ENGINEERING DESIGN OF A SKIMMER BOAT FOR COASTAL WASTE MANAGEMENT IN BALIKPAPAN CITY

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SUMMARY

Water pollution in the coastal areas of Balikpapan City due to the accumulation of domestic waste and plastic waste has become a serious problem that disrupts the ecosystem and activities of coastal communities. To overcome this problem, a skimmer boat (garbage transport ship) was designed, which is equipped with a conveyor system as a tool for collecting garbage from the water surface effectively and efficiently. The design process uses the Parent Design Approach method with the help of Maxsurf software to obtain the optimal main dimensions of the ship according to the characteristics of the waters in Balikpapan. The design results show that the main dimensions of the ship are LOA = 13.3 m, width (B) = 6,5 m, draft (T) = 1.09 m, height (H) = 1.8 m, and hull width (B1) = 1.9 m, with an operating speed of 6.5 knots. This ship uses a stable catamaran hull and is equipped with a 7-ton capacity garbage tank, as well as a conveyor that functions to continuously lift garbage from the water surface to the tank.

Dokumen ini diformat dalam konvensi yang diperlukan untuk semua makalah konferensi

NOMENCLATURE

[Symbol]	[Definition] [(unit)]
LOA	Long Over All (m)
LWL	Length water line (m)
LPP	Length Between Perpendicular (m)
B	Breadth (m)
B1	Demihull (m)
H	Height (m)
T	Draught (m)
Vs	Speed (Knot)
Re_{LWL}	Reynolds Number Waterline
h	Boundary layer
D	high interceptor (mm)
S	Interceptor width (mm)

1. INTRODUCTION

Balikpapan City, as one of the coastal cities in Indonesia, faces serious problems in waste management due to rapid population growth and increasing economic activities. With an area of around 503.3 km², Balikpapan is the third most populous city in East Kalimantan after Samarinda and Kutai Kartanegara, which in 2022 reached 688,138 people. This high population directly contributes to the increase in the volume of waste produced every day, which originates from various sources, such as households, industry, and commercial activities. If not managed properly, this accumulation of waste can pollute the environment, damage aquatic ecosystems, and have a negative impact on public health. [1].

One of the main challenges in waste management in Balikpapan is waste disposal into rivers and the sea. The large amount of waste carried by the current into the waters causes serious environmental pollution, threatening the sustainability of the marine ecosystem and the life of the biota in it. Plastic waste is one of the types of waste most commonly found in Balikpapan waters, which takes a long time to decompose. Data from the Balikpapan City Environmental Service in 2025 shows that the waste produced on the coast can reach 7 to 9 tons per day [2].

Based on the description above, the problem arises regarding how to design an effective ship to overcome the accumulation of waste in river waters and determine the appropriate main size for river waters in Kalimantan. One solution that can be applied is the use of a trash skimmer boat. A skimmer boat is a type of ship specifically designed to collect and transport waste floating on the surface of waters, such as rivers, lakes, canals, and seas. This ship is generally equipped with a conveyor system or net to catch waste and has a temporary storage tank before the waste is disposed of or recycled. The use of a skimmer boat is one solution to maintaining the cleanliness of waters and reducing environmental pollution due to domestic and industrial waste [3].

2. RESEARCH METHODOLOGY

2.1 PARENT DESIGN APPROACH METHOD

The parent design approach in ship design is a method that refers to existing ships with similar characteristics as the main mode l4]. In its application, ship designers choose ships that have proven performance and have dimensions and functions that are close to the ship to be developed [5]. With this strategy, the design process can be carried out more quickly and efficiently because it only modifies existing designs [6].

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2.2 SHIP DEPLOYMENT

The placement of garbage ships in the coastal areas of Balikpapan, especially from Semayang Port to Seraya Beach, is a strategic step in supporting efforts to manage and transport garbage that has accumulated on the coastline due to port activities and ocean currents. This area is known as one of the points with a fairly high volume of garbage. Even the Balikpapan City Environmental Service (DLH) noted that the average coastal garbage transported reached 6 to 9 tons per day.

Figure 2.1: Cruise Route

3. RESULTS AND DISCUSSION

3.1 PRIMARY SIZE DETERMINATION

After carrying out calculations using the parent design approach method, the main dimensions of the ship were obtained as follows:

Table 3.1 Correlation Data

Ratio	Min Value	Actual	Max Value	Refferences
L/B1	7	7	11	Insel & Molland (1992)
L/H	6	7.4	11	Insel & Molland (1992)
B/H	0.7	4.1	4.1	Insel & Molland (1992)
S/L	0.19	0.2	0.51	Insel & Molland (1992)
S/B1	0.9	1.1	0.41	Insel & Molland (1992)
B1/T	1.5	1.7	2.5	Sahoo,Browne & Salas (2004)
B1/1	0.15	0.3	0.31	Dubrousky, V (2001)

The results of the calculation of the main dimensions of the ship are LOA = 13.3 m, width (B) = 6.5 m, draft (T) = 1.09 m, height (H) = 1.8 m, and hull width (B1) = 1.9 m, with an operating speed of 6.5 knots.

