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Collapse behavior based on optimum design of grillage systems with multi-objectives

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Summary

In this study a micro genetic algorithm based method is developed for the optimum design of grillage systems. Many real-world design problems involve simultaneous optimization of multiple objectives. In the case of multiple objectives, there may not exists one solution which is the global optimum with respect to all objectives. In the multi-objective optimization problem, there exists a set of solutions which are superior to the rest of solutions in the search space when all objectives are considered but are inferior to other solutions in the space in one or more objectives. These solution are known as Pareto-optimal solutions or non-dominated solutions. The considered grillage design is a multi-objective optimization problem, since there are two objective functions, namely, the weight design and the cost design. Thus, the solution of this optimization problem requires specialized method suitable for multi-objective problems. In this kind of problems, a design is optimal when it is non-dominated or by using another term Pareto-optimal. A design is non-dominated if no other feasible design exists which is better with respect to any objective and at least equally good with respect to all the other objectives. Grillage is common types of structures in marine and land-based structural system. Grillage systems that increase the stiffness of plate used by two rectangular stiffeners is a part of deck, side shell and bottom of ships. The non-dominated sorting and sharing approaches are adopted to find as multiple Pareto-optimal solutions as possible under an appropriate design environment. The approaches eliminate the biasness towards some Pareto-optimal solutions and thereby distribute the population over the entire Pareto-optimal regions. The nonlinear constrained multi-objective optimization is a very important from the point of view of practical problem solving. Therefore, the real-coded genetic algorithm with multiple genetic operators is proposed to find the optimum grillage systems without handling any of penalty functions. The hybrid method (real-coded genetic algorithm including the non-dominated sorting and sharing approaches) performs a marvelous explorability in finding a diverse set of solutions and in converging near the true Pareto-optimal set. The results obtained are very encouraging, since they show that we can produce an important portion of the Pareto front at a very low computational time frame. Actual ship plates are subjected to relatively small water pressure except for the impact load due to slamming and panting etc. The present paper also describes an accurate and fast procedure for analysing the elasto-plastic large deflection behavior up to the ultimate limit state of bottom panel under lateral pressure load. The objective of this analysis is to study the structural response of the grillage systems

of the bottom structure and also verify that the stress level and buckling capacity of primary structures under the applied static and quasi-dynamic loads are within the acceptable limits.