COMPARISON FOR TAXI BOAT DESIGN BETWEEN SHAFT PROPELLER WITH WATER JET AS A PUBLIC TRANSPORTATION ALTERNATIVE AND TOURISM OF KALIMAS RIVER

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ABSTRACT

*Taxi Boat is a passenger boat with capacity 5 person using double outboard engine design existing. Purpose Taxi boat design to provide alternative government of Surabaya to reduce the density of vehicles on road. Besides, this boat can also be used as a means of supporting tourism is by proposed segment of the main road Surabaya in enjoying from the boat that along Jakarta street to Jembatan Merah street along Kalimas River. The problem in the Kalimas River is that the amount of garbage that drifts along the river, especially in the dry season, this situation will cause the propeller to get rid of the garbage and will cause the propeller to stop spinning, on that basis will be compared if the propellers replaced water jet, will calculated the advantages and disadvantages of technical and financing aspects of both boat propulsion systems. With the same engine power of 80 HP, for outboard engine Yamaha 2x40 HP obtained speed of 27.6 knots, with a propeller efficiency of 0.55 weight of engine 194 kg, for water jet 1x80 HP Hamilton Model No. 751 obtained speed 28.3 knots, efficiency 0.58 and weight water jet 41 kg, while inboard engine 2x40 HP Yancheng Shunyu Machinery obtained speed 26.6 knots, the efficiency of propeller 0.50 and weight of engine 440 kg. S*o for the taxi boat selected water jet as boat propulsion

Keywords: taxi boat, river, public transportation, tourism, propeller, water jet.

INTRODUCTION

Back ground

Traffic density for working hours in Surabaya is not a public secret and one of the factors that triggered the problem is the use of private vehicles and motor cycle increase. Ease of vehicle loan is very easy, that's some amplifier factor that causes how the traffic in Surabaya is very crowded. Inadequate road conditions on road routes also increase traffic on road routes. Especially with the weather conditions of the rainy season of the segment of the road in Surabaya is very crowded, it also causes an increase in accidents on the road route. Not a few accidents due to traffic density have become commonplace and the risks they must accept.

The geographical condition of Surabaya City that there are many ecosystems ranging from ecosystem such as Coastal ecosystem, River ecosystem, Reservoir ecosystem, Green Open Space ecosystem, Agricultural ecosystem, Fish ponds ecosystem become big capital ie the government make alternative choice of public transportation not only in road. It can be seen from the map of Surabaya City area, the river area is very big potency and wide reach, it is lifted from the problem in Surabaya city and as proposer make new idea that is creating public vehicle which can be alternative of public and support alternative in river channel, namely Taxi Boat.

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Figure 1. Road congestion in Surabaya city

Taxi Boat is a passenger boat with a capacity of about 5 people with agro system (paid in monitor screen display). Just like a car taxi, passengers only need to pay as far as the distance traveled. Taxi Boat can be the choice of people to be bored with driving on road routes and is very economical. It is expected that this proposed design can provide a solution for the Surabaya City government in the development of the river route transportation. During the dry season, the Kalimas river, filled with garbage and drifting grass, will cause the propellers to get rid of garbage, hence, it is appointed a research proposal entitled "Comparison Design of Taxi Boat with Propeller Propulsion and Water Jet Propulsion as a Public Transportation alternative and Tourism of Kalimas River".

Kalimas River Profile

The city of Surabaya is one of the most important cities in Indonesia, the second largest city and the second largest port city in Indonesia. Surabaya became the capital of East Java province until now transformed into a city with high economic growth. Worth it if the city of Surabaya holds the title of metropolitan city, even megapolitan.

River that flows in the city of Surabaya there are six major rivers, namely Lamong river, Perbatasan river, Surabaya river, Wonokromo river , Kalimas river, Kedurus river.

Figure 2. Kalimas River

MATERIALS AND METHODS

Stages of Research

Stages of research that will be conducted on research entitled:

"Comparison Design of Taxi Boat with Propeller Propulsion and Water Jet Propulsion as a Public Transportation alternative and Tourism of Kalimas River".

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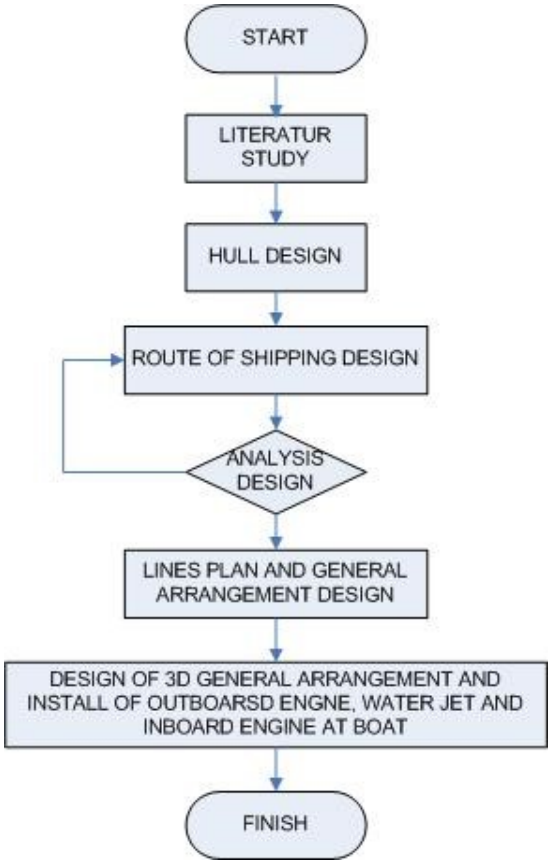

