Shipyard Operations
Teacher’s Manual

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• Teacher’s Instructions
• Assessment Sheet
• Instruction Sheets for Shops
• Plate Drawings for Construction
• Design Calculations, Student Worksheet
• Drawings for Design Calculations
• Answer Key for Design Calculation
• Compact Disc

This activity was developed under a grant from the National Shipbuilding Research Program (NSRP)
SHIPYARD OPERATIONS
Teacher’s Instructions

Kit Contents
- Shipyard operations activity kit contains material sufficient for one group. Each group requires one pair of scissors, two rulers, one glue stick, tape, one protractor, instruction sheets for the respective shops, assessment sheet for teacher and a set of drawing sheets (each set contains eight sheets).
- Students need to bring calculators and pencils.
- AutoCAD drawings for more groups can be printed on 65 lb cardstock sheets.
- The power point presentation describing the shipyard operations activity, AutoCAD drawings, student worksheets and instruction sheets for the respective departments can be downloaded and printed from the following web site.
- The power point presentation describing the activity is provided on the CD attached with this manual.

Set Up
- This shipyard operations activity requires two class periods. (Day – 1 and Day – 2)
- Answer key and assessment sheet are included in the kit for the teacher.

Day – 1
- Please use the power point presentation for day -1 activity. (10 to 15 min)
- Divide students into groups of four.
- There are three different shops i.e. Plasma Cutting shop, Plate shop and Welding & Final Assembly shop. Assign the Welding & Final Assembly shop to two students and the other two shops to one student each.
- Order of the Shops - Plasma Cutting shop, Plate shop, Welding and Final Assembly shop.
- While the Plasma Cutting shop processes the parts, make sure that the other two shops go through their respective instruction sheets until they receive the parts and start processing.
- The order in which the parts will be processed and sent to the next shop is-
  Bow Sub-Assembly (Bow, Bow Bulk Head, Bow Deck Plate), Mid-Hull Module Sub-Assembly (Mid-Hull Module, Mid-Hull Bulk Head, Mid-Hull Deck Plate), Stern Sub-Assembly (Stern, Stern Bulk Head, Stern Deck Plate), Super Structure. However, parts are numbered for clarity.
- Based on the assessment sheet provided, teacher will assign points to each group. The group with maximum number of point wins.
Day – 2
- Please use the power point presentation for day - 2 activities. (10 to 15 min)
- Divide students into groups of four.
- Day-2 activity involves design calculations where the students will to calculate: Weight of water displaced by the ship.
- Worksheets are provided to the students for calculations; teacher evaluates the worksheets at the end of the shipyard operations.
- Check the kit contents for any missing or damaged part and put the contents back in the box.
- Use the assessment sheets to assess performance of each group.
SHIPYARD OPERATIONS

DAY – 1

- Plasma Cutting Shop – One Student
- Plate Shop – One Student
- Welding & Final Assembly Shop – Two Students

This activity was developed under grant from National Shipbuilding Research Programme (NSRP)
This Assessment sheet is to be used by the Teacher to evaluate the quality of Shipyard Operation

<table>
<thead>
<tr>
<th>Group No:</th>
<th>Date(mm/dd/yy):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Names</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Characteristics</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the cutting done on the solid lines?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Are the bends straight and properly creased?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have the corners and intersections been cut properly?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there no Gaps at the joints between subassemblies?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the Hull bottom aligned and straight?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are the joints glued/taped properly?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Points: _________

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Marine Kit - 1

SHIPYARD OPERATIONS

DAY – 1

INSTRUCTION SHEETS FOR SHOPS

This activity was developed under grant from National Shipbuilding Research Programme(NSRP)

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Instructions for Plasma Cutting Shop

1. Cut the drawings along the solid lines. Use care to make straight cuts.
2. Don’t cut tabs, they are required for welding purposes.
3. Each part has been numbered to indicate the order in which the parts are to be processed and forwarded to the next shop.
4. Check the items for quality before sending them to the next shop.
   - Corners and intersections should be cut carefully.
   - Cutting should be done on the solid lines.

