DETAIL DESIGN OF WASTE PLASTIC BOTTLES RESCUE BOAT

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ABSTRACT

The increasing numbers of waste plastic bottles over the years has create environment issue across the world. By using the waste plastic bottles to arrange at the waterline section of a boat not only to instill the awareness regarding environment issue, but enhance the safety of the boat. Obviously, a fiberglass boat has the tendency to crack during the hit by the heavy wave or accidents. Hence, the wasted plastic bottles filled inside the rescue boat could act as a floating object to support the rescue boat for a while and avoid the boat to sink directly. Despite of the arrangement of bottles in the boat is major objective in the thesis; the design of general arrangement of the boat behaves as a part of objectives. The design of general arrangement is followed the Safety Of Life At Sea (SOLAS) regulations and several analyses on the design have been made to show the compatible of the design. The methodology utilized in this project from the design software to lines plan and general arrangement of rescue boat. From the result, the total displacement of rescue boat is 868.7kg including six people with an average weight of 100kg. The total wasted plastic bottles used are 332 with a total weight of 13.12kg. If the leaking problem occurs, the bottles are able to support 56% of buoyancy from the total weight. The design of the general arrangement is also consider the weigh distribution of a boat. The passenger seat is concentrated at the middle of the boat to maintain the stability of the rescue boat.

ABSTRAK

Jumlah botol plastik sampah yang meningkat setiap tahun telah mewujudkan isu alam sekitar di seluruh dunia. Dengan menggunakan botol plastik terbuang untuk menguruskannya di bawah bahagian air bot bukan sahaja untuk memupuk kesedaran mengenai isu alam sekitar, tetapi meningkatkan keselamatan bot penyelamat. Selain itu, bot yang dibuat daripada gentian serabut kaca mempunyai kecenderungan untuk pecah apabila dipukul ombak atau terlibat dalam kemalangan. Oleh itu, botol plastik terbuang yang diisi dalam bot boleh bertindak sebagai objeck terapung untuk menyokong bot penyelamat untuk meggelakkan bot tenggelam serta merta. Walaupun sususan botol dalam bot antara objektif projek ini, reka bentuk susunan umum bot juga sebahagian daripada objektif. Reka bentuk susunan umum mengikuti peraturan Keselamatan Kehidupan Pada Laut (SOLAS) dan analisis bot telah dibuat untuk menunjukkan serasi reka bentuk. Kaedah yang digunakan di dalam tesis ini dari perisian reka bentuk, pelan garis sehingga susuan umum bot. Daripada keputusan kajian ini, anjakan jumlah bot penyelamat adalah 868.7kg termasuk enam orang yang mempunyai berat sebanyak 100kg. Jumlah botol plastik terbuang yang digunakan adalah 332 buah dan beratnya adalah 13.12kg. Jika berlakunya bot membocor, botol terbuang akan menyokong 56% daripada berat keseluruhan. Reka bentuk susunan umum juga tidak melupakan analisis pengagihan berat bot. Tepat duduk penumpang tertumpu pada bahagian tengah bot untuk mengekalkan kestabilan bot penyelamat.

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LIST OF ABBREVIATIONS

PET	-	Polyethylene Terephthalate
BC	-	Before Christ
SOLAS	-	Safety of Life At Sea
LOA	-	Length Over All
LBP	-	Length Between Perpendiculars
LWL	-	Waterline Length
B	-	Beam/Breadth
D	-	Draft/ Draught
DWT	-	Deadweight Tonnage
LWT	-	Lightweight Tonnage
EHP	-	Effective Horsepower
BHP	-	Major Driving Force
CSA	-	Curve Sectional Area
LCB	-	Longitudinal Centre of Buoyancy
NSP	-	Nederlandsch Scheepbouwkundig Proefstation
HP	-	Horsepower
LSA	-	Life Saving Appliances

