Towing support tool and object drift at sea

National Maritime Research Institute

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(presented by Michel Olagnon)
Research background

- Nakhodka oil leakage incident (Jan. 1997)
- Erika oil leakage incident (Dec. 1999)

- Importance of drift prediction and towing technology of disabled ships in rough waves

- Estimation of drift motion
- Estimation of towline force
- Needed power in rough waves
- Towline settlement
- Towing method

Development of support system for optimum towing
Research committee for Towing technology

Japan Coast Guard, Universities
Salvage company, Wire rope company
Synthetic fiber rope company

(1) Research on the drift motion
(2) Research on the estimation of the towline tension
(3) Research on the optimum towing
(4) Development of the synthetic supporting system for optimum towing
Research committee WG

(1) Towing support system WG (NMRI, JCG, Salvage co.)
- Investigation of optimum towing support system
- Investigation of the past incidents

(2) Towing techniques WG (NMRI, JCG, Salvage, Wire rope co., Synthetic fiber rope co.)
- Towline settlement and strength test
- Towline materials database

(3) Drift simulation WG (NMRI, JCG, Meteorological Agency Universities)
- Improvement of the accuracy of drift simulation
- Water tank test
Reference to past results or default values
## Sea conditions

**Be sure to input *marked items.**

| *Wind* |  
|--------|----------------|
| *Velocity* | 5 m/s  
| *Direction* | 0 deg  

| *Current* |  
|-----------|----------------|
| *Velocity* | 0 m/s  
| *Direction* | 180 deg  

| *Wave* |  
|---------|----------------|
| *Type* |  
| regular  
| irregular: *long crested*  
| *short crested*  

| *Height* | 1.5 m  
| *Period* | 7 s  
| *Direction* | 0 deg  


Principal dimension of disabled ship

Be sure to input '*' marked items.

<table>
<thead>
<tr>
<th>Type</th>
<th>tanker (double hull)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading condition</td>
<td>full</td>
</tr>
<tr>
<td>Size</td>
<td>L: 265 m</td>
</tr>
<tr>
<td></td>
<td>B: 48.3 m</td>
</tr>
<tr>
<td></td>
<td>D: 22.4 m</td>
</tr>
</tbody>
</table>
Broken condition of disabled ship &
Calculation of center of gravity and damage stability

Display button of screen.

Start button of damage stability calculation

Display button of screen.
Specifications of tow ship and towline

Be sure to input '*' marked items.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used towline</td>
<td>Existens</td>
</tr>
<tr>
<td>Type of towship</td>
<td>Patrol boat</td>
</tr>
<tr>
<td>1000t class</td>
<td></td>
</tr>
<tr>
<td>Dimension of towship</td>
<td>L: 91.47 m, B: 11 m, D: 5 m, d: 4.06 m</td>
</tr>
<tr>
<td>Material</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>Length</td>
<td>400 m</td>
</tr>
<tr>
<td>Diameter</td>
<td>75 mm</td>
</tr>
<tr>
<td>Tow speed</td>
<td>From: 1 kt, To: 5 kt, Every: 1 kt</td>
</tr>
<tr>
<td>Tow direction</td>
<td>North: 0 deg, East: 90 deg, From: -60 deg, To: 60 deg, Every: 10 deg</td>
</tr>
</tbody>
</table>

Flow
GZ-curve
Longitudinal strength

Longitudinal Strength

Shear Force (MT)

