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Design of Motorcycle-Passenger Ship (Klotok) Catamaran Type for Kampung Baru Balikpapan-Penajam Paser Utara

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Abstract*– Balikpapan City has an area of 508.9 km2 which has 646,727 people living here. Balikpapan City is also known as a port city because it has two domestic ports namely Kampung Baru Port and Semayang Port. Currently, the port of Kampung Baru is still active in carrying out daily activities, namely the klotok boat crossing and also the dock for motor boats berths. The condition of mobility for crossing vessels in the port of Kampung Baru that uses boat klotok is inadequate due to the lack of supporting components for access to the ship so the safety of this port is questioned. besides that, klotok ships are also only able to carry a maximum of 21 passengers and 5 motorcycles and access to loading and unloading exits is very unsafe. The purpose of this study is to design a crossing ship that can be used safely for transportation for passengers and motorcycles that will pass the sea lane for crossing to the North Penajam Paser area. The ship is designed to have an easy access door or ramp door for passenger and motorcycle mobility to improve the safety of crossings at the port of Kampung Baru. The parent Design Approach method is used in this project, this method is one way of designing a ship using comparison or comparison, namely by taking a ship that is used as a reference for a comparison ship that has the same characteristics as designed ship. The main focus to be achieved in this research obtained a General Arrangement which has more cargo than the klotok ship with a capacity of 25 passengers and 10 motorcycles, and the dimension of the ramp door used in this final project is L 1.50 m and B 1.50 m. The Principal dimension of the ship obtained in this research is Loa = 12.50 m, Lpp = 11.50 m, Lwl = 11.96 m, B = 5.75 m, B1 = 1.64 m, H = 1.8 m, T = 0.85 m, Cb = 0.56, Vs = 15 Knots. The results of this study provide a good idea of the modernization of a comfortable ferry fleet for this area.

Keywords-Ship Design, Motorcycle-Passenger Ship, Klotok, Catamaran, General Arrangement

I. INTRODUCTION

Balikpapan in the future is one of the supporting cities for the new state capital of Indonesia with a population of 809,294 in 2025 [1]. following President Joko Widodo's decision at the DPR/MPR plenary meeting RI on August 26, 2019, which resulted in an agreement to move the national capital from Jakarta to Jakarta East Kalimantan region [2]. The Kampung Baru port is now expected to be the entrance to the new capital city of North Penajam Paser Regency. Currently, the Kampung Baru port is still carrying out daily activities, namely the klotok pier and also the motor boats port for anchoring. until now, research on klotok vessels has not existed. the research related to klotok ships is only limited to analyzing passenger health due to ship engine vibrations [3], and while research related to the redesign of klotok ships does not yet exist. for research on ship design everything is almost the same, starting from determining the main dimensions, calculating resistance to drawing lines and general arrangement of ships as in research on cargo ship cargo ship hull optimization design for variations in the shape of sea waves [4], research on patrol ship designs to protect Natuna Island [5], redesigning LCT ships to become ship power plans [6] and the design of a multipurpose fishing vessel [7].

Transportation facilities at Kampung Baru Port are still limited, generally, motor boats are used more for tourism [8], Balikpapan the community still relies on motor boats and klotok for their daily transportation needs where the level of security of these transportation facilities is still lacking due to the absence of supporting components for access to the ship.Therefore the safety of this port is questionable. klotok is a type of traditional boat that is often found on the Kalimantan river and is generally used as a means of transportation [9]. The access to the ship for passengers and motorcycles at the Kampung Baru port is carried out by the ship's crew by lifting a motorcycles from the edge of the pier to the klotok ship leaning on the pier so that the security of access to the ship is still poor and can endanger passengers who will use this transportation. Good port and ship facilities must also be able to accommodate passengers with disabilities [10]. Thus, it is necessary to build a ship

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that is relatively safe and comfortable to serve as a means of crossing from the Klotok Kampung Baru Port to the North Penajam Paser Klotok Port with supporting access from ships to facilitate mobility at the Kampung Baru Port, Balikpapan.

