論　文　の　要　旨

題　目　Design methodology of ship structure based on optimization algorithm
（最適化アルゴリズムに基づく船舶構造設計法）

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In this thesis, some main optimization methods (topology optimization, shape optimization, size optimization) combined with manufacturing constraint based on different algorithm are proposed to optimize the ship structures. This thesis mainly includes two parts, the first part is to apply the two-stage optimization method to find the optimal stiffener layout and size on the ship prow, a reasonable ship prow structure is obtained; the second part is to apply the integration shape and size optimization to optimize the radar mast structure, and finally a reasonable radar mast shape and thickness is obtained.

The main work that has been done and future work that needs to be done will be discussed in the following section.

In chapter 1, beginning with optimization applications in aerospace, shipbuilding and other field as the research background, these cases provide a reference for optimizing the ship structures in this thesis. after that, the optimization methods used and their difference in this article are introduced in detail, the effects of some manufacturing constraint are explained, later the research purpose of this thesis is related.

In chapter 2, at first the research object and the complex load cases it bears are discussed, and introduced how to connect these complicated load cases together by using the influence factors in detail. Later two kinds of method about stiffener layout optimization are introduce (the optimal thickness distribution and the ground structure method), and the method of optimal thickness distribution method is applied to determine the stiffener layout in this thesis after comparing the advantages and disadvantages for these two methods. then taking multi-objective function based on compromising method instead of traditional single objective function as optimization objective function to generate stiffener based on some manufacturing constraints,

getting a reasonable material distribution (potential stiffener). Actually, these potential stiffeners are hard to be manufactured because these stiffeners are curved, so we construct regular stiffeners instead of protentional stiffeners based on optimization results, shipbuilding rules and balance rules.

In chapter 3, size optimization method is adopted to optimize the above stiffener structure. Firstly, the section area of stiffener and plate thickness are selected as design variables based on some criterions, for making the optimization results reasonable and having practicability, the range value for each design variable is set in advance; besides the parameter relationships among these five design variables are set up which can avoid producing invalid dimensions effectively. Secondly, the mathematical model of optimization is established with manufacturing constraints, the minimum mass is set as the objective function based on allowable stress. Lastly, a finite element model based on size optimization result is built, then conducting analysis for this new model, the final analysis results prove that the size optimization is reasonable stage after topology optimization for ship prow structure design.

In chapter 4, the integration shape and size optimization method is adopted to optimize the radar mast, which is usually located at the top of ship and used for radar mounting, and it is highest component for ship. for good precision in detecting and target tracking, radar mast should be as steady as possible. the purpose for this object is to minimize its weight within the eigen frequency. the integration shape and size optimization method is adopted, then an approximate shape and size results can be obtained, but its curve is not uniform, it is hard to manufacture. Then a new model based on the above optimization results, and optimize the curve equations of its top and bottom section, finally a reasonable radar mast shape is obtained, the strength and eigen frequency meet the requirement.

To obtain even better structural performance, the following points should be considered in the future. the SIMP method uses a gradient optimization algorithm whose results converge toward a local optimum. Manufacturing constraints and appropriate optimization parameters are adopted in this study, which guide the research closer to a global optimum. Hence, an appropriate algorithm should be explored that can avoid local convergence in 3D model optimization.

In general, these results prove that structure optimization technology is helpful to design new ship and shorten the design cycle.