Universität Rostock Traditio et Innovatio

HOPPE MARINE

EMship Advanced Design

Master thesis:
Development of a practical tool to determine the hull damping of modern ship hull forms

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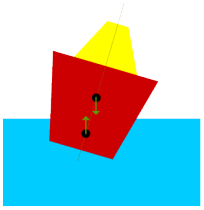
Motivation

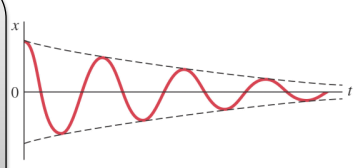
- Roll damping prediction: Why ?
  - Response in rough weather
  - Design of Stabilisation equipments
- Aim ?
  - Modern hull forms
  - New methodology for roll damping prediction
  - Alternative to Experimental model tesing

Obstacles and Challenges



Energy dissipation
Spring mass system Equation

$$(I_{44} + A_{44}(\omega))\ddot{\phi} + B_{44}(\dot{\phi}) + C_{44}(\phi) = M_{44}(t)$$



Obstacles

High Non linearity

$$B_{44}(\dot{\phi}) = B_1\dot{\phi} + B_2\dot{\phi}|\dot{\phi}| + B_3\dot{\phi}^3 + \ldots$$

Remedy

Equivalent linear roll damping coefficient

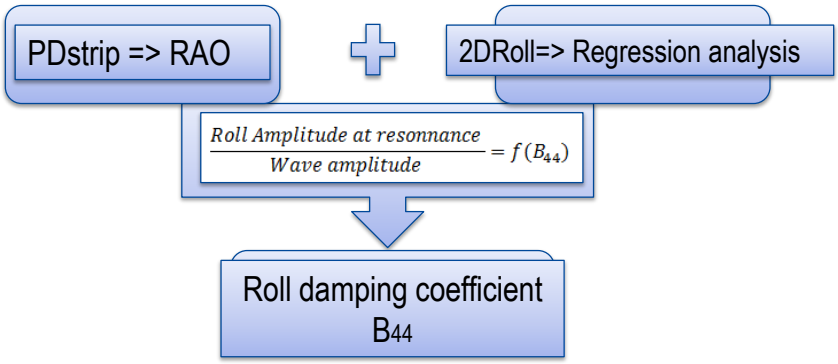
$$B(\dot{\phi}) = B_{eq}\dot{\phi}$$

Scenario of the Numerical simulations

- 4 Simulation tools
  - CFD: Potential flow theory: PDstrip
  - Component Analysis Method: IKEDA Original Method
  - Component Analysis Method: IKEDA Simple formulation Method
  - Empirical method: Miller method
- 3 Test case ships
  - 16000-18000 TEU Ultra large container ship (Container ship N°1)
  - 8000-9000 TEU Large container ship (Container ship N°2)
  - DTMB 5415: ARLEIGH BURKE-class destroyer (US Navy Ship)

Potential flow theory simulation: Pdstrip solver

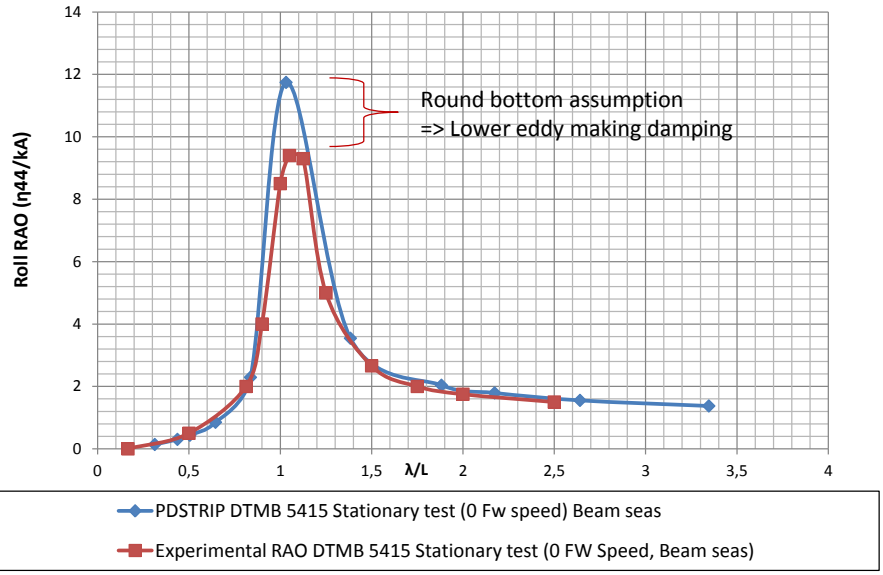
- Potential flow solver : Strip theory+ Panel method
- Wave damping accurately predicted
- Forces on fins and appendages
- Output => Transfer function(RAO)