The focus of this research covers the above problems, the existence of safe, comfortable, and good crossing ships must absolutely be available to serve the crossing between the two traditional ports, the catamaran ship design was used in this study because there has been a lot of research related to catamaran ships such as traditional fishing vessels [11][12], some even conduct research related to catamaran ships that function as tourist ships because of the advantages of catamaran ships that have good stability and are faster than mono-hull ships [13][14].

II. Method

The research begins with observing or surveying locations, namely the Kampung Baru Harbor and Penajam Harbor. the results of observations found the fact that the process of loading and loading motorcycles and passengers from the crossing pier to the ship and vice versa is very unsafe, and the potential for accidents is still very large, besides that, data on klotok ships in the field are also recorded and the amount of cargo that can be transported is also used as main data. This research takes references from scientific work such as books, journals, and the internet that are related to this research and can support the completion of the design of motorized and passenger ferries [15]. Every day the klotok boat has a fairly affordable rate of IDR 10.000, - per person and IDR 35.000,- by motorcycle. The crossing using a klotok with a distance from the Klotok Harbor of Kampung Baru Balikpapan – Penajam Paser Utara takes 30 - 45 minutes of travel. The capacity that can be loaded into the klotok ship is 21 passengers and 5 motorcycle [3]. However, projects the lack of passenger safety levels where there is no entry access from the dock to the ship which is a very hazardous process. By looking at the aspects of safety and comfort that are lacking, to answer these weaknesses a ship design is needed that is comfortable, safe and of course can facilitate access to loading motorcycles and passengers from the crossing pier to the ship and vice versa. The research method is carried out by collecting primary data and secondary data, then determining the main size using the parent ship design method, making lines plan, making general arrangements, determining ramp design, and conclusions. The shipping route in this research is starting from the Klotok Port of Kampung Baru Balikpapan - Penajam Paser Utara which is 2.01 Nm [16].

Figure 1. Men Loading Motorcycles in Klotok at Kampung Baru Port

III. Results and Discussion

The main achievement of this research are the lines plan and general arrangement of motorcycle-passenger ships with a catamaran type, a more complete description of the results of this research can be seen in the description as follows

A. Conseptual Design

Determination of the main dimensions in the process of designing this ship uses the parent design approach method. Where one ship will be selected which will be the reference for determining the main dimension. The main size was determined based on the parent ship design approach method. The ship "CATAMARAN FLASH CAT 43" was used as a comparison ship. Previous studies compared the magnitude of the resistance value between mono-hull, catamaran, and trimaran ship models. From the results of the analysis, the structure of the catamaran ship was obtained, which has the lowest resistance value when the speed of the ship increases [13][17], not only that, catamarans also allow large loads (wide ship hull) and are included in the fast ship category [18].

The following comparative data for Catamaran Flash Cat 43 are is shown in Table 1:

TABLE 1.
THE MAIN DIMENSION OF CATAMARAN

Length Overall (L_{OA})	12,00 m
Breadth Moulded (B)	5,75 m
Draft (T)	0,80 m
Passangers and Crew	29 Person
Displacement	13,50 Ton

The next step is to do the ratio of main the dimension on the design ship [19]

TABLE 2.
SHIP MAIN DIMENSION RATIO

L/B_1	7,01	→	$6 < L/B_1 < 11$
L/H	6,39	→	$4 < L/H < 10$
B/H	3,19	→	$0,7 < B/H < 4,10$
S/L	0,21	→	$0,2 < S/L < 0,50$
S/B1	1,50	→	$1 < S/B < 4$
B_1/T	1,93	→	$1 < B/T < 3$
B_1/B	0,28	→	$0,15 < B_1/B < 0,30$
Cb	0,56	→	$0,36 < Cb < 0,59$

The ratio of the main dimension of the catamarans has been carried out, then the main dimension of the ships used are as follows:

B. Lines Plan

The line plan is a projection of the image of the hull that is cut in the transverse direction of the hull (Body Plan), longitudinally (Sheer Plan), and vertically lengthwise (Half Breadth Plan). Lines plan and general arrangements a very important and must exist before the ship is built. The lines plan is shown Fig 2.

