Committee Report

COMPARATIVE STUDIES ON THE EVALUATIONS OF BUCKLING/ULTIMATE STRENGTH AND FATIGUE STRENGTH BASED ON IACS JTP AND JBP RULES

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The Committee on International Common Rules of Ship Structures
The Japan Society of Naval Architects and Ocean Engineers
(JASNAOE)

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SUMMARY

Having reviewed the 2nd and 3rd draft CSR for double hull oil tankers and bulk carriers, the Committee on International Common Rules of Ship Structures of the Japan Society of Naval Architects and Ocean Engineers (JASNAOE), have carried out some investigations, by comparatively studying the JTP and JBP rules focusing on typical structures and structural details. We hope that the results could offer useful background information for the anticipated harmonization of the two CSR in the near future.

The report is organized in the following manner; in Part 1, comparative studies are carried out for buckling and ultimate strength analyses of plates and stiffened panels by using JTP PULS and JBP GL methods. In Part 2, comparative studies are carried out for ultimate strength analyses of various hull girders. In Part 3, regarding the fatigue strength evaluation, we have applied both JTP and JBP methods to an experimental result of a large-scaled bilge hopper connection, which is subjected to programmed variable loading under the changes of mean stress level.

With regard to the ultimate strength analyses of stiffened panels subjected to biaxial thrust, the PULS, GL and finite element methods are compared and the results are found to be in good correlation with each other. PULS may overestimate the ultimate strength of panels with large web height due to the insufficient modeling of the lateral-torsional buckling of stiffeners. PULS assumes the initial imperfections following the elastic critical modes. This in general leads to a conservative estimate of the ultimate strength of stiffened panels that actually have symmetric hungry-horse mode imperfections due to fillet weld and never the asymmetric ones. Some conservatism is inevitable in rules, but over-conservatism without rational and realistic backgrounds is to be avoided, because recently we observe less systematic buckling damages in ship structural members due to the improved knowledge on loads and buckling/ultimate strengths.

Ultimate hull girder strength is compared by the JTP and JBP methods, together with a progressive collapse analysis code, HULLST, where the both methods seem to give good estimation of the ultimate hull girder strength. It is also found that the initial yielding strength could be a good measure of the ultimate hull girder strength under sagging condition.

With regard to fatigue strength assessment, the JTP and JBP methods are used to compare the result of a bilge knuckle joint subjected to a block program loading condition. Although, the both methods use different procedures for the hot spot stress, mean stress, and residual stress evaluations as well as different fatigue S-N curves, the final results are found to be in good agreement with each other. Obviously, it is impossible to conclude from this single example, but we need more evidence in order to reach the harmonization.

We believe that the direct fatigue strength calculation may also be applied to the connection of a longitudinal stiffener and a transverse frame, which may lead to the design flexibility of structural details. We recommend the IACS JTP and JBP groups to carry out the comparative studies of the fatigue strength evaluation of specific ships with records of fatigue damage. By doing such calibrations, a better harmonization could be reached so that it can clearly distinguish the damage/no damage conditions for actual ships in service.

It should also be noted that in ramification studies in Japan, considerable increase of plate thickness is sometimes observed in certain areas of double hull tankers. For the rational harmonization of the rules together with the assumed loads and specific safety margins, we believe that such increase of scantlings should be answered with satisfactory background data as soon as practical. We hope that the present studies may contribute to the better harmonization of the IACS common rules from this respect.