Item 1: Bow Plate cutting

Item 2: Bow Bulkhead – cut part

Item 3: Bow Deck Plate – cut part

Item 4: Mid Hull Module – cut part
Item 5: Mid Hull Front Bulkhead – cut part

Item 6: Mid Hull Rear Bulkhead – cut part

Item 7: Mid Hull Deck Plate – cut part

Item 8: Stern Plate – cut part

Item 9: Stern Bulkhead – cut part

Item 10: Stern Deck Plate – cut part

Item 11: Super Structure – cut part
Instructions for Plate Shop

After receiving parts from Plasma Cutting Shop, check parts for accuracy, (cutting along the solid lines and tabs). If a defect is found, send the defective part to the Plasma Cutting Shop.

1. All tabs are bent at 90°.
2. All bending is done along dashed lines. Use straight edge ruler for ease in bending.
3. For accuracy, use the protractor to measure the angles after bending.
4. Parts are to be processed in the same order in which they are received.
5. Check the items for quality before sending it to the next shop.
   - Ensure bends (folds) are straight and creased. For proper creasing, bend all parts using a ruler.
Item 4: Mid Hull – bent part

Item 5: Mid Hull Front Bulkhead – bent part

Item 6: Mid Hull Rear Bulkhead – bent part

Item 7: Mid Hull Deck Plate – bent part

Item 8: Stern Plate – bent part

Item 9: Stern Bulkhead – bent part

Item 10: Stern Deck Plate – bent part

Item 11: Super Structure Plate – bent part
WELDING & FINAL ASSEMBLY INSTRUCTIONS

After receiving parts from Plate Shop, check parts for accuracy (angle of bend) if defective, send the part to the Plate Shop.

1. Welding in this shop is represented by glued/taped joints.
2. Hold each tab firmly to the corresponding part while gluing/taping it.
3. Inside tab: means the tab should be welded to the inner edge of the part.
4. Outside tab: means the tab should be welded to the outer edge of the part.
5. Welding (gluing/taping) should be done along the entire length of the joint.
6. The final order of assembly for each ship is the Bow sub-assembly, Mid Hull sub-assembly and stern sub-assembly.
7. The front of the Super Structure is placed on the centerline where the Mid Hull and Stern are joined.
8. Check the assembled modules for quality.
   - Check for gaps at the joints.
   - Position of the Super Structure.
   - Once the final assembly is complete, lay a ruler at the bottom of the ship and verify hull alignment.
Item 1: Step 1 - Tabs are welded

Item 1: Step 2 - Bow Bulkhead is welded to the bow

Item 1: Step 3 - Bow Deck Plate is welded to the bow – Bow sub-assembly is complete

Item 2: Mid Hull sub-assembly is complete

Item 3: Stern sub-assembly is complete

Item 4: Super Structure is complete

Item 5: Final assembly of ship is complete

Testing hull alignment
SHIPYARD OPERATIONS

DAY – 1

PLATE DRAWINGS FOR CONSTRUCTION

(STEEL PLATES)

(These drawings are master copies. Do not use these in the class. Please use these master templates for making additional copies for classroom use)
Simulate - Day I
Shipyard Operations

8. STERN

Step 1: Bend 90 degrees up
Step 2: Bend 90 degrees up
Step 3: Bend 20 degrees up
Step 4: Bend 40 degrees up

Read 40 degrees up
Inside Tab - Top

8 Outdoors up
Step 2 - 40 degrees up
II. SUPER STRUCTURE

Simulation - Day 1
Shipyard Operations

Outside Tab - 90 degrees up
Step - 1: Bend 90 degrees left
Outside Tab - 90 degrees up
Step - 2: Bend 90 degrees up
Outside Tab - 90 degrees up
Step - 3: Bend 90 degrees up
Outside Tab - 90 degrees up
Step - 4: Bend 90 degrees up

90 degrees up
Outside Tab
90 degrees up
Outside Tab
90 degrees up
Outside Tab
90 degrees up
Outside Tab
DESIGN CALCULATIONS

&

STUDENT WORKSHEETS

Marine Kit - 1

SHIPYARD OPERATIONS

DAY – 2

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Area Calculations - Bow

Area of Bow = $A_1 + A_2 + A_3 + A_4 + A_5 + A_6 = \text{________sq. mm} = \text{________sq. m}$

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Shipyard Operations
Lean Institute, ODU
August 2008
Area Calculations – Bow Deck Plate

