

New Generation Intact Stability Criteria: Stability under Dead ship condition

by

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Introduction

- IMO is going to develop new generation intact stability criteria by 2012 for allowing the use of first-principle tools .
- These will cover
 - Harmonic resonance under dead ship condition,
 - Manoeuvring-related problems such a broaching-to,
 - Stability variation problems such as parametric rolling.
- It was agreed that the new criteria should consist of vulnerability criteria and performance-based criteria, i.e. direct stability assessment.

Introduction

- The intersessional correspondence group on intact stability (ISCG) was established at SLF 51 (July 2008) and was instructed to collect draft criteria and sample calculation results from Member States and NGOs.
- Responding to the invitation, the delegation of Japan submitted its proposals with sample calculation results, which are based on its earlier submission to SLF 51 (SLF 51/4/3), to the ISCG.
- This paper describes the contents of its submission for wider discussion at this conference.

Stability under dead ship condition

- Safety against capsizing under dead ship condition is the most basic design requirement for ships,
 - Because operational aspects are totally excluded.
 - If a ship is guaranteed to be safe under dead ship condition, a ship master can choose an option to survive.
 - Except for parametric rolling, stability in beam wind and beam waves is the worst case in dead ship condition. This was confirmed by Umeda, et al. 2007a by calculating capsizing probability with drifting attitude taken into account for all possible combination of wind and wave conditions.
- Stability in beam wind and beam waves should be modelled.

DEAD SHIP COND: vulnerability criterion

- For stability in beam wind and waves, the weather criterion was widely used even within the current IS Code.
- However, its limitation due to empirical formulae for some coefficients sometimes induces doubt of its applicability to unconventional ships.
- Thus, if these formulae for roll damping, effective wave slope coefficient and so on are updated, the weather criterion can be used as a vulnerability criterion.
- It is noteworthy here that safety level implicitly included as wind velocity should be readjusted using an advanced tool, which would be a direct stability assessment method.

DEAD SHIP COND: vulnerability criterion

- Roll angle should be estimated with following formulae.

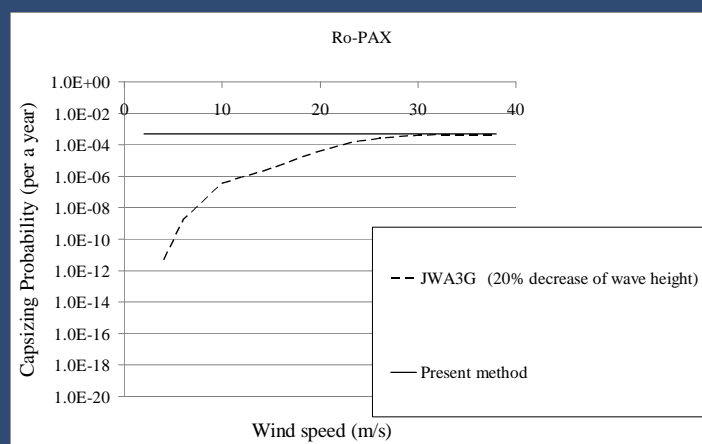
$$\phi_0 = 0.7 \sqrt{\frac{\pi r s}{2N}}$$

- N: Simplified version of Ikeda's semi-empirical formulae (Kawahara . Maekawa & Ikeda, APHYDRO 2008)
- r: Froude-Krylov formula for rectangular sections (Umeda and Tsukamoto, OC 2008)
- Wind velocity should be determined for realising appropriate safety level.

DEAD SHIP COND: direct assessment method

- Probabilistic method is desirable.
- The Monte Carlo simulation is not feasible because practical ships inherently have very small capsizing probability.
- Piece-wise linear approximation of nonlinear restoring moment is promising because it fully utilises an analytical solution in each range. (Belenky, 1993)
- The capsizing rate in a stationary seaway is calculated as the product of rate of out-crossing the border and conditional probability of roll divergence when the roll angle exceeds the border.
- Then, the capsizing probability is calculated as a Poisson process together with wind and waves statistics.