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CHAPTER 1

INTRODUCTION

1.1   BACKGROUND

The waste plastic bottle has a trend of increasing over the year. This can be shown at the graft below. The Figure 1.1 shows the sales wasted and recycled bottle rate in the United State from year 1991 to 2009. Both the sales and wasted bottle have increase from the year 1991 and reached the peak in year 2007. The sales and wasted bottle then experience the shrinkage after the year until 2009. Luckily, the recycle bottled show an increasing rate through out the year. However, the recycled rate is far less behind the wasted rate.
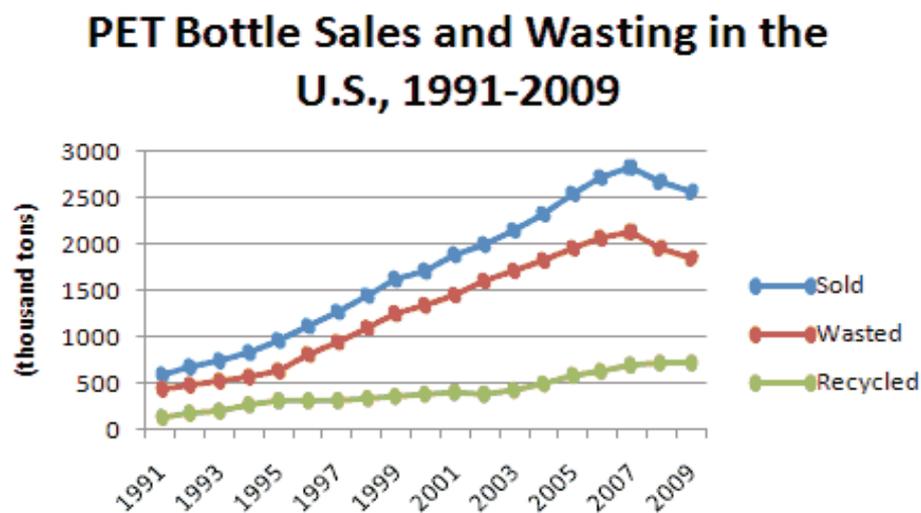
Figure 1.1: The wasted and recycled rate of PET bottle in US from 1991 to 2009

Source: http://www.container-recycling.org/facts/plastic/data/petsaleswasterec.htm

The wasted plastic bottles inspire the idea of making rescue boat using the wasted plastic bottle. This idea is not only to inculcate the environmental awareness among the public, but it can increase the safety of the rescue boat.

The project is continuing from the previous study of design rescue boat by using waste bottle plastic. The plastic bottles will be arrange in the core of the boat to avoid sinking since the fiberglass layer of the boat have the tendency to crack.

Detail design of ship is very important before it is ready to fabricate. Besides, material analysis, technical aspect of the ship operation and facility of ship will consider on the design. The project would determine the amount needed of the wasted plastic bottles in the core of the boat. The line plan and the general arrangement of bottles in the boat will be designed and some theoretical analysis will be done. On the other hand, the facilities of the rescue boat will of the rescue boat will be determined through this project.

1.2   PROBLEM STATEMENT

The boat that made from the fiberglass is noticed to have high possibility to crack at the bottom part of the boat. It may due to the hit by the heavy wave. Besides, the fiberglass will have the tendency to crack during an accident. The consequence is the boat will sink and fail to act as a rescue boat. To overcome this problem, there is an idea to design a fiberglass boat that has arrangement of waste plastic bottles in the frame of rescue boat before it laminated by fiberglass so that even the fiberglass layer crack the boat will still float.

On the other hand, 40 millions of waste plastic bottle are throwing away a day. In contrast, the recycling rate for plastic soft drink bottles is around 30 percent. The community nowadays still lack of conscious about the consequences of producing waste plastic. Furthermore, the concept of reuse the plastic bottle still far away in the peoples' mind. Hence, the use of waste plastic bottle inside the rescue boat would give the plastic bottle a second chance and this action is able to instill the conscious in reduce the use of plastic bottle among the university students.

1.3   OBJECTIVE

The main objective of this study is to design a fiberglass rescue boat that has arrangement of waste plastic bottles in the frame of the rescue boat.

1.4   PROJECT SCOPE

The scopes of this project are:

i.   Detail material used and the orientation of the waste plastic bottle in the boat.

ii.   Design of the ship facility.

iii.   Technical analysis of ship operation.

1.5   EXPECTED OUTCOME

The expected outcome of the project is to produce a line plan design of the rescue boat together with the arrangement of the plastic bottles. The line plan design consists of the waterline and baseline in each ordinate and also the orientation of bottle arrangements and amount of bottles needed.

1.6   SIGNIFICANT OF THE STUDY

The greatest advantage of the plastic bottles rescue boat is to provide extra safety purpose for both the rescue boat itself and passengers. The boat is not facing the sinkage problem if cracking occurred at the bottom part of the fiberglass.