<table>
<thead>
<tr>
<th></th>
<th>Area of Bow Deck Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td></td>
</tr>
<tr>
<td>$A_2$</td>
<td></td>
</tr>
<tr>
<td>$A_3$</td>
<td></td>
</tr>
</tbody>
</table>

Area of Bow Deck Plate = $A_1 + A_2 + A_3 = \text{___________}\text{sq. mm} = \text{___________}\text{sq. m}$
Area Calculations – Mid-Hull

<table>
<thead>
<tr>
<th></th>
<th>Area of Mid-Hull</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td></td>
</tr>
<tr>
<td>$A_2$</td>
<td></td>
</tr>
<tr>
<td>$A_3$</td>
<td></td>
</tr>
</tbody>
</table>

Area of Mid-Hull = $A_1 + A_2 + A_3 = \_\_\_\_\_\_\_\_\_\_sq. \text{mm} = \_\_\_\_\_\_\_\_\_sq. \text{m}$

Area of Mid-Hull Deck Plate = $A_2 = \_\_\_\_\_\_\_\_\_sq. \text{mm} = \_\_\_\_\_\_\_\_\_sq. \text{m}$
# Area Calculations - Stern

<table>
<thead>
<tr>
<th>Area of Stern</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1 = A_3$</td>
<td>$A_1$</td>
</tr>
<tr>
<td>$A_4 = A_6$</td>
<td>$A_4$</td>
</tr>
<tr>
<td>$A_2$</td>
<td>$A_2$</td>
</tr>
<tr>
<td>$A_5$</td>
<td>$A_5$</td>
</tr>
</tbody>
</table>

Area of Bow = $A_1 + A_2 + A_3 + A_4 + A_5 + A_6 = \underline{\quad}\text{sq. mm} = \underline{\quad}\text{sq. m}$
Area Calculations – Stern Deck Plate

Area of Stern Deck Plate $A_1 = \underline{\underline{\text{\_\_\_\_\_\_\_\_sq. mm}}} = \underline{\underline{\text{\_\_\_\_\_\_\_\_sq. m}}}$
# Area Calculations – Bulkhead

<table>
<thead>
<tr>
<th>Area of Bulk Head</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td></td>
</tr>
</tbody>
</table>

Area of Bow Bulk Head $A_1 = \_\_\_\_\_\_sq. \, mm = \_\_\_\_\_\_sq. \, m$

Area of Mid-Hull Front Bulk Head $A_1 = \_\_\_\_\_\_sq. \, mm = \_\_\_\_\_\_sq. \, m$

Area of Mid-Hull Rear Bulk Head $A_1 = \_\_\_\_\_\_sq. \, mm = \_\_\_\_\_\_sq. \, m$

Area of Stern Bulk Head $A_1 = \_\_\_\_\_\_sq. \, mm = \_\_\_\_\_\_sq. \, m$
## Area Calculations – Super Structure

<table>
<thead>
<tr>
<th>Area of Super Structure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td></td>
</tr>
<tr>
<td>$A_2 = A_4$</td>
<td></td>
</tr>
<tr>
<td>$A_3$</td>
<td></td>
</tr>
<tr>
<td>$A_5$</td>
<td></td>
</tr>
<tr>
<td>$A_6$</td>
<td></td>
</tr>
</tbody>
</table>

Area of Bow = $A_1 + A_2 + A_3 + A_4 + A_5 + A_6 = \underline{\text{square mm}} = \underline{\text{square m}}$

---

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# Calculation of Weight of the Ship

Hull Plate thickness: 5cm  
Deck Plate thickness: 2.5cm

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Area of paper boat (m$^2$) (1)</th>
<th>Area of original ship (m$^2$) (2) = (1) *(400)$^2$</th>
<th>Thickness (m) (1m=100cm) (3)</th>
<th>Volume (m$^3$) (4)=(2)*(3)</th>
<th>Weight of Each part (kg) (5)=(4)*density of steel (Density of steel=7800kg/cu.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bow Bulk Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bow Deck Plate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Hull</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Hull Bulk Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Hull Deck Plate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stern Bulk Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stern Deck Plate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super Structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total weight of the Steel Plates =
Calculation of Weight of the Ship

1. Total weight of steel used = __________________tons
   (Weight of steel used is approximately 50% of the weight of ship)

