DESIGN OF DOUBLE CHINE FLAT BOTTOM FISHING CANOE FOR LAKE FISHERY.

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ABSTRACT

A 7.0 meters Length Overall (LOA) flat bottom canoe similar to the one commonly used for fishing in kainji lake, but with some modifications, was designed. The improvements/modifications over the local canoe include, an additional chine to reduce the flatness of the bottom which was absent in the local canoes commonly used. The canoe's light displacement (weight empty) was 0.48Tonne, which was similar to local canoe of same size. The draft obtained was 0.13 M(13cm), which is 36.9% of its depth (0.48 M). The capacity of the canoe was, 1.304 tones. The water plane area (WPA) was 3.89 M^2; WPA coefficient, and block coefficient were 0.83, and 0.82 respectively. The modification on the canoe resulted in provision of a canoe with the bottom shaped close to V-bottom to aid better performance on rough turbulent water such as the Kainji lake, and increased life span of canoe and safety of fisher folk while aboard fishing.

Keywords: Canoe, double chine, light displacement, draft, life span.

INTRODUCTION

A Fishing boat/canoe can be described as a floating plat-form used to transport the crew, gear, and cargo to and from the fishing ground and to support the crew and equipment during fishing operation (NRC,1988). Bulk of the domestic fish production in Nigeria comes from the inland capture fisheries, dominated by the artisanal fisheries sub-sector. Out of the 511,720 tonnes of fish production in 2002, the artisanal fisheries accounted for 88.13% of the production (Eyo and Ahmed,2005).The traditional canoes can be improved often without radically altering the basic design; a respect for tradition will increase their acceptance. To produce a canoe acceptable to local fishermen with modern design and construction, a drawing from which necessary plans can be worked out is needed, so that quantities can be worked out correctly. Love (1979) stated that designs do not begin with T-square and drawing instrument, they begin with ideas nurtured on experience and on observations, then best developed by translating the mental picture thus formed into freehand sketches made with soft pencils. According to NRC, (1988) small crafts designed should be based on the traditions of a given region, vessel sizes and designs that have evolved in an area are usually well adapted to the local fishing gear and methods and range of operations. Radical departure from the traditional hull design may not gain local acceptance (NRC, 1988). Designs with a high length to beam width ratio and a low displacement to length ratio have less resistance per unit of displacement than do fat, heavy hull forms. Therefore, narrowing the beam lightening the draft and decreasing the displacement ratio will result in less fuel consumption at a given speed. FAO (1988) designed single-hulled vessels are mostly used in small-scale fisheries.

According to Omorodion (1983), a number of flat and V-bottom boats have been designed, constructed and are operating on the Kainji lake since 1970, that V-bottoms are best for use on turbulent water, hence they are recommended for use on the lake. The author further stated that flat bottoms are the easiest and cheapest to design and construct, but best for calm or peaceful and shallow waters. They are stiffer more stable but pound heavily on turbulent water causing discomfort to occupants and resulting in the weakening of boat joints and structure, easy leakage, there by resulting to short lifespan.

However, the main objectives of this work are :-

1. **To produce an affordable canoe with improved performance on rough water body,**
2. **Integrate the advantages of both the flat and V-bottom boats in one craft, and**
3. **Improve artisanal fishing activities.**

MATERIALS AND METHODS

Freehand sketch and scale drawing.

According to Love (1979), designs do not begin with T-square and drawing instrument, they begin with ideas nurtured on experience and on observations, then best developed by translating the mental picture thus formed into freehand sketches made with soft pencils. To obtain the design data of the canoe (Table 1 and 2), a free hand sketch of the canoe was drawn. The data obtained from the freehand sketch was then used to draw the canoe to scale (1:50), as shown in Figure 1a. The design guidelines according to Dalgarno (1950) which states that beam = length/5, depth = 1/2 beam, and draft = length/10 or 20, was adopted to achieve the design. The straight horizontal design lines (baseline and water line), and the curved horizontal lines (chine/keel and sheer heights above base chine and sheer half breadth), were determined by taking measurements from the base line. The straight vertical lines (sectional lines) were measured from the centre line.

Body plan projection

Measurements taken at each section were used to obtain the shape of the canoe at each section. The point of interceptions at sheer HA/B and sheer H/B were joined with a straight lines to the points of interceptions at chine HA/B and chine H/B points, at the two sides of the centreline.

