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Optimization of Arrangement of Longitudinal Stiffeners on Shell Plate at Fore and Aft Parts of Vessels

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Summary: Since the hull form of ship gets slim at fore and aft parts, the arrangement of longitudinal stiffeners on curved shell plate at the parts is difficult compared with midship part. The design of longitudinal stiffener arrangement relies on designer's skill, therefore there is a large possibility that better solutions are obtained when optimization technique is introduced and it is studied here.In this optimization, the space between longitudinal stiffeners and the scantling and angle of them are taken as design variables. But, the number of the longitudinal stiffeners should be given by designer before the optimization. Constraints are strength by rule and requirements from construction. The objective function is total cost, which is calculated from steel weight and man-hour used for assembling longitudinal stiffeners.The number of joints between longitudinal stiffeners should be increase for saving the cost of steel, although the number of joints should be a few in view of reduction of man-hour for assembling. In order to solve this problem, a cost parameter for handling the number of joints is added to the objective function. The creation of the joints is decided from if the two consecutive longitudinal stiffeners have the same scantling and angle. The geometrical condition of longitudinal stiffeners is also added for judging the necessity of the joints.A simplified model, in which the unit cost of man-hour for the joint is changed, is solved for showing the validity of the proposed methods. The design candidate where the steel weight is reduced and the number of joints is increased is obtained when the unit cost of man-hour for the joint is set as low. On the other hand, when the unit cost of man-hour for the joint is set as high, steel weight is increased and the number of joints is reduced.The proposed method is applied into the real ship structure. The hull form of fore and aft parts is imported from the 3 dimensional product model and the genetic algorithm is adopted as an optimization method.