   Therefore, the **Weight of the Ship** is __________________tons

2. Weight of the cargo(1500 TEU containers)
   (Weight of 1 TEU container=24 tons)

   Weight of 1500 TEU containers = ________________tons

   Therefore,
   **Total weight of the ship (w) =Weight of the Ship + Weight of the Containers**
   =_____________________________ tons
Calculation of Draft of the Ship

Draft Calculation Chart

Draft of the ship (m) vs Weight of Water Displaced (tons)

Draft of the Ship = ____________ m

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Calculation of Kinetic Energy of Ship

1. **Kinetic Energy of the Ship, KE = \( \frac{1}{2} m v^2 \)**

   We know, \( w = m \times g \) \((g = 9.8 m/s^2)\)

   (\( w \) is weight, \( g \) is acceleration due to gravity and \( m \) is the mass)

   Velocity (\( V \)) is 26 knots \((1 \text{ knot} = .514 \text{ m/s})\)

   \(1 \text{ kg} = 9.8 \text{ N}, 1 \text{ Ton} = 9800 \text{ N}\)

**Solution:**
Marine Kit - 1

SHIPYARD OPERATIONS

DAY – 2

DRAWINGS FOR DESIGN CALCULATIONS

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### 4. MID HULL

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>202.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>76.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MID HULL**
10. Stern Deck Plate

9. Stern - Bulk Head

Simulation - Day 2
Shipyard Operations
II. SUPER STRUCTURE

Simulation - Day 2
ANSWER KEY FOR DESIGN CALCULATION

Marine Kit - 1

SHIPYARD OPERATIONS

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## Area Calculations - Bow

<table>
<thead>
<tr>
<th>Component</th>
<th>Formula</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>$A_1 = \frac{1}{2} \times b \times h$ + $l \times b$</td>
<td>$A_1 = \frac{1}{2} \times 55 \times 17 + 55 \times 60$ $= 3767.5$ sq.mm</td>
</tr>
<tr>
<td>$A_4$</td>
<td>$A_4 = \frac{1}{2} \times b \times h$ + $l \times b$ + $l \times b$ + $l \times b$</td>
<td>$A_4 = \frac{1}{2} \times 7 \times 12 + 36 \times 55 + 7 \times 43 + 25 \times 43$ $= 3398$ sq.mm</td>
</tr>
<tr>
<td>$A_2$</td>
<td>$A_2 = \frac{1}{2} \times b \times h$</td>
<td>$A_2 = \frac{1}{2} \times 76 \times 46.4$ $= 1763.2$ sq.mm</td>
</tr>
<tr>
<td>$A_5$</td>
<td>$A_5 = l \times b$</td>
<td>$A_5 = 76 \times 68$ $= 5168$ sq.mm</td>
</tr>
</tbody>
</table>

**Area of Bow** $= A_1 + A_2 + A_3 + A_4 + A_5 + A_6 = 21261$ sq. mm $= 0.0212$ sq. m
## Area Calculations – Bow Deck Plate

<table>
<thead>
<tr>
<th></th>
<th>Area of Bow Deck Plate</th>
</tr>
</thead>
</table>
| **A<sub>1</sub>** | \[ \frac{1}{2} \times b \times h \] + \[ l \times b \]  
= \[ \frac{1}{2} \times 76 \times 67 \] + \[ 76 \times 36 \]  
= 5282 sq.mm |
| **A<sub>2</sub>** | \[ l \times b \]  
= 76 \times 13  
= 988 sq.mm |
| **A<sub>3</sub>** | \[ l \times b \]  
= 76 \times 25  
= 1900 sq. mm |

Area of Bow Deck Plate = A<sub>1</sub>+A<sub>2</sub>+A<sub>3</sub> = **8170** sq. mm = **0.0082** sq. m
### Area Calculations – Mid-Hull

<table>
<thead>
<tr>
<th></th>
<th>Area of Mid-Hull</th>
</tr>
</thead>
</table>
| $A_1$ | $[ l \times b ]$  
    | $[ 43 \times 202 ]$  
    | $= 8686 \text{ sq.mm}$ |
| $A_2$ | $[ l \times b ]$  
    | $= 76 \times 202$  
    | $= 15352 \text{ sq.mm}$ |
| $A_3$ | $[ l \times b ]$  
    | $[ 43 \times 202 ]$  
    | $= 8686 \text{ sq.mm}$ |

