171 kW, which is increased with 15% (to 1347 kW) to compensate for waves, wind and such. The MS Ingrid then requires 1806 horsepowers to proceed at her full speed of 13.8 knots.

L [m]	88
Lpp [m]	80
B [m]	12
T [m]	4.5
D [m]	5.8
H [m]	18
Freeboard [m]	1.0
Displacement [tonnes]	2687
Deadweight [tonnes]	1652
Lightweight [tonnes]	1034
CB	0.62
V [knots]	13.76
KG [m] depends on cargo	2.4-3.4
GM_o [m]depends on cargo	2.4-2.9

The maximum number of containers is 36, nine in length and 4 in breadth. As comparison small containerships normally carry about 250-800 TEUs.The containers must be placed with caution to preserve stability, see image below.

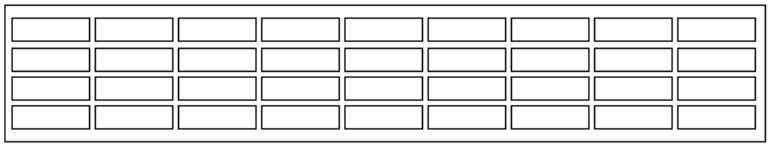

Figure 3 – placement of containers on top deck when shipping coffee

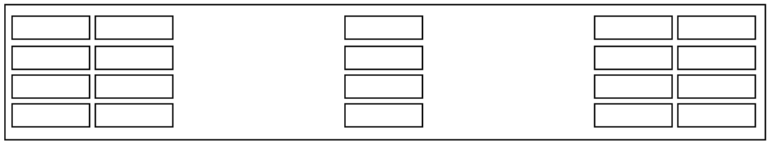

Figure 4– placement of containers when shipping sugar

The ballast water (502 tonnes or 490 m^3) is placed in the space between the double bottom and there is also a permanent ballast of lead (800 tonnes). Trim tanks are added in the stem and stern. By suggestion from Mr. Göran Frisk the ship was equipped with an oil tank to increase its usability. The oil tank is located under deck at the same level as the engine room and holds 624 m^3. It should however be noted that the shipment of oil is connected to high risks why the safety restrictions related to this type of cargo must be followed at all times with no exceptions. To increase the safety of the crew there will be a sprinkler system as well as fire extinguishers at all levels of the ship. In addition to this all of the cabins will be located above deck in the deckhouse close to an emergency exit and lifeboats, there will be one lifeboat on each side of the ship.

The engine chosen is a 16 litre marine engine with output 449 kW. Since the shaft power needed at design speed is 1347 kW, three engines are required. These engines have an RPM of 2100 and therefore gears must be used to slow down the output to the approximate 200 RPM of the propeller. Data for the optimum propeller given by Tribon is shown in the table below.

Diameter	2.800	metres
Pitch ratio	0.923	
Effective BAR	0.582	(0.581 min)
Local Cavitation no	0.577	
Thrust load. coeff.	0.196	(0.196 max)
Kt/J^2	0.597	
Adv. coeff. J	0.576	
Thrust coeff. Kt	0.198	
Torque coeff. Kq	0.0309	
Open water eff.	0.587	

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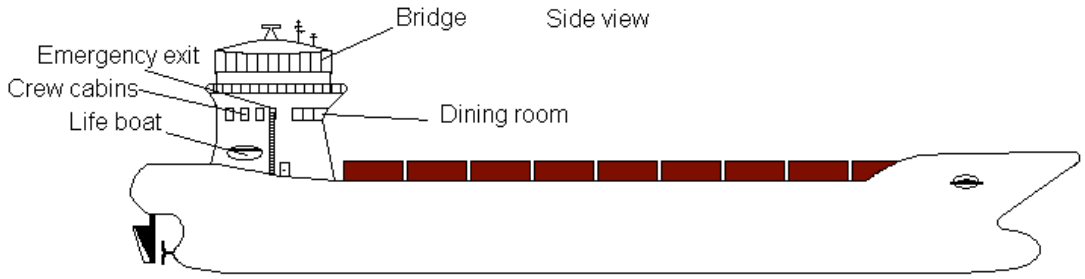
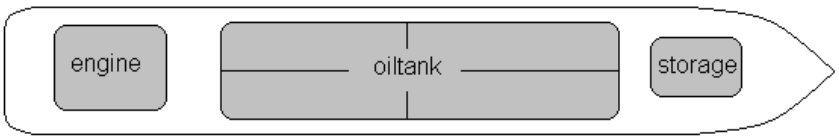
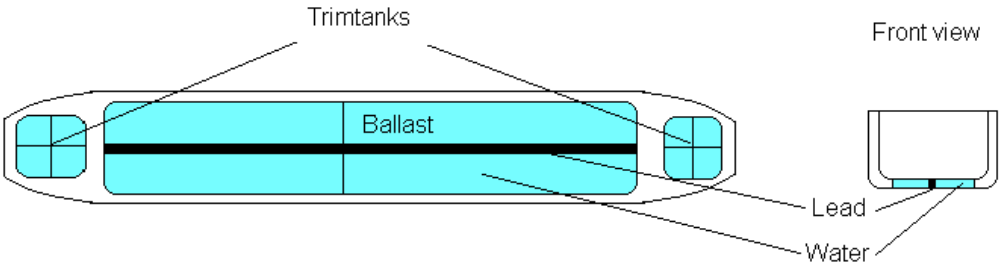


cross section one



cross section two



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