1.7   PROCESS FLOW CHART

Figure 1.2 shows the process flow of how this project is done. This makes useful tools how processes work is done throughout the project.

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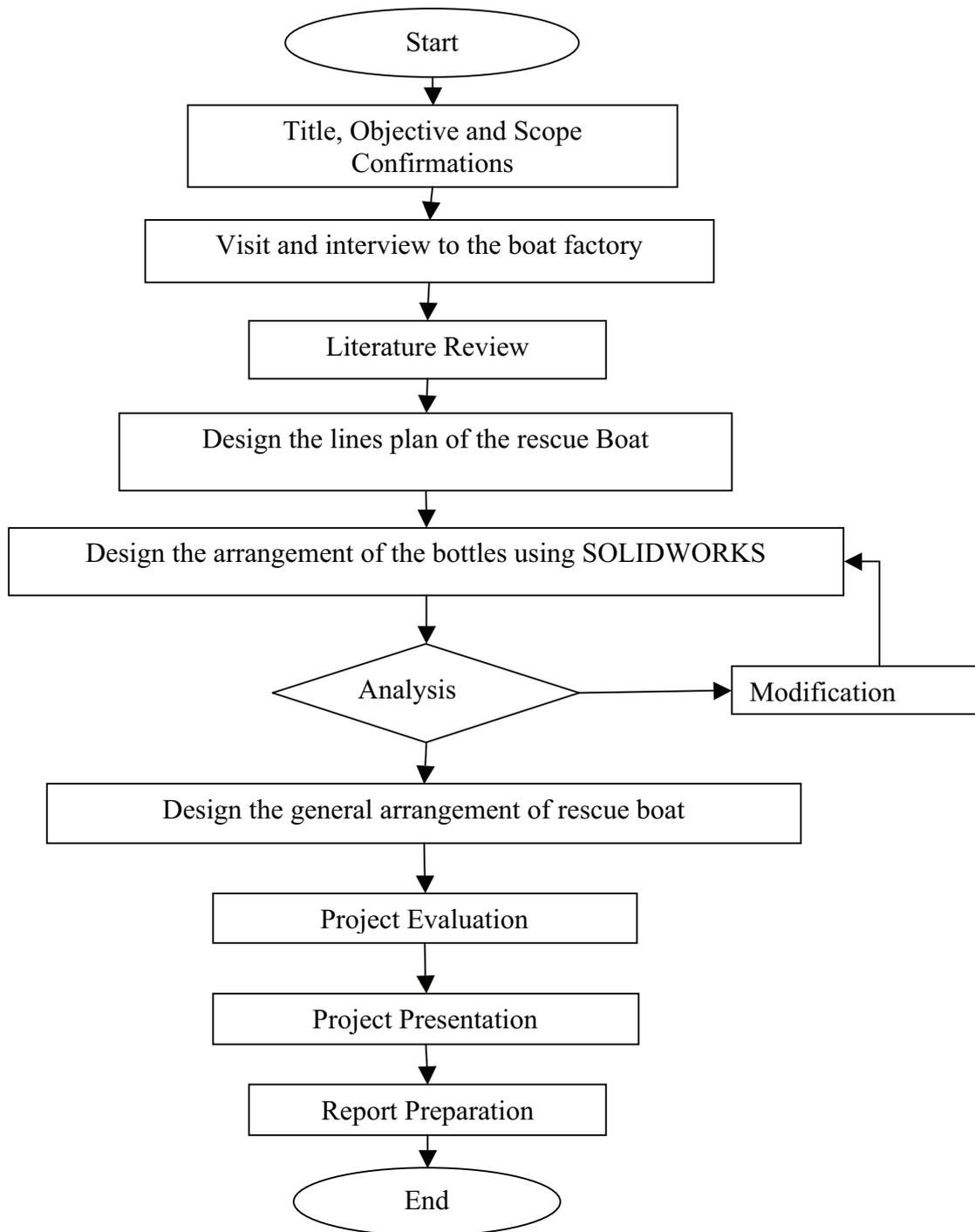
Figure 1.2: Process flow chart

CHAPTER 2

LITERATURE REVIEWS

2.1   ARCHIMEDES'S PRINCIPLE

The Archimedes principle is one of the earliest scientific principles and it is uses in wide range of application. A mathematician, Archimedes of Syracuse, discovered the theory of buoyancy. The idea came from Archimedes who had a flash of inspiration as he felt his own buoyancy in a public bath.

