The Twenty-Fifth International Symposium on Artificial Life and Robotics 2020 (AROB 25th 2020),
The Fifth International Symposium on BioComplexity 2020 (ISBC 5th 2020),
B-Con Plaza, Beppu, Japan, January 22-24, 2020

Shape Optimization of Ship-RUV Structure

Imam Sutrisno[1,1], Budianto[1,2], Mohammad Basuki Rahmat[1,3], Ari Wibawa Budi Santosa[2,4],
I Putu Sindhu Asmara[1,5], Agus Dwi Santoso[3,6]

[1]Shipbuilding Institute of Polytechnic Surabaya, Indonesia
[2]Diponegoro University, Indonesia
[3]Politeknik Pelayaran Surabaya, Indonesia

(Tel: 62-31-594-7186, Fax: 62-31-594-7186)

[1]imamsby01@yahoo.com, [2]budianto.structure@gmail.com, [3]mbasuki.rahmat@gmail.com,
[4]arikapal75@gmail.com, [5]putusindhu@ppns.ac.id, [6]agusbp2ipsby@gmail.com

Abstract: To optimize the mass load that has been designed on the ship-RUV structure, it is necessary to do a shape optimization analysis on the structure. The structure must be ensured to be safe and strong by analyzing static, vibration and buckling loads. Shape optimization will provide a level of structure that is strong but not over strength. It will also provide economic value benefits in terms of material requirements designed at ship-RUV. In addition to minimizing the condition of excess strength in the Ship-RUV structure that results in the high cost of making these structures or can realize low-cost technology, by ensuring the structure remains strong. The mass of the left or right cover on the Ship-RUV structure with an initial weight of 1.8 kg while the results obtained after the optimization of the structure obtained results of 1.3 kg, so that the material can be reduced by 25%.

Keywords: optimization, shape, stresses, RUV.

1 INTRODUCTION

To optimize the gravity of the ship-RUV construction that has been designed, the Ship-RUV is required to re-design the structure so that it has a light construction weight so that the thrust can be maximized in its operations. In addition to minimizing the condition of excess strength in the Ship-RUV structure that results in the high cost of making these structures or creating low-cost technology, by ensuring the structure remains strong. In the initial stages of designing the ship-RUV is designed with aluminum material with marine used specifications. The design of Ship-RUV can be shown in the following picture:

Fig. 1. Existing Ship-RUV

The components of the ship-RUV part can be categorized in the constituent parts, including the structure of the Ship-RUV, driving motor, mainboard, and control system. To ensure the strength of the structure that remains strong in accepting the load that is in the operation required supporting calculations. One of the supporting technologies performs calculations using the finite element method. Where the structure is divided into the form of structural elements that can be applied to existing placement and loading conditions. In the previous research, several analyzes were carried out to ensure the strength and safety of the structure including static load analysis, capital frequency analysis and Buckling analysis. Where results can be shown as follows:

1. Static Load Analysis.
   The actual condition of the Voltage in the Ship-RUV st ructure is still Fulfilled can be shown in thepicture belo w:

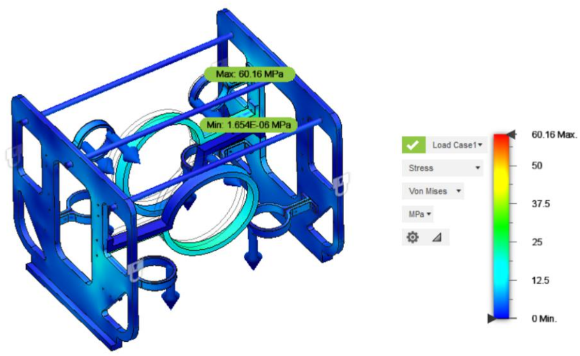

Fig. 2. Static Load Analysis Ship-RUV

The structure can be said to be quite strong and safe in operation if the value of the stress that occurs is smaller than the allowable stress value. The allowable stress has been included elements in the material factor and the safety factor.

2. Modal frequency analysis

In the condition of vibrations that occur due to the excitation frequency of the driving force (motor and propeller) of the Ship-RUV, it is necessary to analyze the capital frequency so that it can cope with excessive vibration in the Ship-RUV structure. An excessive vibration occurs if the value of the excitation frequency is the same as the natural frequency value.

