論　文　の　要　旨

Study on Optimal Design of Plate Structure Considering Several Optimization Methods
(複合的最適化手法を用いたプレート構造物の最適設計に関する研究)

氏　名　　GERRY LISTON PUTRA

Currently, shipyard industries, especially global ones, are facing many challenges in designing structures with optimal weight, strength, and cost. The demand for new shipbuilding has decreased because of the effect of the economic crisis that hit almost every country in the world. Shipyard companies must think innovatively and creatively to survive under the pressure of this crisis by evaluating various studies and improvising new methods to achieve efficiency. Furthermore, The International Maritime Organization (IMO) Marine Environment Protection Committee released a policy to implement a global sulfur cap of 0.5% mass/mass from 1 January 2020 (IMO 2016). The policy affected the fuel type ships use. The price difference between fuel types can be significant (Priftis et al. 2018). Thus, a challenge for ship owners involves decreasing operating costs owing to the use of low sulfur fuel grades, which are more expensive. Additionally, increases in raw materials impacted manufacturing costs in the shipyard industry. The solution to the aforementioned problems involves decreasing the mass and substituting ship structure material via structural design optimization. Thus, this is expected to reduce mass, manufacturing and operation cost.

First study attempt to optimize the stiffened plate such as bottom, side, and deck structures in order to reduce the mass of the ship structure. The stiffened plate was optimized that is used for building most of the ship structure. Further, this study proposed the hybrid Genetic Algorithm (GA) technique, which combines a genetic algorithm and subsequent optimization methods. The design variables included the number and type of stiffeners, stiffener spacing, and plate thickness. The number and type of stiffeners are discrete design variables that were optimized using the genetic algorithm. The stiffener spacing and plate thickness are continuous design variables that were determined by subsequent optimization. The plate deformation was classified into global and local displacement, resulting in accurate estimations of the maximum displacement.

The second study move to hatch cover which is also composed of plates and stiffeners. This study considers material selection as a new variable to press the mass and material

cost. The mass and material cost of the hatch cover was optimized as an objective function using the Pareto approach with developed optimization methods. Plate thickness *t*, stiffener shape *s*, and plate material type *m* were selected as design variables in this study along with some constraints. To estimate optimal plate thickness, an expression of stress equations was developed using an optimization technique. Furthermore, stiffener shape and plate material type selection were optimized using a genetic algorithm (GA).

The third study continues to optimize hatch cover with add new design variable and optimization method to get more optimal design. This study proposed A three-stage optimization to optimize the hatch cover of a ship. In the first stage, the material selection process provides a potential plate material and stiffener type via a genetic algorithm. In the second stage, a size optimization method is performed to optimize plate thickness. Additionally, in the last stage, the layout optimization method as a new method is conducted to propose a suitable plate layout of the top and bottom of the hatch cover. The multi-constraint is applied by following class regulation in the optimization process to provide a real design that can be implemented in the shipyard industry. The results indicate that the developed optimization method effectively produces the optimal design.

The last study improves the method of the second and third study in provide material type. This study proposes an easy method that can reduce computational time instead of genetic algorithm (GA). The material cost of the plate structure was optimized as an objective function. Plate material type *m* and plate thickness *t* were selected as design variables in this study along with some constraints. The proposed method was developed to choose suitable plate material types. Furthermore, plate thickness was optimized by an expression of stress equations using an optimization technique.