" The buoyant force acting on a body immersed in a fluid is equal to the weight of the fluid displaced by the body, and it acts upwards through the centroid of the displaced volume. "

Archimedes principle stated that buoyant force acting on an immersed object is equal to the weight of the displaced water. The explanation is not limited to the liquid but the gases too. Both density of an object and fluid will determines the buoyant force. An object will float if the object is less dense than the fluid. In contrast, an object will sink if the object is denser than the fluid.

Figure 2.1 : Archemedes of Syracuse (287-212 BC). Greek mathemathician, physicst and engineer. Discovered the formulae for area and volume of cylinders and spheres, and invented rudimentary infinitesimal calculus. Formulated the Law of the Lever, and wriote two volumes on hydrostatic titled On Floating Bodies, containing his Law of Buoyancy

Source : Benny Lautrup, 2008

2.2   SHIP DESIGNED USING WASTED PLASTIC BOTTLE

2.2.1   Plastic Bottle

The bottles for mineral water are utilized by Polyethylene Terephthalate(PET) plastic, an amorphous or transparent material. A PET plastic are also included the semi-crystalline thermoplastic material that own the opaque and white surface. The latter is widely used to store the detergent, lubricant and etcetera. This material is generally good resistance to mineral oils, solvents and acids but not to bases. The semi-crystalline PET has better strength, ductility, stiffness and hardness compare to amorphous type that has better ductility with less stiffness and hardness. On the other hand, the PET will not react with oxygen and carbon dioxide and this well barrier are suitable for the use for mineral water.

2.2.2 Plastiki

Plastiki is a ship that inspired by the Kon-Tiki voyage, which made from approximate 12,500 reclaimed plastic soda bottles (PET). The owner or the expedition leader David de Rothschild conceived the idea after reading a report that indicated the world's oceans were under the threaten of the pollution. The voyage set sail from San Francisco; United State to Sydney Australia across the Pacific Ocean and the duration for the voyage took about 4 months.

Then, his team started to design by fit the bottles together in the right way was the key to producing a solid structure and this inspiration was largely taken from the formation of a pomegranate which pack together many soft seeds to create a hard outer structure. The bottles provide the boat 68% of her buoyancy.

The main material- plastic bottles were filled with dry ice, making them solid and consist in order to provide a smooth exterior as streamline as possible. Despite of recycling the use of plastic bottles, the Plastiki's structure would be made by a new material called Seretex, which is a self re-enforcing PET that is fully recyclable.

Besides, the team has developed special organic glue using cashew nut husks and sugarcane in order to apply at places within the structure. This organic glue is friendly environmental and it is non-toxic material that will not pollute the seawater. Despite all this plastic, the Plastiki weighs in at 12 tons. This ship is 60 feet long and 40 feet high.

On the other hand, the vessel consist a cabin that provide a living space for the crews. The cabin consist a sleeping quarter, main cabin with two sleeping berth, galley, slelf-contained head and navigation room. The cabin is inspired from the eggshell and it is capable to withstand outside pressure though it is thin. The roof of cabin covered by solar panel to generate electricity and has a rainwater capture system to collect the fresh water. Other than solar panel, the electricity bike and wind turbine act as a mini power station to generate adequate electricity for navigation and communication system.

The six-crew members meet and share at least one meal per day and the meal was prepared using the galley. Since there is no fridge on board and the team have to be innovative in their preservation methods such as sourcing local, sustainable produce to be canned, dried and stored pre-departure. However, the vessel contained vertical hydroponic gardens to provide the crew with nutritious greens throughout the voyage.


Figure 2.2: The voyage of Plastiki in sea

Source: http://www.theplastiki.com/photos/

2.2.3 Isara Bottle Boat

An Isara charity project based in Nong Khai, and the boat founder Kirk Gillock design the catamaran. He plan to travel down the Mekong River by boat to remind the people about the household waste that pollute the river. The main design is strongly refer to the Plastiki. The two hulls are made from timber, steel frame join the hulls and support the cabin structure. The buoyancy obtained solely from 5000 recycled plastic bottles. The boat powered by electric motors with a combination of wind and solar power generation.