The two side were joined with a straight line at the keel to form the shape of the canoe at the section. Combination of the projected sections constitutes the body plan of the canoe (Figure 2).

The canoe is designed maintaining the traditional shape of the commonly used fishing canoe, but modified by adding a chine to reduce the flat surface of the bottom.

Water plane area and WPA coefficient projection.

The Surface area of water the boat occupies when placed on it, is known as water plane area (WPA). This was projected by measuring the length of waterline across each section.

The sections were connected on the two sides with curves to form the outline of the water plane (Figure 3).

Water plane area coefficient, the ratio of water plane area to its rectangle was projected by: Placing the area of water plane (Figure 3) in a rectangle with same length and breadth as the water plane area (Figure 4).

Block coefficient of fines projection.

The block coefficient of fines, is the ratio of the underwater volume of the canoe to it's prism. This was projected by : extracting the shape of the underwater volume,

placing the underwater volume in a box having same length, breadth, and draft as the underwater volume (Figure 5).

Determination of specifications.

The light displacement (weight empty) was determined by using the formula: weight of construction materials + 1/3 same weight for scantlings (Teal, 1981) known as estimation method, and by using Archimedes' principle which states that a submerged body is subject to a buoyancy force that is equal to the weight of the fluid displaced by that body. This explains why a heavily laden ship floats; its total weight equals exactly the weight of the water that it displaces, and this weight exerts the buoyant force supporting the ship (Redmond, 2005). The volume of water displaced was determined by:

calculating the area of under water part of each section and placing them against Simpson's formula: 1/3 common interval x sum of product and ratio 1:4:1 (Simpson, 1951). The volume was then divided by 1(weight of $1m^3$ of water).

Other specifications including capacity, water plane area, were also determined same as above. Water plane area coefficient, and block coefficient were calculated as : $\frac{\text{water plane area}}{\text{Area of rectangle (L X B)}}$, and $\frac{\text{under water vol.}}{\text{Vol. Of prism}}$ respectively

Tones per centimeter immersion was calculated as : $\frac{\text{water plane area}}{}$ (fresh water)

RESULTS AND DISCUSSION

The design lines that constitutes the main sketch and the projected sections are shown in Figure 1 and 2.The design data obtained from the free hand sketch and the full size design data are shown in Tables 1 and 2 respectively. The detail of the water plane area is shown in Figure3. Figures 4 and 5 explain the details of water plane area coefficient and block coefficient respectively. Detailed views of canoe are shown in Figure 6, the sectional details of the mid-ship section of the canoe are shown in Figure 7. The result of the determination of specifications (Table 3) shows that the beam is 1.15 M , and depth is 0.48 M, which is in accordance with Dalgarno (1950). The light displacements were 0.27 tones (T) and 0.68 tones (T) for estimation and Simpson's rule respectively, Capacity was calculated to be 1.099 tones (T). Water plane area was 3.89 M^2, and a water plane area coefficient of 0.83 was obtained .The block coefficient was 0.82. The result of the light displacement by estimation (0.27 T), and by calculation (0.68 T), gave a difference of 0.41 T.

This indicates that the canoe, when constructed with the material on which the estimation was based (25mm x 300mm x 3600 mm, hard wood plank), will float at a lower draft.

Hence, it was necessary to make a balance between the two levels. The designed waterline was adjusted to fall half way between the initial designed line and the level of draft based on light displacement by estimation. The adjustment reduces ½ of the difference in displacement (0.205T) from the light displacement by calculation (0.68T), to give an adjusted light displacement of 0.475 T. The adjustment also increased the capacity by 0.205 T, reduced draft by 5cm to give an adjusted results of 1.304T and 13cm for capacity and draft respectively..

Table 1 : Design Data (cm) in Scale

Section (Frame)	1	2	3	4	5
Keel/Chine2 HA/B	**0.36**	**0.30**	**0.28**	**0. 30**	**0. 36**
Sheer HA/B	**1.20**	**1.16**	**1.10**	**1.16**	**1.20**
Chine1HA/B	**0.90**	**0.86**	**0.80**	**0.86**	**0.90**
Sheer H/B	**0.60**	**1.00**	**1.16**	**1.00**	**0.60**
Chine1 H/B	**0.50**	**0.76**	**0.90**	**0.76**	**0.50**
Chine2 H/B	**0.20**	**0.40**	**0.50**	**0.40**	**0.20**

