The Influence of Roll-Trailer Loaded with heavy weight cargo on PCTC cargo deck

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1. Introduction
There are a warp of the deck by the overload and a report of the damage recently in PCTC. The transported Passenger-Cars, Trucks and Construction machines by PCTC increase to cargo dimension and weight year by year.

It is very important that protect the cargo that was required to marine transportation from a customer until final destination for shipping line. Then, of course the cargo damage accident is very serious for a customer and some vessel’s damage by over-load is very serious for shipping line too.

Accordingly, it is very important that it does confirm and investigate when we make pre-stowage plan for prevent these accidents and damage beforehand.

In this study, we target heavy-cargo which was stress on PCTC cargo deck. The heavy cargoes that PCTC transports are self-propelled construction machines usually. However, Vessel’s ramp-way has strength restrictions (=Ramp capacity) for entering to cargo hold. Therefore, the heavy weight cargo is taken apart less than ramp capacity and stow to in-hold by Roll-Trailer loaded with heavy cargo.

PCTC can cargo operation in the time when it is shorter than a conventional vessel. So, we guess that the cargo work style of PCTC using Roll-Trailer will increase in a future.

2. Loading Cargo
2.1 Roll-Trailer
The requirement to load self-propelled heavy cargo on PCTC is as follows,
• Cargo height less than Clear height of cargo-hold.
• Cargo weight less than Ramp-way capacity.

If cargo height or cargo weight over above requirements, over height or weight cargo is taken apart less than ramp capacity or clear height of cargo-hold and stow to in hold by Roll-Trailer loaded with heavy cargo. (Fig 1)

2.2 Stowing Cargo
We adopt the following cargo to study the influence of loading deck.(Fig 2)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>L×W×H (m³)</th>
<th>Weight (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Body</td>
<td>930×210×360</td>
<td>41.1</td>
</tr>
<tr>
<td>Center Weight</td>
<td>163×255×478</td>
<td>11.7</td>
</tr>
<tr>
<td>40' Roll-Trailer</td>
<td>1255×255×326</td>
<td>7.6</td>
</tr>
<tr>
<td>TTL (Judgment)</td>
<td>H=63 (OK) &lt; 660</td>
<td>63.6 (OK) &lt; 100</td>
</tr>
</tbody>
</table>

3. Simulation
3.1 The influence of Loading-Deck by Heavy cargo
In this section, we performed a simulation on a warp of loading-deck.

3.2 Calculation method
We built the lattice environment model by Beam and Deck-Trans. (Fig 3)

Fig 3. Lattice model of loading-deck

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First, we load Roll-Trailer with heavy weight cargo on the lattice model. Second, solve a sectional force by lattice calculation. Third, calculate each stress to act loading-deck. Fourth, compare each stress and evaluate safety.

3.3 Loading Environment
In this section, we built models of stuffing Roll-Trailer for 2 pattern (A&B). Next, perform a simulation on a warp of loading-deck.. (Figs4&5)

4. Result of Simulation
We show state of a warp that obtain by simulation as follows, (Figs6&7)

5. Conclusions
In this study, we built a stowage environment model of stuffing Roll-Trailer, next, considered and simulated the influence of PCTC cargo deck.

Thus, the conclusion obtain in the present study is given as follows,

The quantity of a warp that we calculate is able to keep enough (Approx 3 to 4times) safety margins in comparison with the breaking stress of the steel materials that constituted loading-deck. (Fig8)

Enough safety margins are very important for cargo and vessel damage prevention in a future.

Reference
(2) ClassNK (2015): Guidance for the Survey and Construction of Steel Ships (Part C)