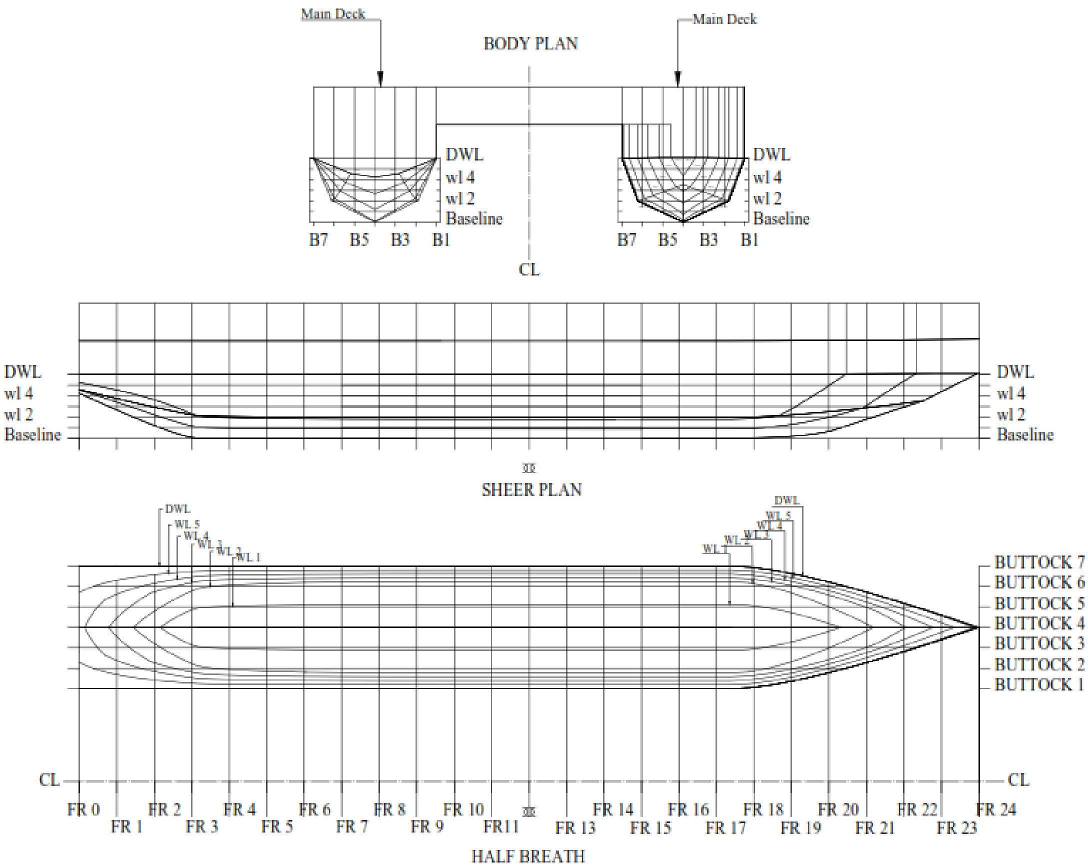

Figure 2. Lines Plan Design for Catamarans

C. Total Resistance of Ship (RT)

The resistance of the ship can be described as follows the flow velocity of the fluid force acting against the ship's motion [18]. the higher the resistance of a ship, the faster the resulting ship will be. While factors that can increase resistance are the presence of waves and wind it will reduce the cruising speed of the ship [20]. There is a difference in resistance between a mono-hull and a catamaran, where the catamaran has a lower level of resistance than a mono-hull [21][22]. In determining engine power, care must be taken so that it is not too large because large power has a large fuel consumption value as well [23][24].

$$RT = 0{,}5\,.\,\rho\,.\,WSA\,.\,V^2\,.\,Ctot \qquad (1)$$

Where,
RT = Total Resistance (kN)
ρ = Density of sea water (Kg/m^3)
V = Ship speed (m/s)
WSA = Wetted surface area
Ctot = Total drag coefficient

Determination of resistance using M. Insel and A.f. Molland's method [20] with a CT (coefficient of total drag) of 3.5 produces a total ship resistance of 19.14 kN.

