Trends in the Development of Container Vessels

Presentation at NTU Athens
Contents

• Technological Development of Container Vessels

• The current size limits and future prospects

• The 9200TEU Post-Panamax Vessels

• Protected Location for F.O. Tanks

• Propulsion Plant

• Specific Design Aspects
TEU = Twenty feet Equal Unit
6,058 x 2,438 x 2,591
20´ = 6,058 m
 Converted T2-Tanker for Container Transport, Sea-Land Inc.
In 1968: 1st Generation
700 TEU at 20 knots
In 1972: 3rd Generation
3000 TEU at 26 knots

- High freeboard
- Only 35% containers on deck
Modern Panamax Container Ship up to 5050 TEU

• More stowage capacity by widening the decks at the ends
• about 50% containers on deck
Close to 60% of containers are stowed on deck

How well can you see from the bridge?
Baltic CS 5600 Panmax Compact
“Typical” Post Panamax Ship of 5500 TEU
$L = 262 \text{ m}$, $B = 40 \text{ m}$
Maersk Sealand – 6,200 TEU – 2000
5500 TEU Type lengthened for COSTAMARE
Post Panamax Ship 7500 TEU
$L = 320 \text{ m}$, $B = 42,8 \text{ m}$
Colombo Express
335 m Length – 14,5 m Draught – 42,8 m Breadth
60,5 m Air draft - 108,000 tdw
Anna Maersk
352,18 m Length - 15 m Draught - 42,8 m Breadth
63,5 m Air draft - 93,496 BRZ- 109,000 tdw
World Containerization of the General Cargo Trades

Source: Transystem Corporation
Freight per TEU between Singapore and Rotterdam
Forecast of rate of growth for container transport

YEAR

TEU - Millions

- Far East
- Mediterranean
- N Europe
- N America
- C America
- Middle East
- S America
- Austraslia
- Indian Sub Continent
- Africa
- Caribbean

Germanischer Lloyd
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## Post-Panamax Container Ships

6800 to 8400 TEU \((B = 42.8m)\)

<table>
<thead>
<tr>
<th>Size</th>
<th>6800 to 7500</th>
<th>7200 to 7800</th>
<th>7800 to 8400</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L_{BP})</td>
<td>286 m</td>
<td>304</td>
<td>319</td>
</tr>
<tr>
<td>B</td>
<td>42,8 m</td>
<td>42,8 m</td>
<td>42,8 m</td>
</tr>
<tr>
<td>T_{scant}</td>
<td>14,0 – 14,5 m</td>
<td>14,0 – 15,0 m</td>
<td>14,5 – 15,0 m</td>
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<tr>
<td>40´bays</td>
<td>18 (4/14)</td>
<td>19 (4/15)</td>
<td>20 (5/15 or 4/16)</td>
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<tr>
<td>Msw</td>
<td>533.000 tm</td>
<td>600.000 tm</td>
<td>630.000 tm</td>
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### Actual Dimensions of 9000 + TEU Container Ships

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Size</td>
<td></td>
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<td></td>
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<tr>
<td>L&lt;sub&gt;BP&lt;/sub&gt;</td>
<td>331,0 m</td>
<td></td>
<td>321,0 m</td>
<td>333,4 m</td>
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<tr>
<td>L&lt;sub&gt;oa&lt;/sub&gt;</td>
<td>347,0 m</td>
<td>349,0 m</td>
<td>336,7 m</td>
<td>349,1 m</td>
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<tr>
<td>B</td>
<td>46,0 m</td>
<td>45,6 m</td>
<td>45,6 m</td>
<td>42,8 m</td>
</tr>
<tr>
<td>H</td>
<td>27,2 m</td>
<td>27,2 m</td>
<td>27,2 m</td>
<td>27,3 m</td>
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<tr>
<td>T&lt;sub&gt;scant&lt;/sub&gt;</td>
<td>14,5 m</td>
<td>15,0 m</td>
<td>14,5 m</td>
<td></td>
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<tr>
<td>T&lt;sub&gt;design&lt;/sub&gt;</td>
<td>13,0 m</td>
<td>13,0 m</td>
<td>13,0 m</td>
<td>13,0 m</td>
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<td>No&lt;sub&gt;zyl&lt;/sub&gt;</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>
8400 TEU Post-Panamax Container Ship