The modal frequency analysis is done to calculate the natural frequency value that is owned by the Ship-RUV structure. Natural frequency which is in the analysis of frequency natural or commonly called eigen-value structure can be calculated by calculating from several components of mass and stiffness.

The results of the analysis of capital frequency can be shown in the analysis of capital frequency in the figure below.

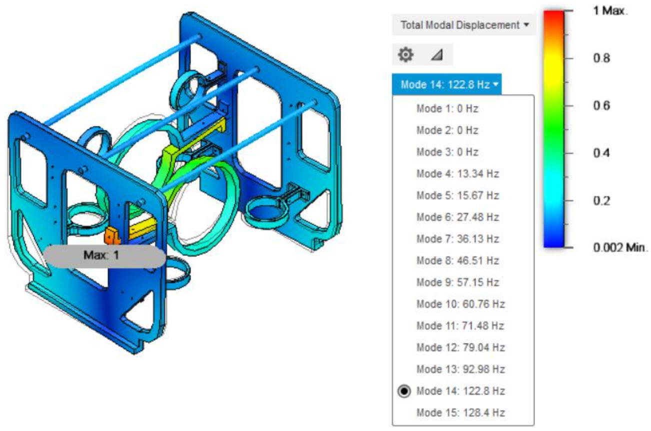

Fig. 3. Modal Analysis Ship-RUV

In the analysis and calculation results show that the natural frequency value is not the same as the value of the excitation frequency that occurs from the driving force (motor and propeller) so that it can be said that the structure is still safe in excess vibration conditions.

3. Buckling Analysis

In bending load analysis is an indispensable condition in maintaining structural strength at Ship-RUV. The bending load is very risky to the structure which can cause the structure to break or deform. So a buckling analysis is performed with the following results:

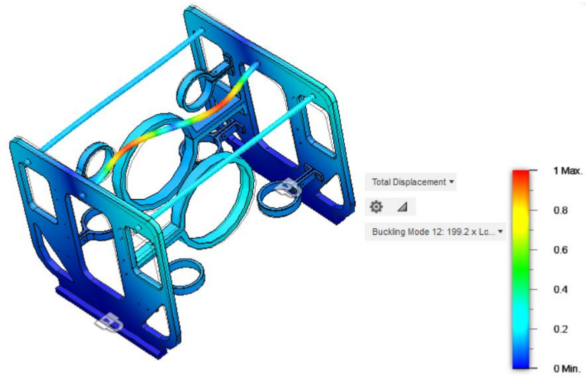

Fig. 4. Buckling Analysis Ship-RUV

In the picture above, the Buckling condition is still safe from the condition of the allowed buckling load on the Ship-RUV structure condition. The maximum bending risk is most at risk in the connection section of the Ship-RUV structure.

To optimize the mass load that has been designed on the ship-RUV structure, it is necessary to do a shape optimization analysis on the structure. So this will provide a level of structure that is strong but not over strength. It will also provide economic value benefits in terms of material requirements designed at ship-RUV.

2 BASIC THEORY

1. Finite element application

In the development of finite element analytical technology is used by various engineering. The objects are discretized into constituent elements. Finite Element provides various structural analysis methods to be carried out on finite element in structure [1]. The application of finite elements can be used in some structural analysis, flow form and others.

2. RUV

RUV (Remote Underwater Vehicle) is a robotic device that can take data in the depths of water. So it can replace the role of divers in the investigation of objects that are in the sea. In technical terms a number of experiments that characterize optical links and demonstrate remote control in RUV [2]. In RUV, the fundamental difference with the control system is that of the cable system.

3. Material Marine Used

Two 60xx alloys commonly used in the marine industry are 6061-T6 and 6082-T6. Such materials usually have a resistance in corrosive operational conditions.

This is evidenced by the very low rate of corrosion and marine life attached to the hull or building structures very few [3,4].

3 METHODOLOGY

- CAD and Material Definition

At the beginning of the analysis can be done by making CAD with existing components. Then do the material definition using 5083 marine used aluminum alloy material.

- Meshing

The meshing process is carried out to discuss the object into the Ship-RUV constituent elements which are conditioned in fine mesh conditions.

