APPOMIMATE METHOD OF COMPUTING MODULUS OF RESISTANCE OF MIDSHIP SECTION.

by Tsuneo Inokuchi.

Let:

\( A = \text{Total sectional area of all longitudinal members in midship section.} \)

\( I = \text{Moment of inertia of the above mentioned about the horizontal neutral axis of the midship section.} \)

\( D = \text{Depth moulded to structural deck.} \)

\( Y = \text{Distance of top of structural deck from the neutral axis.} \)

\( C = \text{a constant which depends upon the structural arrangement as well as the form of midship section.} \)

\( Y = \frac{C \cdot A \cdot D}{I} \)

where \( C \) is a constant which depends upon the structural arrangement as well as the form of midship section, and the structural arrangements of longitudinal members similar, it may be inferred that the above relation may mathematically be similar; but for vessels of ordinary type in which the proportions of breadth to depth is usual, actually, \( C \) cannot be a constant in strict sense for all ships, as the midship sections are not generally mathematically similar.

For similar midship sections, the modulus of resistance of which is of cubic dimension, will vary as the third power of the linear dimensions or in other words area multiplied by depth. Therefore we may write:

\( Y = \frac{D \cdot I^2}{A} \)

\( Y = \text{Distance of top of structural deck from the neutral axis.} \)

\( D = \text{Depth moulded to structural deck.} \)

\( I = \text{Moment of inertia of the above mentioned about the horizontal neutral axis of the midship section.} \)

\( A = \text{Total sectional area of all longitudinal members in midship section.} \)

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MODULUS OF RESISTANCE OF MIDSHIP SECTION.
The values of the constant C are calculated by taking three different awning decked vessels, or the so-called shelter decked vessels without tonnage openings, and five different heavy decked vessels.

The values of the constant C are calculated by taking:

- A. 200 ft. oin. x 33 ft. oin. x 24 ft. oin. to awning deck,
- B. 300 ft. oin. x 43 ft. oin. x 29 ft. 6 in. to awning deck,
- C. 400 ft. oin. x 53 ft. oin. x 34 ft. 6 in. to awning deck,
- D. 400 ft. oin. x 53 ft. oin. x 29 ft. 9 in. to awning deck,
- E. 400 ft. oin. x 53 ft. oin. x 29 ft. 9 in. to awning deck,
- F. 400 ft. oin. x 53 ft. oin. x 29 ft. 9 in. to bridge deck.

For the calculation of the moment of inertia of the midship section, the following assumptions are made:

- It is 0.6.
- The vessel H is the same as those of C, but has a long bridge, the proportion of length to depth for the vessel H is 1.4, and that for the vessel A is 1.1, which is very near 1.3, above which Lloyd's Rules require a bridge extending over the half length of vessel amidships. The dimensions of length to depth for the vessel F is 1.23, and that for the vessel G is 1.34, which is very near 1.35, above which Lloyd's Rules require a bridge extending over the half length of vessel amidships.

The vessels A and B are of single bottom type, and the others have double bottom. The proportion of length to depth of the vessel F is 12.3, and that for the vessel G is 13.4, which is very near 13.5, above which Lloyd's Rules require a bridge extending over the half length of vessel amidships.

The scantling of these vessels are determined by Lloyd's Rules of 1913-1914. The heavy decked vessels have the following dimensions:

- A. 200 ft. oin. x 33 ft. oin. x 18 ft. 6 in. to upper deck,
- B. 300 ft. oin. x 43 ft. oin. x 25 ft. 6 in. to upper deck,
- C. 400 ft. oin. x 53 ft. oin. x 32 ft. 6 in. to upper deck,
- D. 400 ft. oin. x 53 ft. oin. x 29 ft. 9 in. to upper deck,
- E. 400 ft. oin. x 53 ft. oin. x 29 ft. 9 in. to upper deck,
- F. 400 ft. oin. x 53 ft. oin. x 29 ft. 9 in. to upper deck.

The principal dimensions of the awning decked vessels are as follows:

- A. 200 ft. oin. x 33 ft. oin. x 24 ft. oin. to awning deck,
- B. 300 ft. oin. x 43 ft. oin. x 29 ft. 6 in. to awning deck,
- C. 400 ft. oin. x 53 ft. oin. x 34 ft. 6 in. to awning deck.

The values of the constant C are calculated by taking the three different awning decked vessels, or the so-called shelter decked vessels without tonnage openings, and five different heavy decked vessels.
1) The reduction in area for the rivet holes in the tension side is not made.
2) Ceiling and plankings are not taken into consideration.
3) The breadth of hatchway is 1/3 of ship's breadth.
4) Moment of inertia of each longitudinal member about its own neutral axis is neglected.

The longitudinal members which are taken in calculation are shown in the midship section given in the accompanying Fig. I. The results are given in the accompanying Table. It can be seen that the constant $C$ varies within a narrow range of 0.26 to 0.31, thus the modulus of resistance of the midship section of ordinary ship can be computed approximately by the above formula.

The End

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<thead>
<tr>
<th>$C = \frac{AD}{I}$</th>
<th>$D$</th>
<th>$A$</th>
<th>$I$</th>
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<tr>
<td>1.01</td>
<td>8.6</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1.02</td>
<td>8.7</td>
<td>0.01</td>
<td>1.01</td>
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<tr>
<td>1.03</td>
<td>8.8</td>
<td>0.02</td>
<td>1.02</td>
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<tr>
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<td>1.05</td>
<td>9.0</td>
<td>0.04</td>
<td>1.04</td>
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</table>

TABLE

<table>
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<tr>
<th>Kind</th>
<th>$C$</th>
<th>$D$</th>
<th>$A$</th>
<th>$I$</th>
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</thead>
<tbody>
<tr>
<td>H 400 ft.</td>
<td>0.26</td>
<td>8.6</td>
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<tr>
<td>G 400 ft.</td>
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<td>8.7</td>
<td>0.01</td>
<td>1.01</td>
</tr>
<tr>
<td>F 400 ft.</td>
<td>0.28</td>
<td>8.8</td>
<td>0.02</td>
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<tr>
<td>E 400 ft.</td>
<td>0.29</td>
<td>8.9</td>
<td>0.03</td>
<td>1.03</td>
</tr>
<tr>
<td>D 400 ft. heavy decked vessel</td>
<td>0.30</td>
<td>9.0</td>
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</tr>
<tr>
<td>C 400 ft.</td>
<td>0.31</td>
<td>9.1</td>
<td>0.05</td>
<td>1.05</td>
</tr>
<tr>
<td>B 400 ft.</td>
<td>0.32</td>
<td>9.2</td>
<td>0.06</td>
<td>1.06</td>
</tr>
<tr>
<td>A 200 ft. arming decked vessel</td>
<td>0.33</td>
<td>9.3</td>
<td>0.07</td>
<td>1.07</td>
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</tbody>
</table>
Fig. 1.
MIDSHIP SECTION OF THE VESSEL "H"
400'-0" × 55'-0" × 29'-9" to upper dk, 37'-9" to Bridge dk.