Area of Mid-Hull $= A_1 + A_2 + A_3 = 32724 \text{ sq.mm} = 0.0327 \text{ sq.m}$

Area of Mid-Hull Deck Plate $= A_2 = 15352 \text{ sq.mm} = 0.0153 \text{ sq.m}$
## Area Calculations - Stern

<table>
<thead>
<tr>
<th>Area of Stern</th>
<th>Formula and Calculation</th>
</tr>
</thead>
</table>
| **A1** = \[
\frac{1}{2} \times b \times h \] + \[l \times b\] + \[
\frac{1}{2} \times b \times h \]
| \[
\frac{1}{2} \times 23 \times 6 \] + \[23 \times 56\] + \[
\frac{1}{2} \times 20 \times 56 \]
| = 1917 sq.mm |

| **A4** = \[l \times b\] |
| = 43 \times 70 |
| = 3010 sq.mm |

| **A2** | \[
\frac{1}{2} \times b \times h \]
| \[
\frac{1}{2} \times 76 \times 46\]
| = 1748 sq.mm |

| **A5** | \[l \times b\]
| = 76 \times 70 |
| = 5320 sq.mm |

**Area of Bow** = **A1** + **A2** + **A3** + **A4** + **A5** + **A6** = **16922** sq. mm = **0.0169** sq. m
Area Calculations – Stern Deck Plate

<table>
<thead>
<tr>
<th>Area of Stern Deck Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
</tr>
</tbody>
</table>

\[
A_1 = \left[ \frac{1}{2} \times b \times h \right] + [l \times b]
\]

\[
= \frac{1}{2} \times 76 \times 48 + 76 \times 70
\]

\[
= 7144 \text{ sq.mm}
\]

Area of Stern Deck Plate $A_1 = \underline{7144}$ sq. mm = \underline{0.0071} sq. m
## Area Calculations – Bulkhead

<table>
<thead>
<tr>
<th>Area of Bulk Head</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td></td>
</tr>
<tr>
<td>$A_1 = [l \times b]$</td>
<td></td>
</tr>
<tr>
<td>$= 75 \times 42$</td>
<td></td>
</tr>
<tr>
<td>$= 3150 \text{ sq:mm}$</td>
<td></td>
</tr>
</tbody>
</table>

Area of Bow Bulk Head $A_1 = \underline{3150} \text{ sq:mm} = \underline{0.0031} \text{ sq.m}$

Area of Mid-Hull Front Bulk Head $A_1 = 3150 \text{ sq.mm} = 0.0031 \text{ sq.m}$

Area of Mid-Hull Rear Bulk Head $A_1 = \underline{3150} \text{ sq.mm} = \underline{0.0031} \text{ sq.m}$

Area of Stern Bulk Head $A_1 = \underline{3150} \text{ sq.mm} = \underline{0.0031} \text{ sq.m}$
Area Calculations – Super Structure

<table>
<thead>
<tr>
<th>Area</th>
<th>Area Calculation</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$</td>
<td>$[l \times b]$</td>
<td>$26 \times 39$</td>
</tr>
<tr>
<td></td>
<td>= $1014 \text{ sq. mm}$</td>
<td></td>
</tr>
<tr>
<td>$A_2 = A_4$</td>
<td>$[l \times b]$</td>
<td>$26 \times 55$</td>
</tr>
<tr>
<td></td>
<td>= $1430 \text{ sq.mm}$</td>
<td></td>
</tr>
<tr>
<td>$A_3$</td>
<td>$[l \times b]$</td>
<td>$39 \times 55$</td>
</tr>
<tr>
<td></td>
<td>= $2145 \text{ sq. mm}$</td>
<td></td>
</tr>
<tr>
<td>$A_5$</td>
<td>$[l \times b]$</td>
<td>$39 \times 55$</td>
</tr>
<tr>
<td></td>
<td>= $2145 \text{ sq.mm}$</td>
<td></td>
</tr>
<tr>
<td>$A_6$</td>
<td>$[l \times b]$</td>
<td>$39 \times 26$</td>
</tr>
<tr>
<td></td>
<td>= $1014 \text{ sq.mm}$</td>
<td></td>
</tr>
</tbody>
</table>