D. Power Calculation and Main Engine Selection

To get the main engine optimized, it can be done by several processes, namely:

a. Calculating EHP (Effective Horse Power) [25]

$$EHP = RT\ x\ Vs \qquad (2)$$

Where,
RT = Total Resistance (kN)
Vs = Ship Speed (m/s)

In this study, the EHP value was obtained, namely 146.40 kW.

b. Calculating DHP (Delivery Horse Power) [25]

$$DHP = \frac{EHP}{\eta D} \qquad (3)$$

Where :

D = Propulsion Coefficient

In this study, the DHP value of 261.316 kW was obtained

c. Calculating BHP (Break Horse Power) [25]

$$BHP = DHP + (X\%\ DHP) \qquad (4)$$

Where,

X% = Correction for East Asia area shipping between 15%-20% DHP.

In this study, the BHP value of 300.51 kW was obtained

Because the design uses 2 machines, the minimum power requirements for each machine are Engine BHP = 150.26 kW. Therefore, the choice of the main engine on the catamaran refers to the BHP of the engine that has been obtained, which is a minimum of 150.26 kW.

TABLE 4.
MAIN ENGINE SPECIFICATION

Main Engine	Value	unit
Model	4LV230	
Engine Power	169	Kw
Engine Speed	3800	Rpm
Dimension	1151x755x772	mm
Fuel oil consumption	8,5	L/h
Type	Yanmar, 4	*Stroke*/Vertikal

Source : Yanmar 2019 [26]

1. General Arrangement

After the line plan is obtained, the next step is to use it for the general arrangement drawing. The General arrangement is defined as the spatial planning required by the functions of the ship and equipment. The characteristics of the general arrangement drawings are divided into 4 parts, namely spatial planning, installation of room dividers, determination and selection of ship equipment, making lanes and access to shipping access officersThe following is a 3D design and general arrangement drawing of this research catamaran can be seen in the figure 3 and 4 [27].