3.2 SHIP HULL MODELING

After the main dimensions of the ship are determined through the optimization method, 3D modeling of the catamaran hull is carried out using the Maxsurf Modeler software. Figure 4.2 shows the catamaran hull that has been designed using the Maxsurf Modeler application.

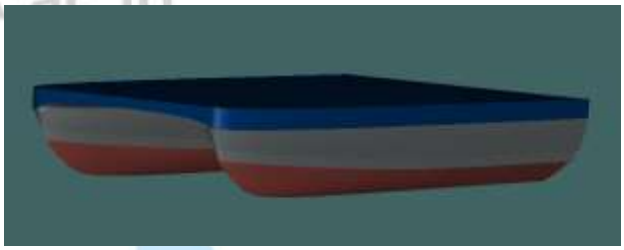

Figure 3.1 Catamaran Hull in Maxsurf Modeler Software

3.3 RESISTANCE CALCULATION

A line plan is a view drawing or projection drawing of the ship's body cut transversely (body plan), lengthwise (sheer plan), and vertically lengthwise (half breadth plan). In the process of making it in this final assignment, I used several software programs, namely Maxsurf Modeler and AutoCAD

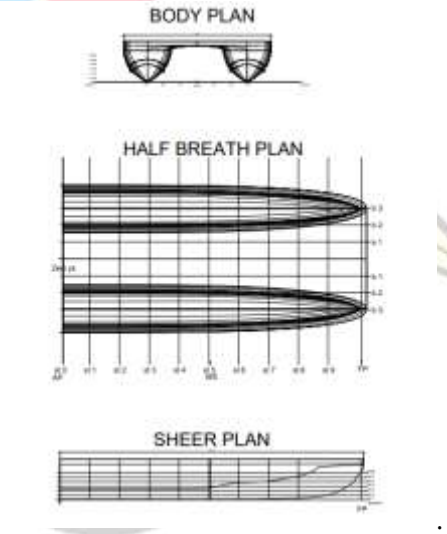

Figure 3.1 Line Plan Design

3.4 RESISTANCE CALCULATION

The purpose of calculating the total ship resistance is to determine the appropriate engine power requirements on the ship. Thus, the ship can operate at the speed desired by the shipowner according to the owner's requirements. To calculate the ship's resistance, the formula from the paper by M. Insel, Ph.D., and A.F. Molland, M.Sc., Ph.D., C.Eng., is used. The ship's resistance is influenced by the value of the ship's WSA and the ship's total resistance coefficient (Ctot). This resistance calculation uses Maxsurf resistance as its software, as shown in Figure 3.2

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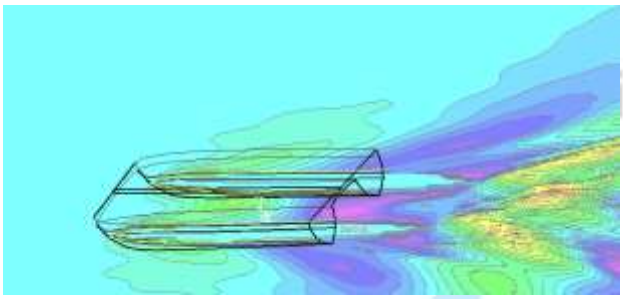

Figure 3.2 Maxsurf resistance display

then the ship's resistance value at a speed of 6.5 knots is 4.9 kN, and the engine power required is 16,221 kW.

3.5 MAIN MACHINE SELECTION

After getting the BHP value, the next step is to select the main engine as the primary propulsion of the ship. The main engine used on this catamaran is an outboard engine. The consideration for choosing an outboard engine is the ease of installation and the relatively small size of the engine so that it does not take up too much space.

Figure 3.3 F 300 BET / FL 300 BET outboard engine

The specifications of the F 300 BET/FL 300 BET outboard engine are

Table 3.3 Simulation results of resistance reduction values

Nama Mesin	F 300 BET / FL 300 BET
Tipe Mesin	24-Valve, DOHC – VCT,Direct Action, 60 °. V6
Tinggi Transom	X = 25.3 in U = 30.3 in
Daya Maksimum	300 PK (220,6 kW)
Vokume (isi) Silinder (cm3)	4169 cc
Diameter x Langkah	96.0 mm x 96.0 mm
Jangkauan Operasi Maksimum	5000– 6000 rpm

After calculating the selection of the main engine, the next step is to search for a generator on the ship with the required power of 5500 kW. Figure 3.4 is a generator that will be used and is expected to be able to support the electricity and conveyor on the garbage ship.