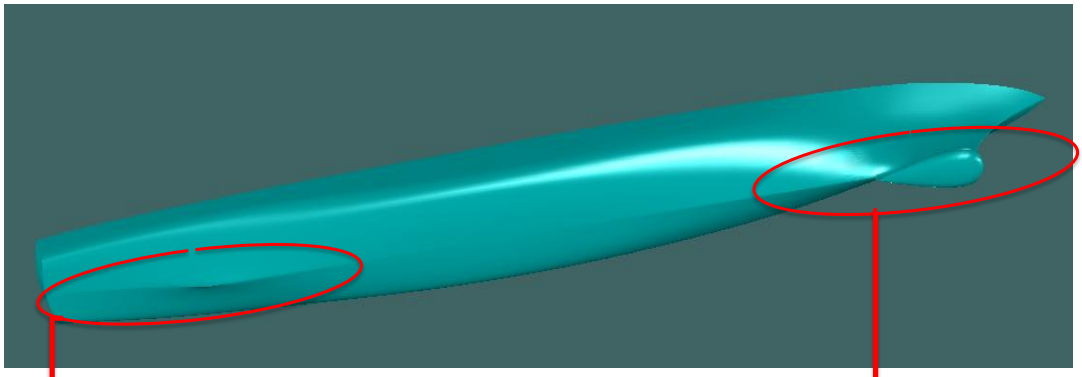
PDstrip Numerical Simulations For the US Navy ship

Estimation of roll damping from the transfer function (RAO)

