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MARITIME

Recent Activities Related to Strength of Large Container Ships

RINA safety committee meeting – March 2015

London

Martin Crawford-Brunt

Size Increase of Container Ships

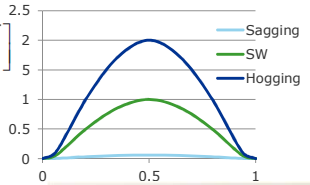
- Load increase
  - Vertical bending

$$M_{WV} = \mathbf{L}^2 \cdot \mathbf{B} \cdot c_0 \cdot c_1 \cdot c_L \cdot c_M$$

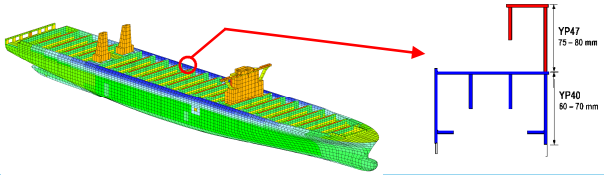
  - Torsion

$$M_{WT,max} = \pm \mathbf{L} \cdot \mathbf{B}^2 \cdot C_B \cdot c_0 \cdot c_L \cdot \left[0.11 + \sqrt{a^2 + 0.012} \right]$$

- Resistance to be increased by use of
  - High strength steel
  - Thick plates up to 100 mm



Example vertical bending

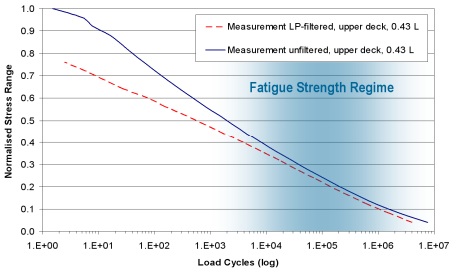


Whipping investigations based on large-scale measurements and experimental fatigue testing

- Full-scale measurements

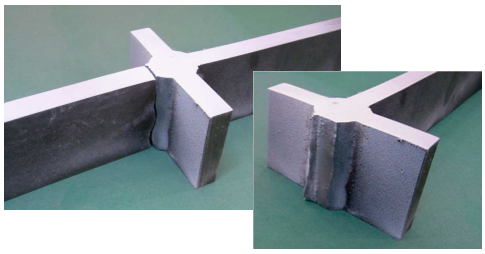
Containership	4600 TEU	8400 TEU	14 000 TEU
Type	Panamax	Post-Panamax	Post-Panamax
Operated route	Europe to East-Asia, westbound	North America to East-Asia, eastbound & East-Asia to North America, eastbound	Europe to East-Asia, eastbound
Measurement since	2007	2013	2010

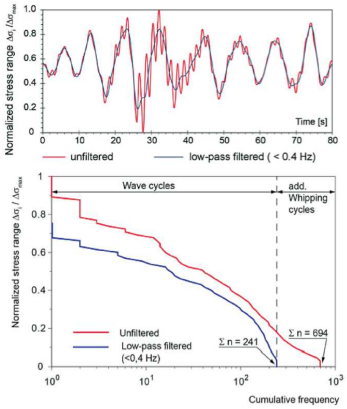
Main deck stress spectra



Whipping investigations based on large-scale measurements and experimental fatigue testing

- Fatigue tests with superimposed high/low frequency loads





- Rainflow counting and the Palmgren-Miner rule are suitable for fatigue assessment of superimposed wave and whipping stresses
- Most of the fatigue damage is caused by the low-frequent wave-induced cycles, enlarged by whipping
- Contribution of additional whipping stress cycles is rather small

Fatigue and Fracture Assessment Material up to YP47, Thickness up to 80 mm

- Running and ongoing JDPs with Korean partners

- Experimental testing
  - YP47 welds show good fatigue performance
  - Butt welds: thickness effect confirmed
  - Longitudinal stiffener: no pronounced thickness effect
  - Crack propagation growth rate of high toughness welds found to be less compared to common Rules and guidelines

Fatigue testing

Butt weld (block joint)

Long. stiffeners (out-fitting detail)

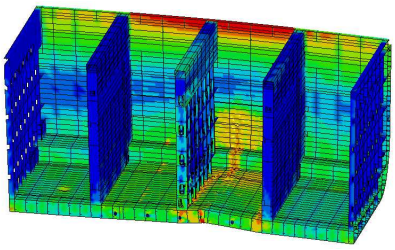
Crack propagation testing

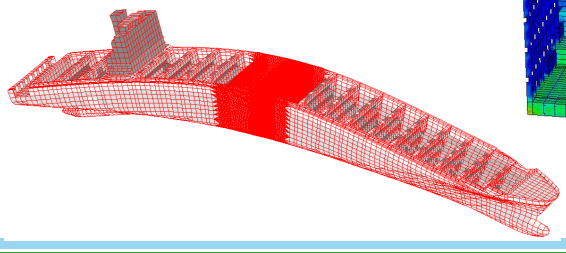
Advanced Ultimate Strength Assessment of Container Ships

Current activities include investigations of

- effect of local loads (double bottom bending effect)
- interaction of hull girder load components (vertical and horizontal bending, torsion)
- dynamic collapse effects (strain rate, buckling behavior)

on ultimate hull girder strength





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