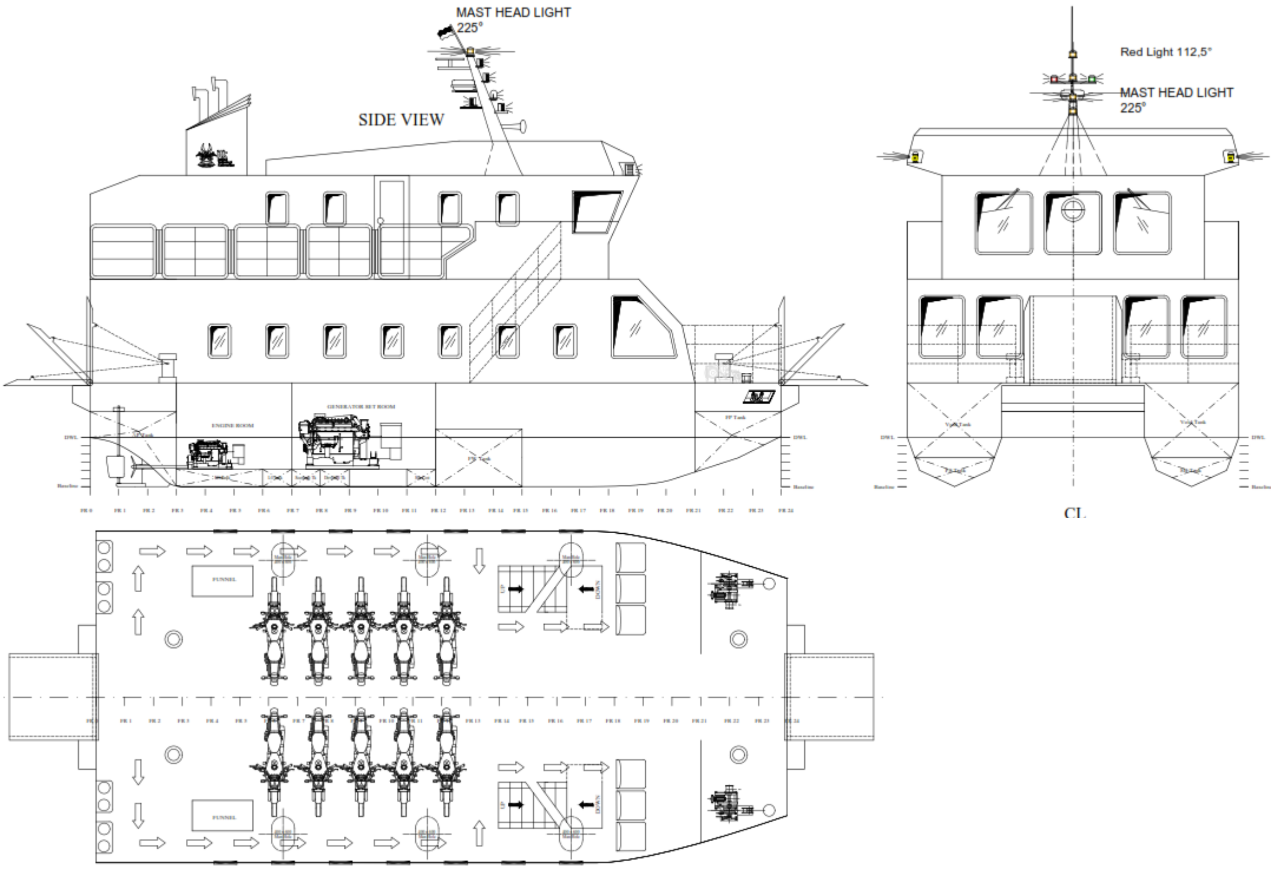

Figure 3. General Arrangement (Side, Top, and Front View)

In this study, designed access to enter the ship using a specific entrance door or commonly known as the Ramp Door. The provision of this ramp door aims to facilitate access for loading and unloading mobility on the draft ship. Determination of mobility access on this ship considers several aspects, namely of the main size of ship, the height of the harbor pier, the cargo carried, and the type of ramp used. The ramp doors used are manual drive systems and the types of ramp doors are stern ramp doors and bow ramp doors, passenger crossings must have access to enter and exit through different doors.

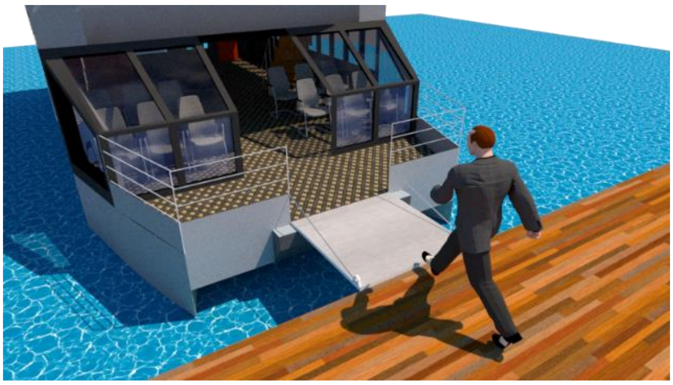

Figure 4. Rampdoor of Catamaran Ship Design

The ramp is designed to be length of 1.5 in meters and width of 1.5 in meters for small vessels and only for passenger and motorbike loads so that it is still possible to be moved by the crew of the ship. Overall, this study provides results in the form of a ship design that can replace the use of klotok ships, there are advantages to this ship design is that this ship can carry more passengers than klotok ships, as well as motorcycles, the process of loading and unloading passengers is much safer than using a klotok ship because it has been equipped with a ramp door which on the previous ship did not exist. ships with this type of catamaran also have a smaller resistance when compared to mono-hull ships.

IV. CONCLUSION

The results showed that the catamaran design for passenger and motorcycle transportation was able to overcome problems related to aspects of ship comfort and safety which so far could not be suitable for klotok boats, for crossing access to the Kampung Baru harbor - North Penajam Paser with the main dimensions of the ship Loa 12.50 m, Lwl 11.96 m, Lpp 11.50 m, B 5.75 m, B1 1.64 m, H 1.80 m, T 0.75 m, S 2.47 m, as well as being able to carry a crew of 4 people with a passenger capacity of 25 people and 10 motorcycles. The speed of the ship is also better than the klotok ship where this ship can go at a speed of 15 knots. For access in and out of passengers using the stern ramp door and bow ramp door with a length and width of 1.5 meters so that it is safer than the motorcycle loading process on the klotok ship.