Beam seas ,0 forward speed & T=6.15 m

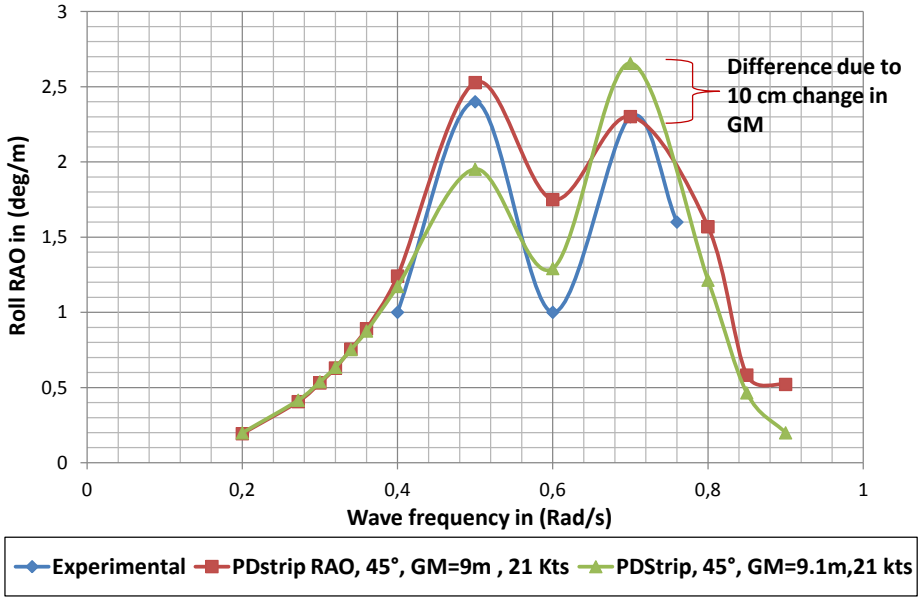


Shape of the bottom of the US Navy ship model DTMB 5415

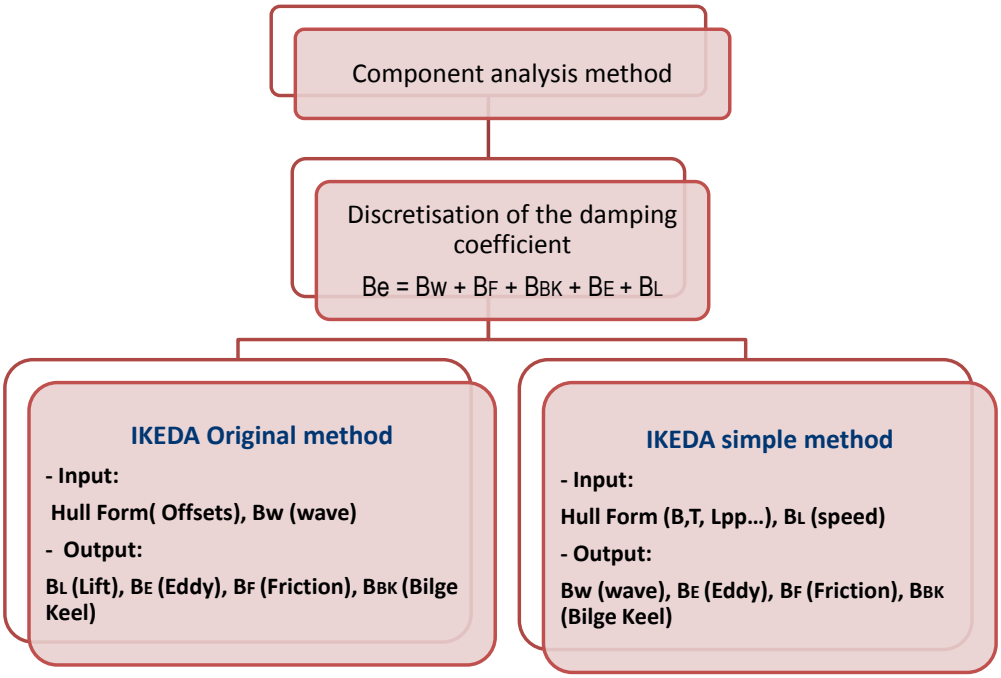


Sensitivity analysis for PDstrip RAO regarding the GM value for the container ship N°1

Roll transfer function(RAO) in (°/m) versus wave frequency in (rad/s)
stern quartering (45° from the stern) , 21 kts, GM=9m