Bending Moment (MT-M)
Main particulars of type ships

<table>
<thead>
<tr>
<th>Type ship</th>
<th>Tanker 1</th>
<th>Tanker 2</th>
<th>Container</th>
<th>Barge</th>
<th>Bob</th>
<th>Cargo</th>
<th>Fishing boat</th>
</tr>
</thead>
<tbody>
<tr>
<td>D/W</td>
<td>258,000</td>
<td>150,000</td>
<td>23,700</td>
<td>12</td>
<td>600</td>
<td>18,000</td>
<td>499GT</td>
</tr>
<tr>
<td>Lpp (m)</td>
<td>320.00</td>
<td>265.00</td>
<td>200.00</td>
<td>70.00</td>
<td>180.00</td>
<td>156.00</td>
<td>53.00</td>
</tr>
<tr>
<td>B (m b) (m)</td>
<td>58.00</td>
<td>48.30</td>
<td>32.00</td>
<td>20.00</td>
<td>32.00</td>
<td>26.60</td>
<td>9.40</td>
</tr>
<tr>
<td>D (m b) (m)</td>
<td>22.80</td>
<td>22.40</td>
<td>16.50</td>
<td>4.00</td>
<td>14.00</td>
<td>14.10</td>
<td>3.95</td>
</tr>
<tr>
<td>d (m b) (m)</td>
<td>18.50</td>
<td>15.20</td>
<td>10.50</td>
<td>3.80</td>
<td>8.50</td>
<td>9.00</td>
<td>3.60</td>
</tr>
<tr>
<td>C</td>
<td>0.83</td>
<td>0.83</td>
<td>0.56</td>
<td>0.92</td>
<td>0.55</td>
<td>0.70</td>
<td>0.66</td>
</tr>
<tr>
<td>lcb (%)</td>
<td>-3.70</td>
<td>-3.30</td>
<td>2.40</td>
<td>-0.90</td>
<td>2.38</td>
<td>-0.54</td>
<td>1.15</td>
</tr>
</tbody>
</table>

1) Principal dimensions
2) Compartment
3) Basic weight
4) Damage stability under basic loading condition
Tank arrangement of 150000DWT tanker and broken position

- C.O.T.
- B.W.T.
- Slop tank
- F.O.T.
- F.W.T.
- Engine room
- F.P.T.
- A.P.T.
GZ-curve (1/3 part of tanker remaining)

Full loaded

Ballast

bow

stern
1/2 fore part of tanker remaining (ballast)
Form of submerged part
Calculation of hydrodynamic force and motion

Start button of hydrodynamic force calculation

Display button of screen

Start button of motion calculation

Caution

Care1: You calculate hydrodynamic force and ship motion newly.
Press buttons as follows, "Force", "Motion" and "Animation".
If "Force" and "Motion" buttons are pressed, MS-DOS
Screens appear until the calculations are terminated. Please wait
and don't press any buttons during calculation.

*Care2: Skip
Press "Close" button.
### Submerged part of type ship status

<table>
<thead>
<tr>
<th></th>
<th>Stern trim 3°</th>
<th>Bow trim 3°</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barge</strong></td>
<td><img src="image1.jpg" alt="Image" /></td>
<td><img src="image2.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Cargo</strong></td>
<td><img src="image3.jpg" alt="Image" /></td>
<td><img src="image4.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Container</strong></td>
<td><img src="image5.jpg" alt="Image" /></td>
<td><img src="image6.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Fishing boat</strong></td>
<td><img src="image7.jpg" alt="Image" /></td>
<td><img src="image8.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>PCC</strong></td>
<td><img src="image9.jpg" alt="Image" /></td>
<td><img src="image10.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Tanker</strong></td>
<td><img src="image11.jpg" alt="Image" /></td>
<td><img src="image12.jpg" alt="Image" /></td>
</tr>
<tr>
<td>(Double hull)</td>
<td><img src="image13.jpg" alt="Image" /></td>
<td><img src="image14.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>Tanker</strong></td>
<td><img src="image15.jpg" alt="Image" /></td>
<td><img src="image16.jpg" alt="Image" /></td>
</tr>
<tr>
<td>(Single hull)</td>
<td><img src="image17.jpg" alt="Image" /></td>
<td><img src="image18.jpg" alt="Image" /></td>
</tr>
</tbody>
</table>
Submerged part of broken tanker