Area of Bow = $A_1 + A_2 + A_3 + A_4 + A_5 + A_6 = \underline{9178} \text{ sq. mm} = \underline{0.0091} \text{ sq. m}$
Calculation of Weight of the Ship

Hull Plate thickness: 5cm
Deck Plate thickness: 2.5cm

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Area of paper boat (m²) (1)</th>
<th>Area of original ship (m²) (2) = (1) * 400²</th>
<th>Thickness (m) (1 m =100cm) (3)</th>
<th>Volume (m³) (4)=(2)* (3)</th>
<th>Weight of Each part (kg) (5)=(4)*density of steel (Density of steel=7800kg/cu.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bow</td>
<td>.0212</td>
<td>3392</td>
<td>.050</td>
<td>169.6</td>
<td>1,322,880</td>
</tr>
<tr>
<td>Bow Bulk Head</td>
<td>.0031</td>
<td>496</td>
<td>.025</td>
<td>12.4</td>
<td>96,720</td>
</tr>
<tr>
<td>Bow Deck Plate</td>
<td>.0082</td>
<td>1312</td>
<td>.025</td>
<td>32.8</td>
<td>255,840</td>
</tr>
<tr>
<td>Mid Hull</td>
<td>.0327</td>
<td>5232</td>
<td>.050</td>
<td>261.6</td>
<td>2,040,480</td>
</tr>
<tr>
<td>Mid Hull Bulk Head</td>
<td>.0063</td>
<td>1008</td>
<td>.025</td>
<td>25.2</td>
<td>196,560</td>
</tr>
<tr>
<td>Mid Hull Deck Plate</td>
<td>.0153</td>
<td>2448</td>
<td>.025</td>
<td>61.2</td>
<td>477,360</td>
</tr>
<tr>
<td>Stern</td>
<td>.0169</td>
<td>2704</td>
<td>.050</td>
<td>135.2</td>
<td>1054,560</td>
</tr>
<tr>
<td>Stern Bulk Head</td>
<td>.0031</td>
<td>496</td>
<td>.025</td>
<td>12.4</td>
<td>96,720</td>
</tr>
<tr>
<td>Stern Deck Plate</td>
<td>.0071</td>
<td>1136</td>
<td>.025</td>
<td>28.4</td>
<td>221,520</td>
</tr>
<tr>
<td>Super Structure</td>
<td>.0092</td>
<td>1472</td>
<td>.050</td>
<td>73.6</td>
<td>574,080</td>
</tr>
</tbody>
</table>

Total weight of the Steel Plates = 6,336,720 kg
Calculation of Weight of the Ship

1. Total weight of steel used = 6336.7 tons
   (Weight of steel used is approximately 50% of the weight of ship)
   \[ = \frac{6336.7}{0.5} \]
   Therefore, the Weight of the Ship is 12,673 tons

2. Weight of the cargo (1500 TEU containers)
   (Weight of 1 TEU container = 24 tons)
   \[ = 1500 \times 24 \]
   Weight of 1500 TEU containers = 36,000 tons
   Therefore,
   Total weight of the ship (w) = Weight of the Ship + Weight of the Containers
   \[ = 48,673 \] tons
Calculation of Draft of the Ship

Draft of the Ship = 11.25 m
Calculation of Kinetic Energy of Ship

1. Kinetic Energy of the Ship, \( KE = \frac{1}{2} \cdot m \cdot v^2 \)

   We know, \( w = m \cdot g \) \quad (g = 9.8 \text{m/s}^2)

   (\( w \) is weight, \( g \) is acceleration due to gravity and \( m \) is the mass)

   Velocity (\( V \)) is 26 knots \quad (1 \text{knot} = .514 \text{m/s})

   1\text{kg} = 9.8 \text{N}, 1 \text{Ton} = 9800 \text{N}

Solution:

\[
 KE = \frac{1}{2} \cdot m \cdot v^2 \\
 v = 26 \text{ knots} \\
 = 26 \times 0.514 \text{ m/s} \\
 = 13.26 \text{ m/s} \\
 m = 48,673 \text{ kg} \\
 KE = \frac{1}{2} \times 48,673 \times (13.26)^2 \\
 = 4279 \text{ MJ}
\]