Table 2 : Design Data (m) Full Size

Section (Frame)	1	2	3	4	5
Keel/Chine2 HA/B	**0.18**	**0.15**	**0.14**	**0.15**	**0.18**
Sheer HA/B	**0.60**	**0.58**	**0.55**	**0.58**	**0.60**
Chine1HA/B	**0.45**	**0.43**	**0.40**	**0.43**	**0.45**
Sheer H/B	**0.30**	**0.50**	**0.58**	**0.50**	**0.30**
Chine1 H/B	**0.25**	**0.38**	**0.45**	**0.38**	**0.25**
Chine2 H/B	**0.10**	**0.20**	**0.25**	**0.20**	**0.10**

Table 3: Canoe Specifications

Length overall (LOA) = 7 M
Breadth overall (BOA) = 1.15 M
Depth = 0.48 M
Draft = 0.13 M (13cm)
Light displacement = 0.48 tones (T)
Dead weight (capacity) = 1.304 tones (T)
Water plane area = 3.89 M^2
Water plane area coefficient = 0.83
Block coefficient of fines = 0.82
Tones per centimeter immersion = 0.0389 tones (38.93 kg)
Scale used = 1:50

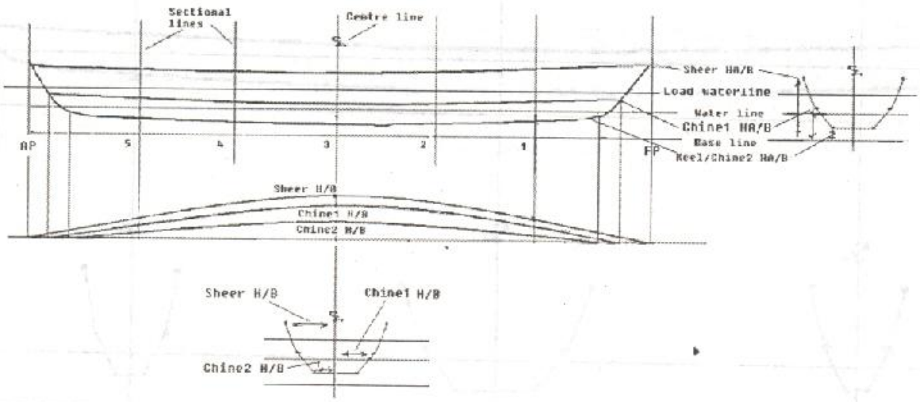

Figure 1: Canoe design sketch

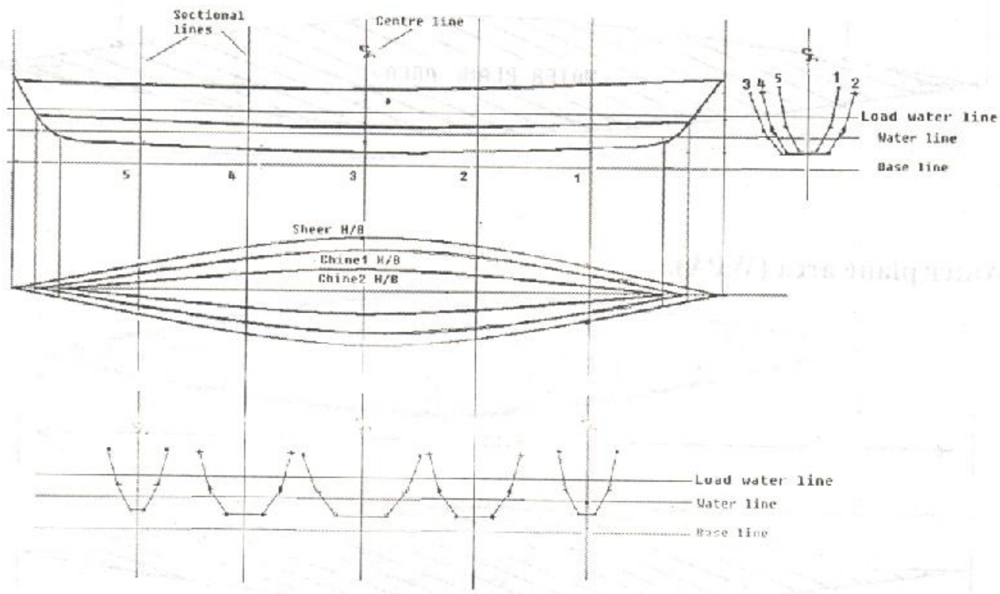

Figure 2: Body plan projection

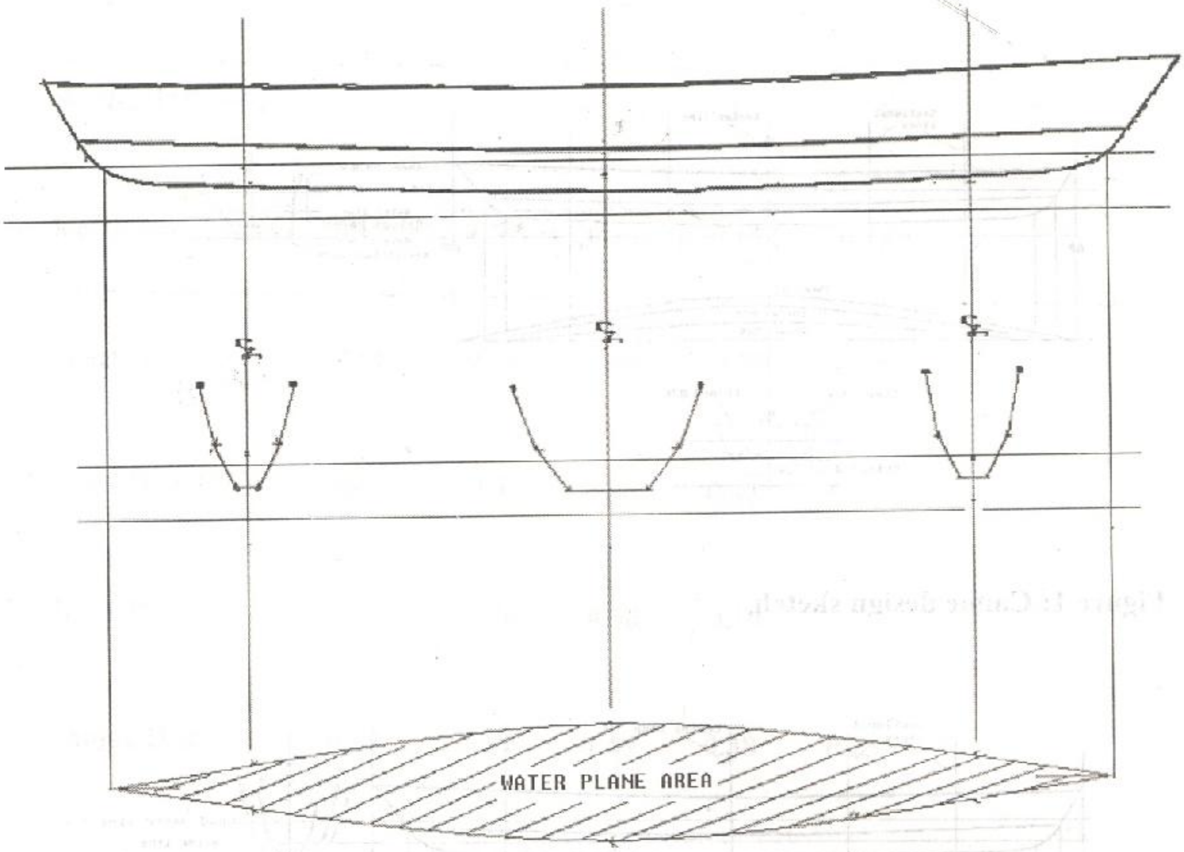

Figure 3: Water plane area (WPA).