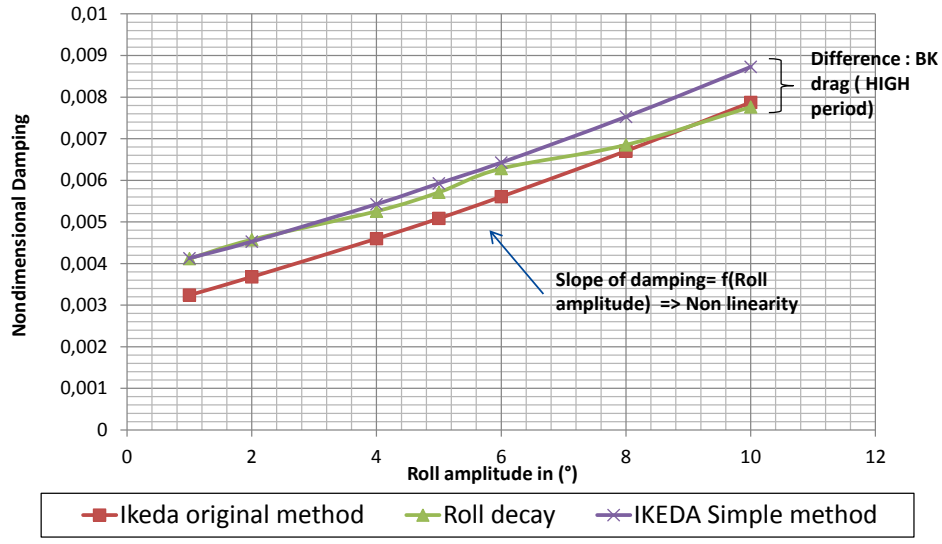


Component analysis method: IKEDA original and IKEDA simple methods



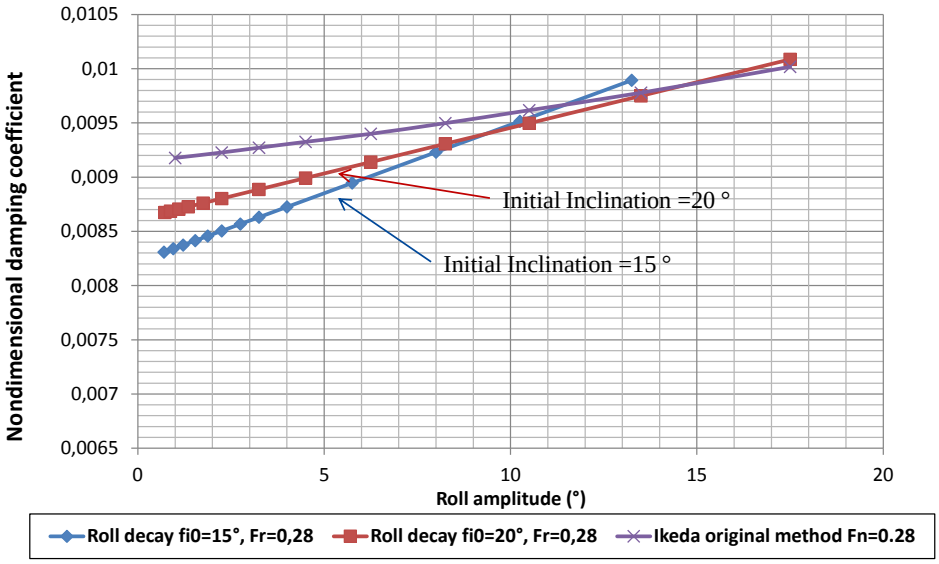
Component analysis method for Ultra large Container ship N° 1 :IKEDA Original and Simple Methods

90° heading (Beam seas), 21 Kts forward speed, GM=2.9 m



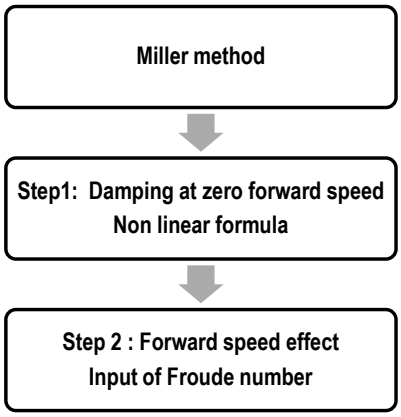
Component analysis method for the US Navy ship: IKEDA original method

Comparison of Ikeda original method results for DTMB 5415 with roll decay test results for two different initial inclination angles(20 ° and 15 °) at Fn=0.28.