Before fabrication, the sample pontoon of about 100 bottles is ready to undergo an experiment. These bottles are arranged in different layouts to see which would be the

most efficient and practical. These three layouts include cylindrical, trapezoid, and rectangle shape. The cylindrical was the easiest to make but connecting the rest of the boat to it would have been very difficult. A trapezoid shape was tested and the result in less drag. A rectangle arrangement will hold more buoyancy and create more buoyancy, but it has more drag.
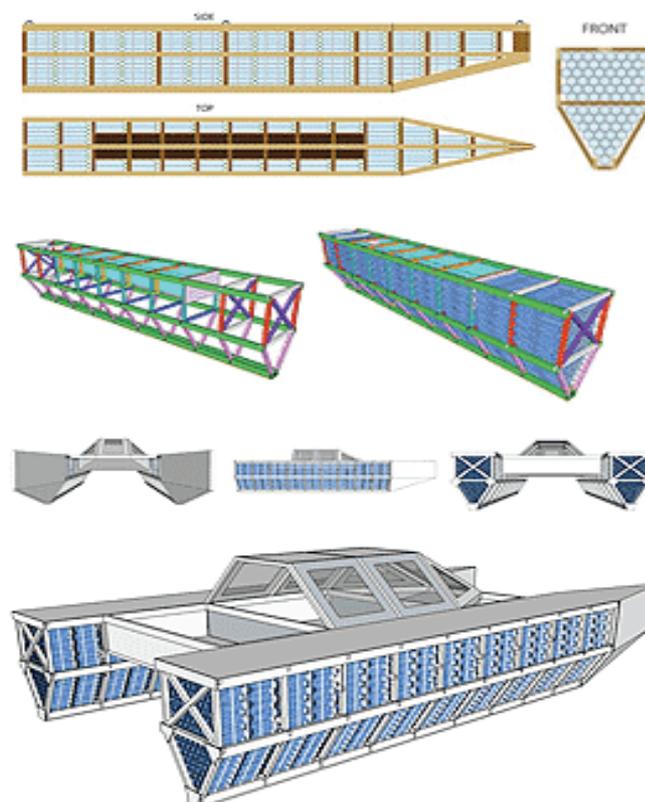
Figure 2.3: Drawing of the Isara Bottle boat

Source: http://www.isara.org/community/pages/plastic-bottle-boat

2.2.4 Bottle Up

The owner's Tom Davies, who claimed that "Bottles Up" is the first plastic bottle in Fiji. 600 empty beverage bottles were used to construct the Fiji's first recycled bottle boat with the length of 4.5 meters and wide of 1.4 meter. All the plastic bottles are 600 ml plastic bottles and the small boat was said to have the ability to cater three big Fiji man. These bottles glue together with a layer of foam underneath to aid in

floatation and some plastic sheeting for the seats and floor deck. Davies said that this is a better way to recycle the bottles as it was tested it can float pretty well. Hence, "Bottles Up" will be used as a form of activity for tourist to paddle around an 110ft-deep lake near his chalet.

Figure 2.4: The Fiji's bottle boat named Bottles Up

Source: The Fiji Time Online, 2010

2.3   GENERAL FEATURES OF RESCUE BOAT

A rescue boat is a vessel that provide special feature for rescuing or saving the lives of people at the sea. Rescue boat may be either of rigid or inflatable construction or a combination of both and it shall not less than 3.8m and not more than 8.5m in length. Besides, the rescue boat shall be capable of carrying at least five seated persons and a person lying on a stretcher. A rescue boats shall have sufficient mobility in a seaway to enable persons to be retrieved from water. On the other hand, a rescue boat shall be fitted with an inboard or outboard engine. If it is fitted with an outboard engine, a rudder and tiller may form part of the engine. The rescue boat is also need the capable to tow life rafts. Figure 2.5 shows the interior design of a rescue boat. The enclosed

cabin area is designed to accommodate a stretcher and a rescue team of three. The storage of rescue materials is located under the patient stretcher area and consist a navigation area. The absorbing seats are designed to absorb any vibration to increase the comfort of the passenger. All the design of rescue boat must follow the SOLAS regulation. Please refer Appendix A.
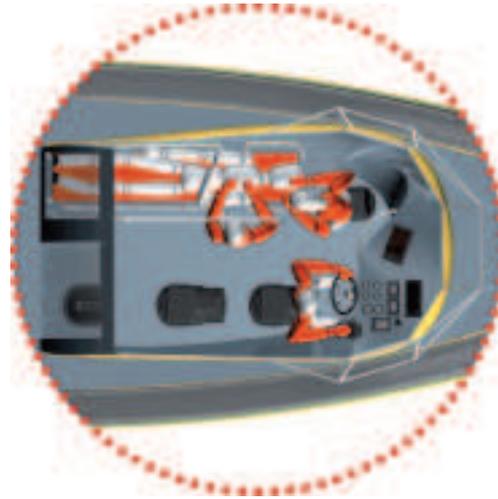
Figure 2.5: The Interior Design of a Rescue-B