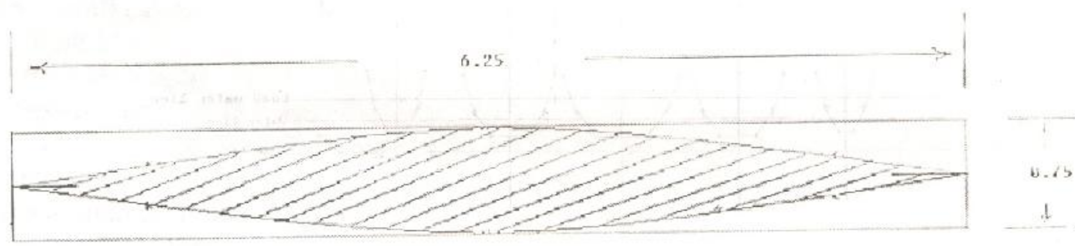

Figure 4: water plane area coefficient

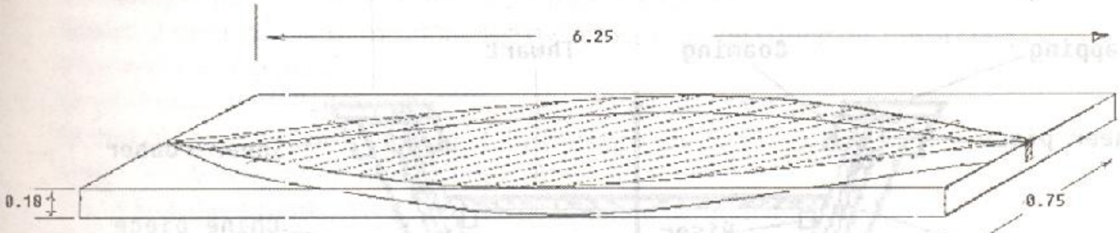

Figure 5: Block coefficient of fineness

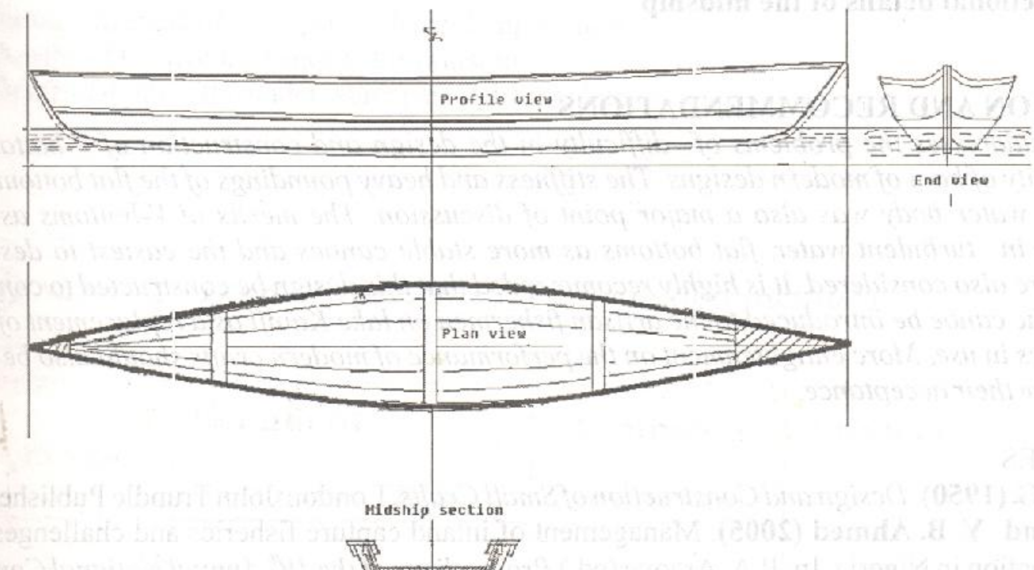

Figure 6: Different views of the canoe

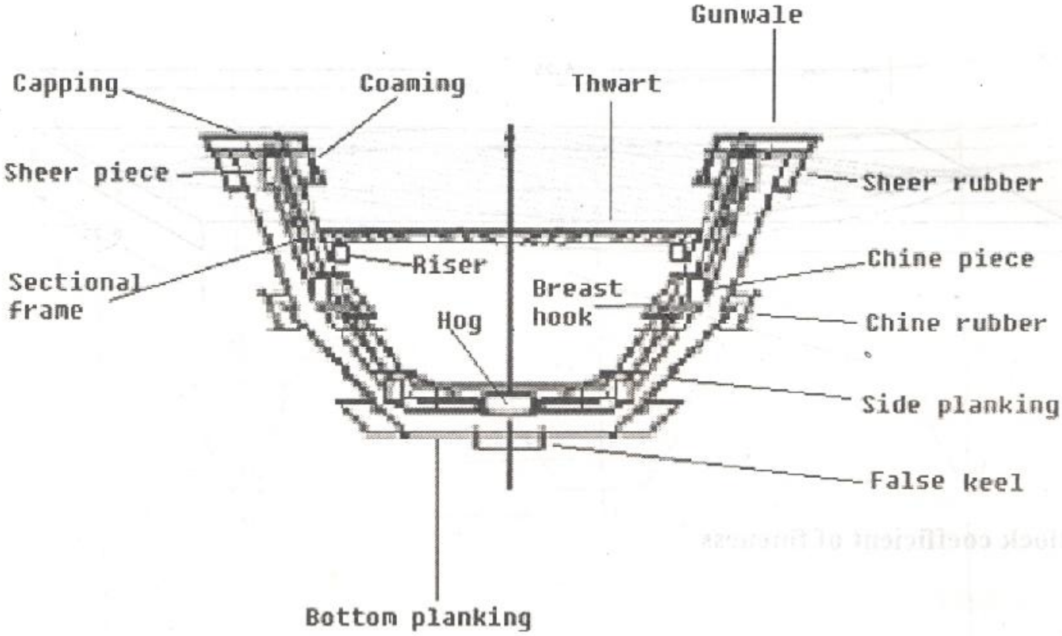

Figure 7: Sectional details of the midship

CONCLUSION AND RECOMMENDATIONS

This design addresses the problems of difficulty in the design and construction of V-bottom boat, unacceptability of boat of modern designs. The stiffness and heavy poundings of the flat bottom canoes on turbulent water body was also a major point of discussion. The merits of V-bottoms as best in performance in turbulent water, flat bottoms as more stable canoes and the easiest to design and construct were also considered. It is highly recommended that this design be constructed to confirm it's efficiency; The canoe be introduced to the artisan fishermen on lake Kainji as a replacement of the flat bottom canoes in use. More enlightenment on the performance of modern crafts should also be carried out to increase their acceptance.

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DEFINITION OF TERMS

1. **Midship**: -Middle section of a vessel
2. **Chine:** -The join between the bottom and side of a boat / canoe especially those with a flat or V-shaped bottom.
3. **Sheer:** -The upward curve of a boat's hull as seen from the side, or the degree to which the hull curves upward.
4. **Keel:** -The main structural element of a canoe, boat or ship, stretching along the centerline of its bottom from the bow to the stem.

5. **Planking:** -The planking is the outer shell that is fastened to the framing
6. **Capping:** -Top shell of the gunwale
7. **Coaming:** - inner shell of the upward curve of a boat's hull.
8. **Riser:** -Longitudinal frame along the two inner sides on which the thwart rest.