REFERENCES

[1] C. D. Pratiwi, K. Sleman, and D. Istimewa, "Application of Differential Equation of Logistic Population Model To Estimate Population in Balikpapan," vol. 10, no. 1.

[2] Theresia, R. Martin Sihombing, and F. Simanungkalit, "the Impact of Indonesia Capital Relocation To Kalimantan Peatland Restoration," *Sociae Polites*, vol. 21, no. 2, pp. 231–241, 2020, doi: 10.33541/sp.v21i3.2262.

[3] M. Fauzan, "Analisa Biaya Operasional Kapal Klotok Terhadap Keselamatan Transportasi Air Pada Pelabuhan Penyebrangan Balikpapan …," *J. Ilm. Tek. Sipil TRANSUKMA …*, vol. 02 Nomor 0, no. 1, pp. 84–95, 2016.

[4] E. Esmailian, S. Steen, and K. Koushan, "Ship design for real sea states under uncertainty," *Ocean Eng.*, vol. 266, no. P5, p. 113127, 2022, doi: 10.1016/j.ocean_eng.2022.113127.

[5] A. I. W. Suardi and T. H. Muhammad Uswah Pawara, "Patrol Ship Design to Guard the Natuna Seas," *Int. J. Mar. Eng. Innov. Res.*, vol. 7, no. 3, pp. 171–179, 2022, doi: 10.12962/j25481479.v7i3.13620.

[6] S. Suardi, "Desain Ship Power Plant Sebagai Alternatif Krisis Listrik di Pulau Kagean, Jawa Timur," *JST (Jurnal Sains Ter.*, vol. 6, no. 2, 2020, doi: 10.32487/jst.v6i2.873.

[7] S. S. Suardi, "Desain Kapal Penangkap Ikan Multipurpose 70 Gt," *Inovtek Polbeng*, vol. 8, no. 2, p. 175, 2018, doi: 10.35314/ip.v8i2.660.

[8] S. Kry, N. Sasaki, A. Datta, I. Abe, S. Ken, and T. W. Tsusaka, "Assessment of the changing levels of livelihood assets in the Kampong Phluk community with implications for community-based ecotourism," *Tour. Man. Pers.*, vol. 34, no. October 2018, p. 100664, 2020, doi: 10.1016/j.tmp.2020.100664.

[9] P. Angriani, Sumarmi, I. N. Ruja, and S. Bachri, "River management: The importance of the roles of the public sector and community in river preservation in Banjarmasin (A case study of the Kuin River, Banjarmasin, South Kalimantan – Indonesia)," *Sustain. Cities Soc.*, vol. 43, no. February 2017, pp. 11–20, 2018, doi: 10.1016/j.scs.2018.08.004.

[10] C. C. Chou, C. L. Tsai, and C. P. Wong, "A study on boarding facilities on wharves and ships for disabled and elderly passengers using public shipping transport," *J. Transp. Heal.*, vol. 18, no. June, p. 100895, 2020, doi: 10.1016/j.jth.2020.100895.

[11] M. Iqbal and Samuel, "Traditional catamaran hull form configurations that reduce total resistance," *Int. J. Technol.*, vol. 8, no. 1, pp. 989–997, 2017, doi: 10.14716/ijtech.v8i1.4161.

[12] Samuel, M. Iqbal, and I. K. A. P. Utama, "An investigation into the resistance components of converting a traditional monohull fishing vessel into catamaran form," *Int. J. Technol.*, vol. 6, no. 3, pp. 432–441, 2015, doi: 10.14716/ijtech.v6i3.940.

[13] Alamsyah, W. Setiawan, E. Dwi Cahya, A. Ika Wulandari, Suardi, and A. Alifantio, "Design of Fishing Vessel of Catamaran Type in Waterways of East Kalimantan (40 GT)," *J. Phys. Conf. Ser.*, vol. 1726, no. 1, 2021, doi: 10.1088/1742-6596/1726/1/012014.

[14] A. Alamsyah, Z. Zulkarnaen, and S. Suardi, "The Stability Analyze of KM. Rejeki Baru Kharisma of Tarakan – Tanjung Selor Route," *Teknik*, vol. 42, no. 1, pp. 52–62, 2021, doi: 10.14710/teknik.v42i1.31283.