<table>
<thead>
<tr>
<th>Part</th>
<th>Trim</th>
<th>LOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aft part</td>
<td>-6.0°</td>
<td>176.6m</td>
</tr>
<tr>
<td>Fore part</td>
<td>6.0°</td>
<td>88.3m</td>
</tr>
<tr>
<td>All</td>
<td>Even keel</td>
<td>265.0m</td>
</tr>
</tbody>
</table>

LOA = Length Overall
<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Submerged Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo</td>
<td>![Cargo Submerged Part]</td>
</tr>
<tr>
<td>draft: 7.69m</td>
<td>trim: 0.53°</td>
</tr>
<tr>
<td>Container</td>
<td>![Container Submerged Part]</td>
</tr>
<tr>
<td>draft: 12.03m</td>
<td>trim: 1.21°</td>
</tr>
<tr>
<td>Fishing boat</td>
<td>![Fishing boat Submerged Part]</td>
</tr>
<tr>
<td>draft: 2.76m</td>
<td>trim: 1.86°</td>
</tr>
<tr>
<td>PCC</td>
<td>![PCC Submerged Part]</td>
</tr>
<tr>
<td>draft: 12.57m</td>
<td>trim: 0.56°</td>
</tr>
<tr>
<td>Tanker</td>
<td>![Tanker Submerged Part]</td>
</tr>
<tr>
<td>draft: 9.52m</td>
<td>trim: 1.22°</td>
</tr>
</tbody>
</table>
Animation

If "Motion_Anim" button is pressed, this ship moves.

View point and scale can be changed with mouse.

Wave period: 9 sec.
Wave height: 3 m
Wave incident angle: 30°
Steady drift calculation

Start button of steady drift calculation

Display button of screen
Results of steady drift calculation

Drift speed, drift direction are displayed

Definition of variables
Maneuver simulation

Start button of maneuver simulation

Display button of screen

Display button of screen

Caution
*Case1: You execute maneuver simulation newly. Press button as follows; "Calculation", "Results" and "Close". If "Calculation" button is pressed, MS-DOS screen appears until calculation is terminated. Please wait and don't press any buttons during calculation.
*Case2: Refer to results without executing calculation. Press buttons as follows; "Results" and "Close".
*Case3: Skip Press 'Close' button.
Result of maneuver simulation

The maximum value of towline tension

The maximum value of unstable motion amplitude of towed ship
Trajectory of tow ship and towed ship

Trajectory and position of the two ships

Tension

Sea condition:
- Wave Velocity: 10.0 m/s
  - Height: 3.0 m
  - Period: 10.0 s

- Current Velocity: 0.0 m/s

Tow speed: 3 km

Ship direction: 0 deg

Sag: ... m
Problems on optimal towing support system

- **Tow speed**
  - Calculating wave drift force on the assumption that tow speed is 0kt

- **Effect of ship status**
  - Not being able to estimate the wind coefficient when ship has large trims or heels

- **Effect of ship form**
  - If ship is broken, it is difficult to estimate hydrodynamic force accurately. Therefore, there is a limit to estimating maneuverability of abnormal ship form. However, it is possible to improve accuracy by accumulating database.

- **Performance of rudder**
  - Not having detailed data of ship which has two rudders, single rudder performance from turning test results are used.

- **Towing point**
  - In choosing towing point, it is general to take towing point at the fore side. Therefore, in case of taking towing point at the aft side, it is difficult to estimate maneuverability accurately.
Application of results and ripple effects

Share data of a drifting ship on network

Salvage companies

Japan Coast Guard
Search and Rescue department

Local branch of coast guard
Search and Rescue department

Patrol boats

Internet

NMRI
OTSS host computer

Construction of emergency towing database

International cooperation: CEDRE, IFREMER (France), SASEMAR (Spain)
Further developments (as could be done in collaboration with ....)

- extend reference database
- improve drift computation
- improve sea conditions description
- present more decision consequences
- help with complex choices

etc.