- Length o.a. about 340 m
- Breadth 42.8 m
- Draught 14.5 m
- Deck Containers
  17 Stacks
  7-8 Tiers
- Hold Containers
  15 Stacks
  9 Tiers
- 12 Cylinder Engine
  68 650 kW
## Post-Panamax Container Ship 8400 TEU

Number of TEU for Different Load Cases

<table>
<thead>
<tr>
<th>Load case</th>
<th>Total TEU</th>
<th>Deck</th>
<th>Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 t</td>
<td>8400</td>
<td>4570</td>
<td>3830</td>
</tr>
<tr>
<td>8 t</td>
<td>7700</td>
<td>3870</td>
<td>3830</td>
</tr>
<tr>
<td>10 t</td>
<td>7500</td>
<td>3670</td>
<td>3830</td>
</tr>
<tr>
<td>12 t</td>
<td>6770</td>
<td>2940</td>
<td>3830</td>
</tr>
<tr>
<td>14 t</td>
<td>5950</td>
<td>2120</td>
<td>3830</td>
</tr>
</tbody>
</table>
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## Principal Dimensions of 8200 / 9200TEU Vessels

<table>
<thead>
<tr>
<th>Size</th>
<th>L&lt;sub&gt;BP&lt;/sub&gt;</th>
<th>Breadth</th>
<th>Depth</th>
<th>T scantling</th>
</tr>
</thead>
<tbody>
<tr>
<td>8200 TEU</td>
<td>319,00 m</td>
<td>42,8 m</td>
<td>24,6 m</td>
<td>14,5 m</td>
</tr>
<tr>
<td>9200 TEU</td>
<td>321,00 m</td>
<td>45,6 m</td>
<td>27,2 m</td>
<td>15,0 m</td>
</tr>
</tbody>
</table>
Global Deformations
Variation of Main Particulars

• Side Structure (Shown in a highly exaggerated scale)

• Transverse Box Girders
Change of Maximum Relative Deformation

Relative Displacement $\Delta u$ [mm]

Breadth or Height [mm]

Double Bottom Height

Breadth of Side Structure

Breadth of Transverse Boxgirders

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Variation of Structural Arrangement

- Double Skinned Watertight Bulkheads
- Additional 20 ft Deep Tank at \( x = 214 \text{ m f. AP} \)

(Shown in a highly exaggerated scale)
Reederei Claus-Peter Offen will receive in summer 2005 the largest Container Ships

Principal Dimensions
L = 337,0m
B = 45,6 m
H = 27,2 m
T = 15,0 m
Reederei Claus-Peter Offen
MSC Pamela
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Water Ballast & Fuel Oil I

Fuel Oil

Ballast Water

Ballast Water
Fuel oil in deep tanks and water ballast water in the side tanks
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55% of the production cost belongs to the main engine
Main Engine for 8200 TEU Container Ships

Max. power: 68,650 kW / 93,360 PS

Fuel consumption: 230 t/day at 25 kn
Top-Level of the World's Powerful Diesel Engine

- Running time between maintenance: 20,000 working hours
- Running condition: 85 to 90% of MCR
- Comparison with car: 1.5 Mio. km with 150 km/h
12 Cylinder engine: bed with crank-shaft

- 12 Cylinder MAN / B&W: 24,6 m bed-plate with 160 t crank-shaft
- 68 650 kW (93 360 PS)
- shortage is the most serious problem when ordering large container ships
ME-Power of Different Ship Typ