DEAD SHIP COND: direct assessment method

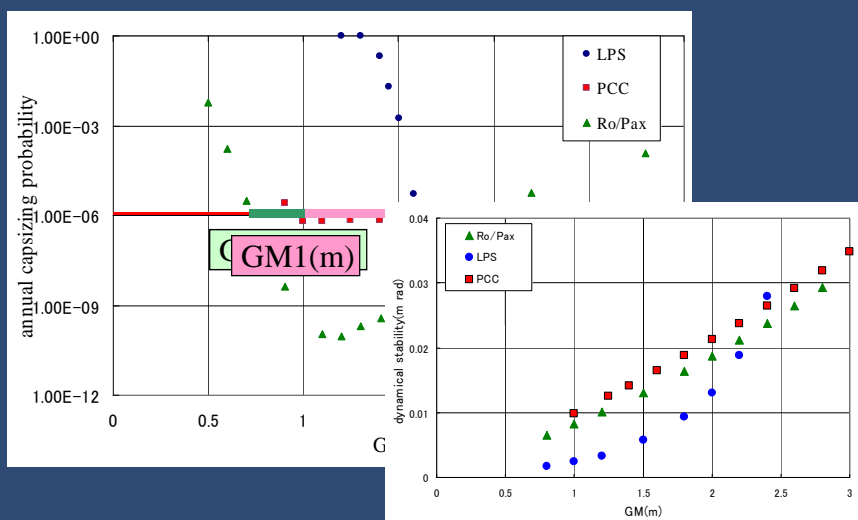


The effect of wave data on annual capsizing probability of the Ro-PAX ferry under dead ship condition. (Ogawa, 2009)

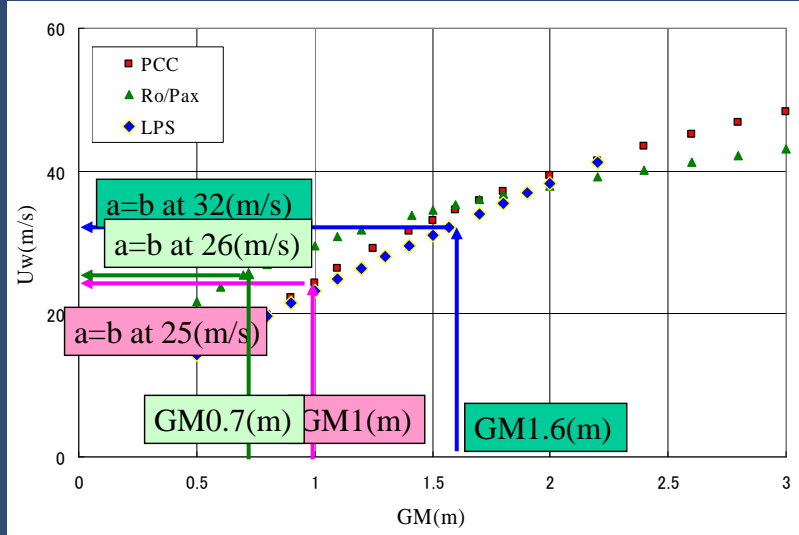
DEAD SHIP COD: sample calculation results

- For determining the mean wind velocity of the modified weather criterion, sample calculation were executed for a car carrier, a RoPax Ship and a large passenger ships in the North Atlantic.

DEAD SHIP COD: sample calculation results



DEAD SHIP COD: sample calculation results



DEAD SHIP COD: sample calculation results

- Since difference is not large, the mean wind velocity of 32 m/s can be tentatively recommended at least for these ships. Further sample calculations are required.
- It is noteworthy here that metacentric height required by the current IMO weather criterion is slightly higher than the modified weather criterion.

Concluding remarks

- Sets of vulnerability criterion and direct assessment method for stability under dead ship condition and broaching are proposed together with sample calculation results.

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