9. **Thwart:** -Sitting platform.
10. **Hog:** -Framework that connects the entire frame along the keel.
11. **Breast Hook:** - Re-enforcement of the frame joints
12. **Hull:** -Main body of the boat/canoe.
13. **Light Displacement:** -Weight of the boat/canoe without load.
14. **Deadweght:** -Amount of load the boat is designed to carry.
15. **Water Plane Area:** -Surface area of water the boat occupies when placed on it.
16. **Watwer Plane Area Coefficient:**- The ratio of water plane area to the area of it's rectangle
17. **Volume of Displacement:** -Volume of the boat below the water line
18. **Block Coefficient:** -Ratio of volume of displacement to it's prism.
19. **Gunwale:** -The top edge of a boat's sides that forms a ledge around the whole boat above the deck.
20. **HA/B:**-Height above base line.
21. **H/B:**-Half breadth
22. **AP:**-Aft perpendicular
23. **FP:** -Forward perpendicular
24. **LOA:**-Length overall
25. **BOA:** -Breadth overall
26. **Beam:**- Breadth of the canoe at the midship section.
27. **Depth:**- Depth of the canoe at the midship
28. **Draft:**- Depth of the under water part at the midship

APPENDIX 2 : Light displacement (calculation method)

Frame	Length of water line (M)	Simpsons multiplier	Product
1	0.30	1	0.30
2	0.65	4	2.60
3	0.75	2	1.50
4	0.65	4	2.60
5	0.30	1	0.30

Sum of product = 1.27 m^2

Common interval (C.I) = $^{\text{Length of water line}}/_{\text{number of intervals}}$
Length of water line = 6.25 M
Number of intervals = 4
Hence common interval = $^{6.25}/_{4}$ = 1.6m
Volume of displacement = $^{1}/_{3}$ C.I x Sum of product,
Hence Vol. Of displacement = $^{1}/_{3}$ x 1.6m x 1.27 m^2
= 0.68 m^3

Light displacement = $^{\text{Volume of displacement}}/_{1}$

Hence Light displacement = $^{0.68\ m^3}/_{1}$ = 0.68 tones (T)