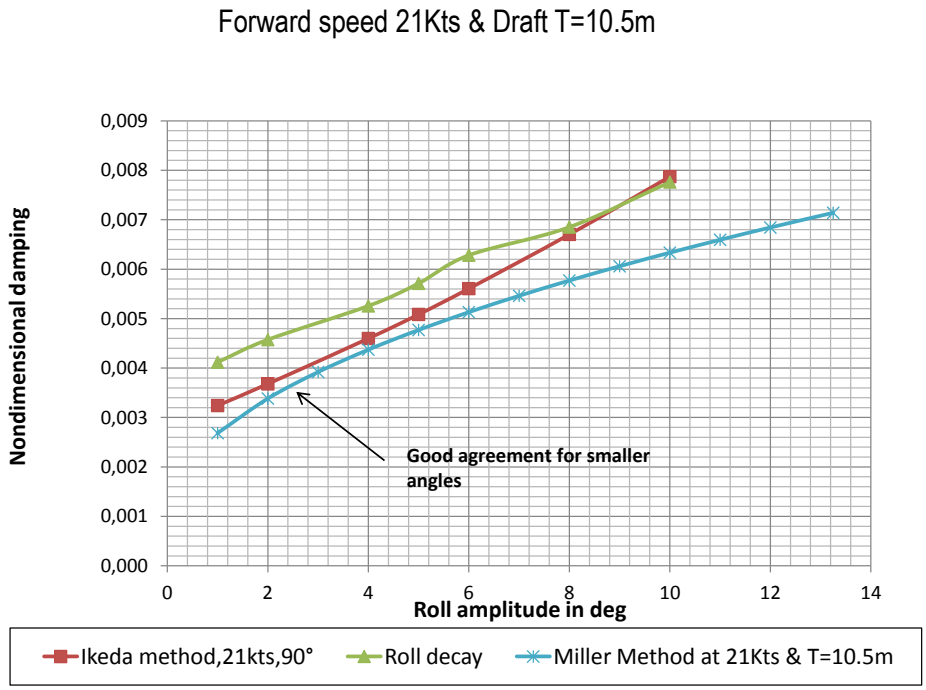


Miller method

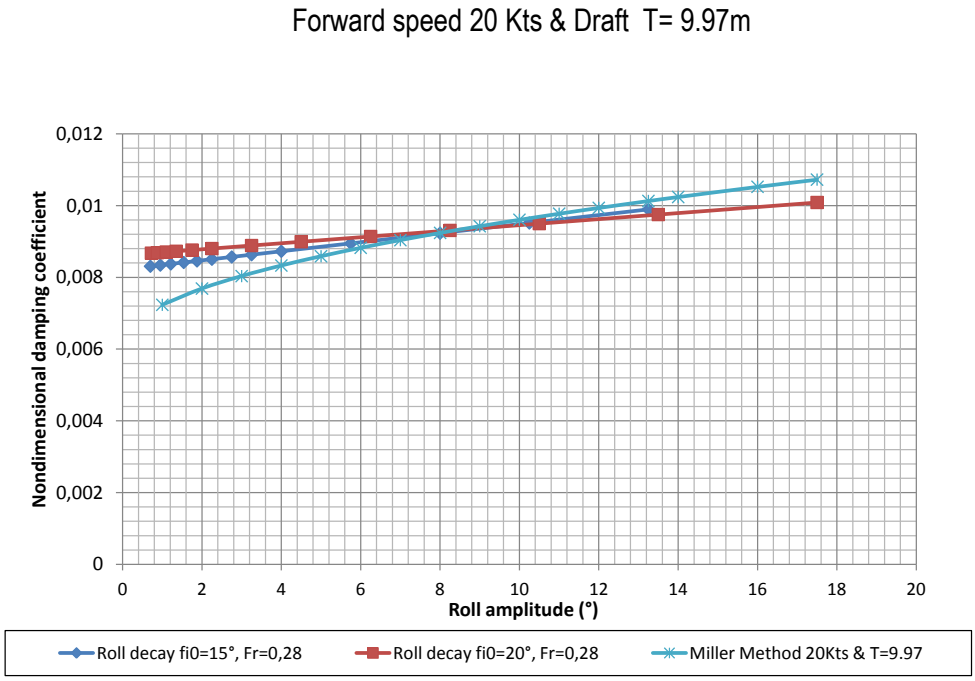
- Regression analysis => US Navy ships
- Early design stage



Miller Method Simulations For (ultra large) Container Ship N°1



Miller method simulation for the US Navy ship



Conclusion

Established methodology for roll damping prediction

No tool available for all kinds for ships

Step 1: Selecting the prediction method according to ship type:

- Potential theory: Pdstrip => - Ships with high Bw
- Component analysis-=>Low VCG (No car carrier , No large passenger vessel)
- Miller method : => Slender ships: Navy ships (Low CB)

Step 2: Approximating the damping coefficient with the fast Miller method

- Order of magnitude
- Fast method

Step 3: Running the selected method

- Benefit from the complementarity of certain methods

Complementarity and different possible combinations