

IMO Second generation intact stability criteria for Parametric roll resonance (Level-1 and Level-2 criteria)

Dr. Shivaji Ganesan T, Mr. Amresh Negi

Dr. Shivaji Ganesan T currently holds the position of Surveyor-I at Indian Register of Shipping, in where he is engaged with research and rule development department pursuing active research related to marine and ocean engineering. He holds a Master's degree and PhD in Ocean Engineering and Naval Architecture from Indian Institute of Technology Kharagpur, India. His main area of research interest is in numerical ship and offshore hydrodynamics, particularly concerning with dynamic stability of ships, wave-structure interactions, and mooring system analysis.

Mr. Amresh Negi is working in research division of Indian Register of Shipping (IRS) since 2006. He received his graduation in Mechanical Engineering and obtained master degree in Ocean Engineering and Naval Architecture from Indian Institute of Technology, Kharagpur, India. He has been involved in various consulting and research works related to development of numerical programs for the variety of marine structural application. His area of interest includes the hydrodynamic load and motion response computation based on potential theories, prediction of long-term and short-term loads on the marine structures and ship stability in waves.

Immediately, after the release of international Intact stability code (IS 2008 code) [1] IMO started the work on second generation intact stability criteria which incorporate the ship dynamics in realistic sea waves [2]. Following detail discussions [3-5] at IMO subcommittee level, it was concluded that 2nd generation intact stability assessment will be based on multi-tier approach for five different failure modes (i.e. Pure loss of stability, parametric roll resonance, surf-riding and broaching to, dead ship, excessive accelerations) with each failure mode containing two vulnerability checks (i.e. Level-1, Level-2) and third level (Level-3 where advanced numerical simulations of ship dynamics in actual sea state is required). Of all the considered five failure modes, this paper focus on parametric roll resonance phenomena which is a common phenomena of slender large fast ship. Parametric roll occur due to change in the restoring arm (GZ) in waves or in other words it is an amplification of roll motions caused by periodic variation of transverse stability in waves when the ship encounter frequency is approximately twice of the ship roll natural frequency. All vulnerability formulas and criteria's are programmed using FORTRAN code in-house. The computed hydrostatic results was verified and validated with industry standard stability software's results such as MAXSURF, NAPA etc. Numerical example of both level-1 and level-2 vulnerability criteria results for C11-postpanamax container ship is presented by following the formulation and explanation outlined in IMO SDC 2-WP 4.0 document [6]. Level-1 vulnerability check is based on magnitude of stability change when a single longitudinal wave of length equaling the ship length passes the ship. Level-2 vulnerability assessment consist of two checks: 1) first check requires calculation of metacentric height variations along with critical ship speed as a weighted average in a set of waves given by IACS recommended scatter table 2) second check requires calculation of maximum roll amplitude in head and following seas acted upon by a regular incident wave of length equal to ship length with different wave amplitude. This vulnerability assessment requires extensive numerical calculations of ship motions in both following and head seas. Finally, all numerical results for a given loading conditions pertaining to both checks are presented in detail.