Mean Engine Power vs TDW, Year of Building 1993-2003

- Bulkers
- Container Ships
- Tankers
Large Main Engine

14 Cylinder

P = 80,000 kW
n = 104 min⁻¹
m = 2400 t
L = 28 m
Maximum Propeller Dimensions

Diameter: 9,10 m
Weight: 102 t (130t on order)
Erosion due to Cavitation II
Cavitation Protection on a Rudder of a Post-Panamax-Vessel (Stainless Steel Cladding)
Surface grid on rudder, fixed fin and propeller
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Number of 40´bays at each Cargo Hold
Case: two 40´bays

- Higher Flexible Loading (reefer / dangerous good)
- Larger structural strength
Number of 40’ bays at each Cargo Hold
Case: three 40’ bays

- Larger Heeling Tank
- Less steel weight
Transportation of Reefer and/or Dangerous Goods

Cargo holds for dangerous goods

Cargo holds for reefer container

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Continuous Hatch Coaming
Continuous Hatch Coaming
Maximum Plate thickness up to 78 mm
Electro Gas Welding (EGW)
EGW Sample
Torsional Deflections
oblique wave with wave crest in the midbody
Different Hatch Coaming Design I
Non-Continuous Structure Arrangement
Different Hatch Coaming Design II
Inclined Structure Arrangement
Detail of Inclined Arrangement I

GL Design

Another Design
Detail of Inclined Arrangement II
Hatch Coaming Design III
20 knuckled Structure Arrangement
(critical design)
20 knuckled arrangement (critical design) II

Crack appear direct in welded knuckle
Parametric Roll

- **Heavy rolling in following seas**
- **Known since 3rd generation container ships**
- **Large container ships: danger of excessive rolling also in head seas**
- **Rolling angles of 50° and more have been reported**
OOCL America – Post-Panmax
Container Stack Collapse in rolling
Overloaded Container Columns
Overloaded Container Fittings
**Concept of the SRA system**

- Seaway measured using the nautical X-band radar
- Hydrodynamic database
- Mass information from loading computer
- Onboard calculation of ship response (OCTOPUS)
  - Monitoring of ship specific response parameters
- Display of results on the bridge

*Transfer functions*
Shipboard Routing Assistance System (SRAS)

Measured wave data

Actual loading condition

Weather forecast (alternatively)

Hydrodynamic database (prepared at office)

Central processing and display unit
Lashing Bridge Design
Lashing Bridge for 4 Tiers
Who dares the jump from 9000 to 12000 TEU
12000 TEU Container Ship

**Principal Dimensions**
- Length O. A.: 367 M
- Length B. P.: 352 M
- Breadth M.L.D.: 56 M
- Depth M.L.D.: 29 M
- Draught M.L.D. (Design): 13.5 M
- Draught M.L.D. (Displacement): 15 M

**Scale:** 1/10001

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## Possible Dimensions of Future Container Carriers > 12000 TEU

<table>
<thead>
<tr>
<th>L&lt;sub&gt;BP&lt;/sub&gt;</th>
<th>352 m</th>
<th>382 m</th>
<th>381 m</th>
<th>382 m</th>
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</thead>
<tbody>
<tr>
<td>B</td>
<td>56,0 m</td>
<td>54,2 m</td>
<td>57,0 m</td>
<td>52,0 m</td>
</tr>
<tr>
<td>H</td>
<td>29,0 m</td>
<td>27,7 m</td>
<td>29,0 m</td>
<td>?</td>
</tr>
<tr>
<td>T&lt;sub&gt;scant&lt;/sub&gt;</td>
<td>15,0 m</td>
<td>15,0 m</td>
<td>14,7 m</td>
<td>16,0 m</td>
</tr>
<tr>
<td>Rows</td>
<td>20/22</td>
<td>19/21</td>
<td>18/22</td>
<td>?/20</td>
</tr>
<tr>
<td>Prop No</td>
<td>2</td>
<td>2</td>
<td>1/2</td>
<td>1</td>
</tr>
</tbody>
</table>
FE-Model 12,000 TEU
Single or Twin Propeller Plant

14-cylinder V-engine

2 x 7 cylinder engine
Germanischer Lloyd will continue to support the development of Container Ships.

Thank you for your attention!