APPENDIX 3 : Light displacement (estimation method)

Number of planks:

- side planks = 6.51
- bottom planks = 5.21
  Total = 11.72 planks
- Average weight of a plank(timber) = 0.8g/cm^3
- Volume of plank = 2x30x360 = 21600cm^3
- Weight of a plank = 21600x0.8g = 17280g (17.28 kg)
- Weight of 11.72 planks = 11.72 x 17.28kg = 202.50kg

Light displacement = weight of material for planking + $^{1}/_{3}$ same weight

$^{1}/_{3}$ of 202.50kg = $^{202.50}/_{3}$ = 67.5 kg

- 202.50kg + 67.50 kg = 270 kg (0.27tones).

APPENDIX 4 : Water plane area (WPA) Calculation

Sum of product = 7.3 M

WPA = $^{1}/_{3}$ C.I x Sum of product
Hence = $^{1}/_{3}$ x 1.6M x 7.3 M = 3.89 M^2

APPENDIX 4 :Water plane area coefficient calculation

WPA Coefficient = $^{\text{WPA}}/_{\text{L x b (area of it's rectangle)}}$

Hence WPA coefficient = $^{3.89}/_{(6.25 \times 0.75)}$ = 0.83

APPENDIX 5 : Block coefficient calculation

Block coefficient of fines = $^{\text{under water volume}}/_{\text{L x b x d (Volume of it's prism)}}$

Hence Block coefficient = $^{0.68\ M3}/_{(6.25 \times 0.75 \times 0.18)}$
= $^{0.68}/_{0.84}$ = 0.82

Sum of product = 1.27 m^2

Common interval (C.I) = $^{\text{Length of water line}} / _{\text{number of intervals}}$
Length of water line = 6.25 M
Number of intervals = 4

Hence common interval = $^{6.25} / _{4}$ = 1.6m
Volume of displacement = $^1/_3$ C.I x Sum of product,
Hence Vol. Of displacement = $^1/_3$ x 1.6m x 1.27 m^2
= 0.68 m^3

Light displacement = $^{\text{Volume of displacement}} / _{1}$

Hence Light displacement = $^{0.68\ m3} / _{1}$ = 0.68 tones (T)

APPENDIX 3 : Light displacement (estimation method)

Number of planks:

- side planks = 6.51
- bottom planks = 5.21
  Total = 11.72 planks
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Light displacement = weight of material for planking + $^1/_3$ same weight

- $^1/_3$ of 202.50kg = $^{202.50}/_3$ = 67.5 kg
- 202.50kg + 67.50 kg = 270 kg (0.27tones).

APPENDIX 4 : Water plane area (WPA) Calculation

Sum of product = 7.3 M

WPA = $^1/_3$ C.I x Sum of product
Hence = $^1/_3$ x 1.6M x 7.3 M = 3.89 M^2

APPENDIX 4 :Water plane area coefficient calculation

WPA Coefficient = $^{\text{WPA}} / _{\text{L x b (area of it's rectangle)}}$

Hence WPA coefficient = $^{3.89} / _{(6.25 \times 0.75)}$ = 0.83

APPENDIX 5 : Block coefficient calculation

Block coefficient of fines = $^{\text{under water volume}} / _{\text{L x b x d (Volume of it's prism)}}$

Hence Block coefficient = $^{0.68\ M3} / _{(6.25 \times 0.75 \times 0.18)}$
= $^{0.68} / _{0.84}$ = 0.82

APPENDIX 6 : Tones per centimeter immersion (TPC) calculations

TPC = $^{WPA}/_{100}$ (in freshwater)

Hence TPC = $^{3.89\ M2}/_{100}$

= 0.0389 tones (38.93 kg)

APPENDIX **7 : Dead weight (Capacity) Calculation**

Frame	Area (m^2)	Simpson's multiplier	Product
1	0.12	1	0.12
2	0.17	4	0.68
3	0.23	2	0.46
4	0.17	4	0.68
5	0.12	1	0.12

Sum of product = 2.06

Volume of displacement = $^1/_3$ C.I X Sum of product.

Hence Vol. Of displacement = $^1/_3$ x 1.6m x 2.06 m^2

= 1.099 m^3

Displacement (capacity) = $^{Volume\ of\ displacement}/_1$ (in freshwater)

Hence Dead weight = $^{1.099 m3}/_1$ = 1.099 tones (T)