Source: http://www.rescueboat.eu/the-boat/
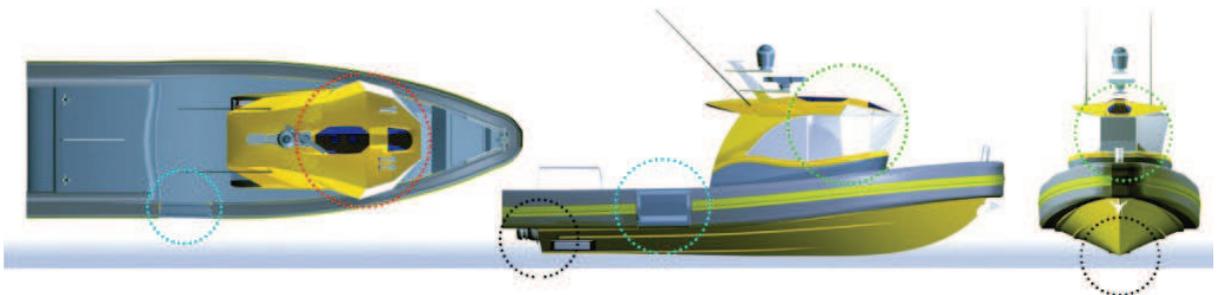
Figure 2.6: Top, side and front view of a typical rescue boat

Source: http://www.rescueboat.eu/the-boat/

2.4   BOUYANCY AND STABILITY OF SHIP

2.4.1 Ship Buoyancy

Ship buoyancy may define as the float ability of a vessel. If the weight of the vessel is less than the weight of an equal volume of water, the vessel will rise or float. The rises of the vessel is due to the force that buoys it up is greater than the weight of the vessel. It will continue to rise until it is partly above the surface of the water. Furthermore, the volume of the submerged part of a floating ship provides the buoyancy to keep the ship float. When the ship is in rest mode, the buoyancy must be equal to the weight of the ship. Hence, the weight of the ship called as displacement, meaning the weight of the volume of water displaced by the hull.

Draft is the depth of a ship below the waterline. As the displacement increase, the draft increases. Figure 2.7 shows the successive draft lines on the midship section of a ship. The volume of an underwater body for a given draft line can be measured in the drafting room by using graphic or mathematical means. The values obtained are plotted on a grid on which y-axis represent the draft in feet and x-axis represent the displacement in thousand tons. Figure 2.8 show a smooth line is faired through the points plotted and providing a displacement curve.

WATERLINE	DISPLACEMENT
28 FEET	18,000 TONS
24 FEET	14,800 TONS
20 FEET	11,750 TONS
16 FEET	8,800 TONS
12 FEET	5,900 TONS
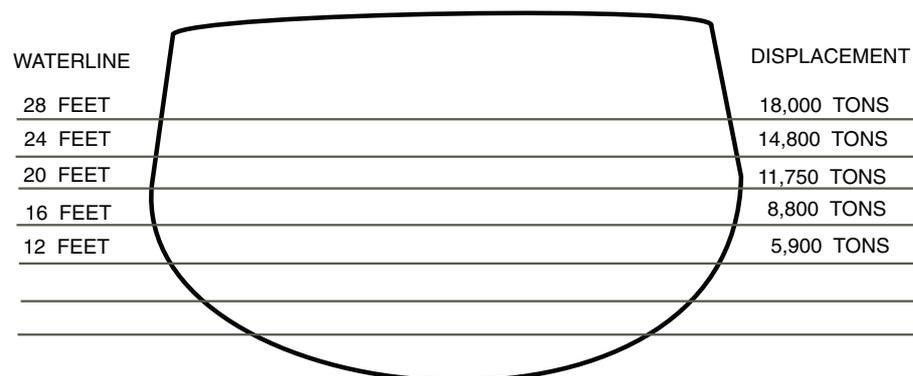
Figure 2.7 : Example of displacement data

Source: Introduction to Naval Engineering, David A. Blank, 2005