- Load and constrain

The loading process is placed in the loading area of the structure which is then entered for the value of the force acting. It's as placement is applied at the bottom of the structure.

- Analysis Process

In the analysis process, it refers to the method of form optimization by getting the optimum mass design in the ability to accept existing loading.[5-7]

4 ANALYSIS RESULT

In shape optimization analysis refers to the target Left and Right Cover Weight. It has an indication of the weight that can be reduced. The components that are modeled on the Left and Right Cover are shown in the following figure.

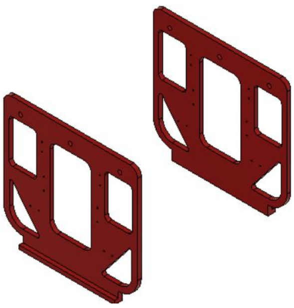

Fig. 5. Left/Right Cover

Table 1. Physical Material

Quantity	Aluminum 5083	Unit
Area	1.670E+05	mm^2
Density	2.660E-06	kg / mm^3
Mass	1.774	kg
Volume	6.668E+05	mm^3

It gets information on emphasis and moment of inertia given information from CAD in the form of bounding boxes. Bounding Box is an analysis structure package facility produced. The bounding box values are obtained from the table below.

Table 2. Bounding Box at Left or Right Cover

Length 20.00 mm
Width 325.00 mm
Height 350.00 mm
World X,Y,Z 0mm,0mm,0 mm
Center of Mass 357.072mm, 298.47 mm, 330.141 mm
Moment of Inertia at Center of Mass ($kg\ mm^2$)
Ixx = 3.794E+04
Ixy = -99.895
lxz = -0.04
Iyx = -99.895
Iyy = 1.766E+04
Iyz = -1.198
Izx = -0.004
Izy = -1.198
Izz = 2.032E+04

To reduce the weight required form optimization by applying a reduction of 25% of its weight, so that the target can be reduced to 75%. Where the results of Shape Optimization are shown in the following results:

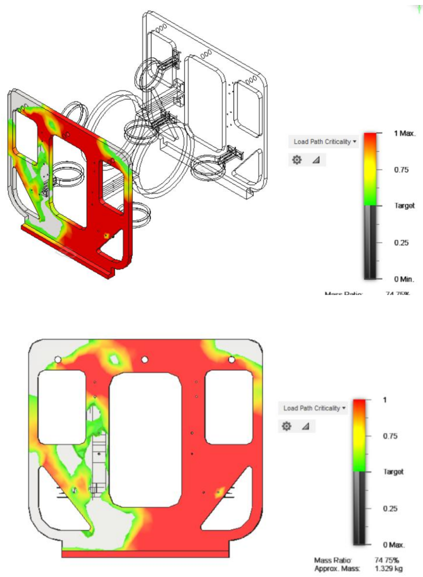

Fig. 6. Shape Optimization Result

While the mass of the left or right cover on the Ship-RUV structure with an initial weight of 1.8 kg while the results obtained after the optimization of the structure obtained results of 1.3 kg, so that the material can save 25%.

Table 3. Mass Value

	Value
Mass before	1.778 kg
Mass after	1.329 kg
Mass Ratio	74.75 %

4 DISCUSSION AND RECOMENDATION

- Mass Application

The recommended reduction is only applied 10% of the weight of the construction left or right cover because it is to maintain strength and increase the value of the existing safety factor risk. The results can be shown as follows for the application of the design. [8]

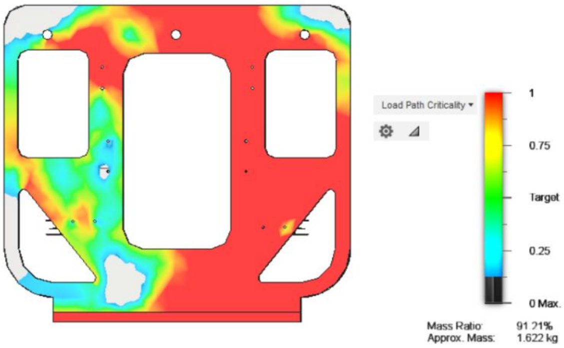

Fig. 7. Mass Reduction Application

- Recommendation

The design after optimization can be shown in the form of ship-RUV structure models can be shown in the picture below as follows:

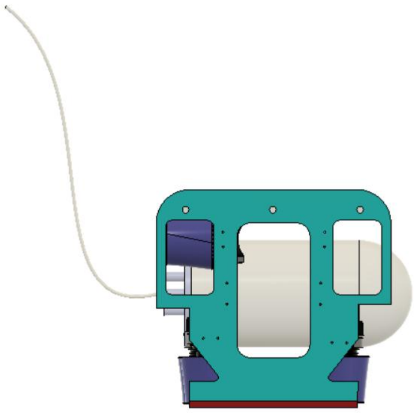

Fig. 8. Final optimization design of Ship-RUV

Acknowledge

Thanks to the Ministry of Research, Technology and Higher Education for applied research grants and the support of fellow PPNS lecturers.

REFERENCES

[1] F. McKenna, "Object-oriented finite element programming: Frameworks for analysis, algorithms and parallel computing.," elibrary.ru, 1999.

[2] M. Doniec, "Using optical communication for remote underwater robot operation," RSJ International Conference on Intelligent Robots and Systems, pp. 4017-4022, 2010.

[3] S. Benson, "Load shortening characteristics of marine grade aluminium alloy plates in longitudinal compression," Thin-Walled Structures, vol. 70, no. 1, pp. 19-32., 2013.

[4] Hanaizumi H, Tsumashima T, Fujimura S (1996), Artificial passive vision using highspeed pixel matching. In:Sugisaka M (ed), Proceedings of the International Symposium on Artificial Life and Robotics (AROB1st), Beppu, Oita Japan, Feb 18-20, 1996, pp.146-149.

[5] Sutrisno I, Jami'in MA, Hu J, Marhaban MH, Mariun N, Nonlinear Model-Predictive Control Based on Quasi-ARX Radial-Basis Function-Neural-Network, 8th Inter. Conference on Mathematical Modelling and Computer Simulation

[6] Sutrisno I, Che C, Hu J, An improved adaptive switching control based on quasi-ARX neural network for nonlinear systems, Artificial Life and Robotics 19 (4), 347–353

[7] Jami'in MA, Sutrisno I, Hu J, The State-Dynamic-Error-Based Switching Control under Quasi-ARX Neural Network Model, in Proc. of the20 th International Symposium on Artificial Life and Robotics (AROB 20 th 2015)

[8] Widodo RB, Quita RM, Amrizal S, Gunawan RS, Wada C, Ardiansyah A, Sutrisno I, Rahmat MB, Arfianto AZ, Handoko CR, Santoso AD, Santosa AWB, Ardhana VYP, Setiawan E, Grasping and Attached Mode in Human-Computer Interaction in the Study of Mouse Substitution, Journal of Physics: Conference Series 1196 (1), 012034

[7] Sutrisno, I., Jami'in, M.A., Hu, J., Modified fuzzy adaptive controller applied to nonlinear systems modeled under quasi-ARX neural network, Artificial Life and Robotics, 2014

[8] Jami'In, M.A., Sutrisno, I., Hu, J., Mariun, N.B., Marhaban, M.H., An adaptive predictive control based on a quasi-ARX neural network model , 2014 13th International Conference on Control Automation Robotics and Vision, ICARCV 2014

[9] Jami'in MA, Sutrisno I, Hu J, Nonlinear Adaptive Control for Wind Energy Conversion Systems Based on Quasi-ARX Neural Network Model

[10] Sutrisno I, Jami'in MA, Hu J, Marhaban MH, Self-organizing quasi-linear ARX RBFN modeling for identification and control of nonlinear systems, 2015 54th annual conference of the society of instrument and control engineers of Japan (SICE). IEEE

[11] Sutrisno I, Jami'in MA, Hu J, Marhaban MH, Mariun N, Nonlinear Model-Predictive Control Based on Quasi-ARX Radial-Basis Function-Neural-Network, 8th Inter. Conference on Mathematical Modelling and Computer Simulation

[12] Jami'in MA, Sutrisno I, Hu J, The State-Dynamic-Error-Based Switching Control under Quasi-ARX Neural Network Model, in Proc. of the20 th International Symposium on Artificial Life and Robotics (AROB 20 th 2015)