Figure 3.4 Generator Engine

The specifications of the generator engine are:

Table 3.4 Generator Engine

Genset Loncin Watt LC4800DDC		
Daya max	6000	Watt
Kapasitas tanki	25	Liter
Panjang	1651	mm
Lebar	812.8	mm
tinggi	965.2	mm
Berat	900	kg
	0.9	ton

3.6 GENERAL PLAN

The first step in making a general plan is to draw the outline of the ship's body from the top, side, and front according to the lines plan that has been made. In the previous calculation of the center of gravity, the planning of the placement of the tanks has been carried out, the planning is depicted in the general plan according to the calculation. In the general plan of the Trash Skimmer Boat, you can see some of the available facilities and infrastructure

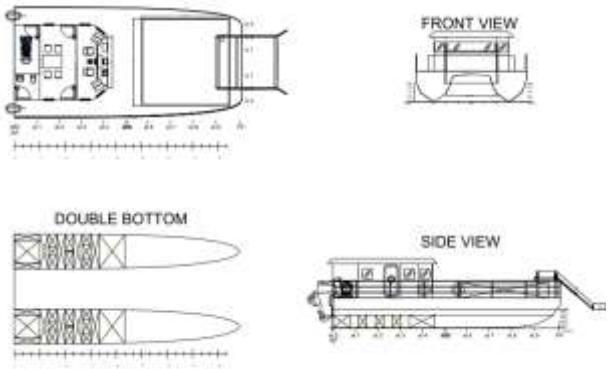

Figure 3.5 General Plan Skimmer Boat

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3.7 DESIGN OF TRANSPORT SYSTEMS ON SHIPS

After conducting a survey in the coastal area of Balikpapan City, most of the waste obtained was plastic waste, and it was very rare to find water plant waste and large wood waste that required the ship to use a cutting system. Therefore, waste transportation using the conveyor method can make it easier to transport waste from the waters to the ship very quickly. Figure 3.4 shows a design of a ship model that has been equipped with a conveyor system, complete with views from the side, top, and front.

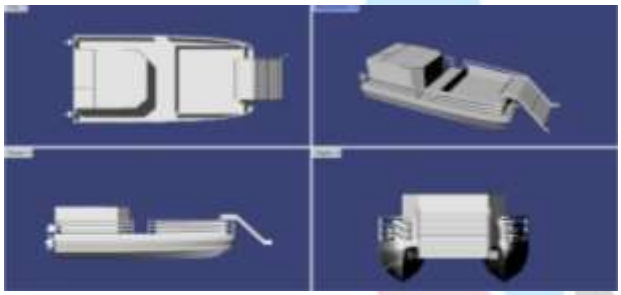

Figure 3.6 Ship modeling in Rhinoceros Software

3.8 DISPLACEMENT CORECTION

Calculating the displacement correction is done after knowing the total weight of the DWT and LWT of the ship. The difference between the displacement and the sum of the DWT and LWT of the Trash Skimmer Boat is determined to be no more than 5%. The following are details of the displacement correction as seen in table 4.12.

Table 3.5 Displacement Correction

Komponen	Berat	Keterangan
LWT	19.734	-
DWT	10.254	-
Displacement	30.38	hasil maxsurf pada sarat 0.88
Displacement-(LWT+DWT)	29.988	-
Correction	1%	(0%-5%)

Figure 3.2: Bare hull (top), Interceptor (bottom), at 20 knots

3.9 3D IMAGE

The 3D image of the garbage cleaning ship produced in this study was created using Rhinoceros software. The use of this software aims to obtain a more detailed and clear three-dimensional visualization of the garbage cleaning ship, so that the resulting design can be more easily understood and analyzed before the prototype manufacturing process is carried out.

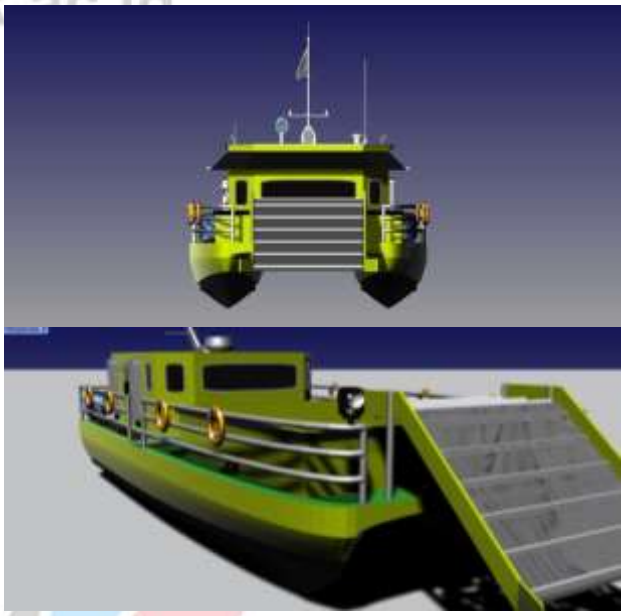

Figure 3.7 3D Skimmer Boat

4. CONCLUSION

Based on the application of the Parent Design Approach method, the main dimensions of the garbage ship are obtained with an overall length of 13.3 meters, a width of 6 meters, a hull height of 1.8 meters, and an air draft of 1.09 meters. This size is designed to ensure a balance between load capacity and ship stability when operating in shallow waters around Semayang Port. This ship is equipped with a 7-ton capacity garbage storage area. This ship is designed to serve a 29.74-kilometer route connecting the estuary of Semayang Port to the coastal area of Sepinggan.

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