[15] D. Utamaÿ, A. Nasirudin, and M. Iqbal, "n 2301-9069," vol. 17, no. 1, pp. 28–39, 2020.

[16] "Baru Ulu, Balikpapan City, East Kalimantan to Ferry Port Penajam-Google_Maps." http://www.google.com/maps/dir/Baru+Ulu,+Balikpapan+City,+East+Kalimantan/Pelabuhan+Ferry+Penajam,+Jl.+Pelabuhan+Ferry,+Penajam+North+Paser+Regency,+East+Kalimantan/ (accessed Aug. 18, 2022).

[17] A. T. S. Nugraha, I. K. A. P. Utama, and I. K. A. P. Utama, "Analisis Sideforce Kapal Katamaran Jenis Flat Side Inside Dan Simetris Terhadap Performa Maneuvering Kapal Dengan Metode CFD," *J. Tek. ITS*, vol. 7, no. 2, pp. 2–7, 2018, doi: 10.12962/j23373539.v7i2.32898.

[18] S. Gebrezgabir, D. S. Holloway, and J. Ali-lavroff, "Slam and wave load response reconstruction in high speed catamarans using transmissibility on full scale sea trials," *Ocean Eng.*, vol. 271, no. Nov 2022, p. 113822, 2023, doi: 10.1016/j.ocean_eng.2023.113822.

[19] A. F. Molland, M., & Insel, "Resistance Analysis of Rescue Boat in Calm Water Condition," *An Investig. Into Resist. Components High Speed Displac. Catamarans. Rina*, 1992.

[20] M. Kim, O. Hizir, O. Turan, S. Day, and A. Incecik, "Estimation of added resistance and ship speed loss in a seaway," *Ocean Eng.*, vol. 141, no. June, pp. 465–476, 2017, doi: 10.1016/j.oceaneng.2017.06.051.

[21] Y. Guo, D. Ma, M. Yang, H. Hu, and X. Liu, "Numerical investigation on the resistance characteristics of a flying boat planing in calm water," *Appl. Ocean Res.*, vol. 117, no. June, p. 111837, 2021, doi: 10.1016/j.apor.2021.102929.

[22] Y. Jiang, H. Sun, J. Zou, A. Hu, and J. Yang, "Experimental and numerical investigations on hydrodynamic and aerodynamic characteristics of the tunnel of planing trimaran," *Appl. Ocean Res.*, vol. 63, pp. 1–10, 2017, doi: 10.1016/j.apor.2016.12.009.

[23] R. J. I. Suardi, Wira Setiawan, Andi Mursid Nugraha Arifuddin, Alamsyah, "Evaluation of Diesel Engine Performance Using Biodiesel from Cooking Oil Waste (WCO)," *J. Ris. Teknol. Pencegah. Pencemaran Ind.*, vol. 14, no. 1, pp. 29–39, 2023, doi: https://doi.org/10.21771/jrtppi.2023.v14.no1.p29-39.

[24] M. U. P. Suardi, Alamsyah, Andi Mursid Arifuddin, "EXPERIMENTAL ANALYSIS OF CASTOR OIL AND DIESEL OIL MIXTURES IN A 4-STROKE COMPRESSION COMBUSTION," *Int. J. Mech. Eng. Technol. Appl.*, vol. 4, no. 5, pp. 167–176, 2023, doi: 10.21776/MECHTA.2023.004.02.6.

[25] P. V Manen, J. D., & Oossanen, *Principles of naval architecture, motions in waves*. Jersey City: The Society of Naval Architects and Marine Engineers., 1989.

[26] "4LV230 (Z) - YANMAR Marine International." https://www.yanmar.com/marine/product/engines/4lv230/ (accessed Aug. 18, 2022).

[27] D.J. Eyres, "Ship Construction 7th ed," in *Ship Construction*, 7th ed., Oxford; Boston: Butterworth-Heinemann: Linacre House, Jordan Hill, Oxford OX2 8DP 225 Wildwood Avenue, Woburn, MA 01801-2041 A division of Reed Educational and Professional Publishing Ltd, 2012, p. 4.