Figure 3. Flowchart of research method

Design and System Planning

Stages of design to create a Taxi Boat as follows:

a. Finding principal dimension of the boat:
   i. Lenght : 11 m
   ii. Beam : 4 m
   iii. Height : 2 m
   iv. Draught : 0.8 m
b. Optimize the shape of the hull and apply the lines plan design.
c. Create a general arrangement design.
d. Install the outboard engine, water jet and inboard engine on boat.
e. In the arrangement of Taxi Boat will be in design can contain 5 passengers.

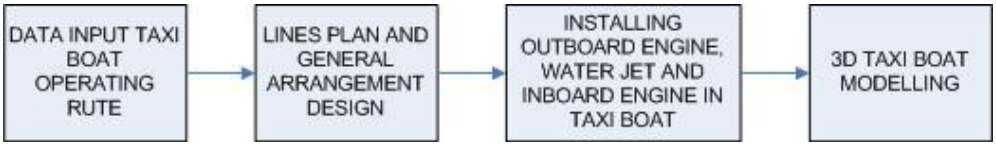

Figure 4. Block Diagram of Taxi Boat design

RESULTS AND DISCUSSIONS

The majority of ships or boats in their operations often use diesel engines, based on the position of the engines, vessels can be grouped into:

i. Inboard Engine, ii. Outboard Engine

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Inboard engine is a model of position the engine is in the ship, the engine is connected with propulsor system. Based on propulsion system often uses submerged propeller, surface propeller, or water jet. When performance efficiency is the main criterion, Blount [1993] argues that submerged propellers are used more by designers for applications with speeds of 25 knots (13 m/s) down, while for applications with speeds greater than 43 knots (22m/s) preferably water jet.

3D Model Propulsion System

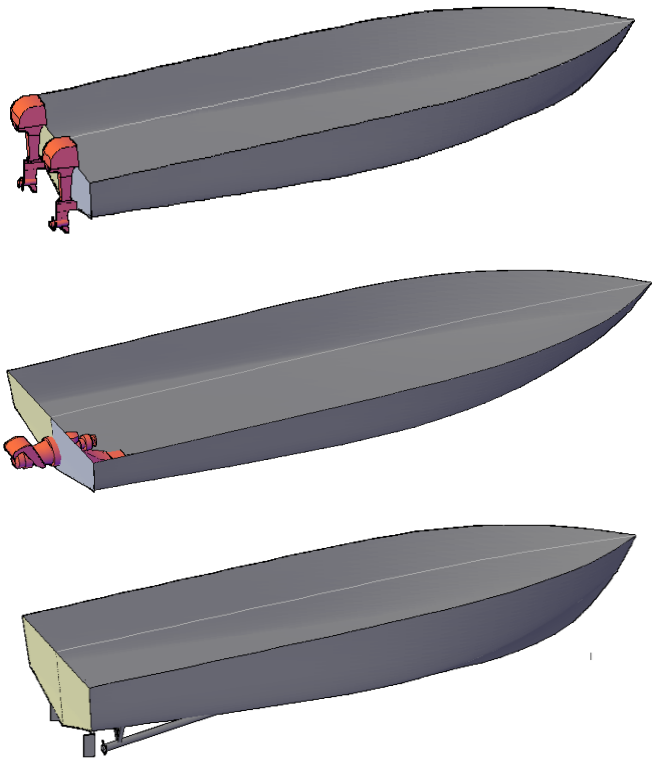

Figure 5. Model driving taxi boat

Speed Power Prediction

1. Outboard engine

Outboard engine Yamaha 2x40HP

Figure 6. Outboard engine propulsion

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Description:

Engine Type	3 cyl
Displacement	747cc
Bore x Stroke	65 x 75mm (2.56 x 2.95 in.)
Prop Shaft Horsepower	40hp at 5500rpm
Full Throttle RPM Range	5000 ~ 6000 rpm
Alternator Output at W.O.T.	17 Amp
Compression Ratio	9.4:1
Fuel Induction System	EFI
Weight*	97 kg (214 lbs) - 101kg (223 lbs)
Recommended Fuel	Octane 87
Recommended Engine Oil	Yamalube® 4M (See owner's manual)
Recommended Fuel Filtration	Yamaha 10-Micron Fuel/Water Separating Filter (external)

Compton

This algorithm is designed for resistance prediction of typical coastal patrol, training or recreational powerboat type hull forms with transom sterns operating in the displacement and semi - planning regimes.

Efficiency for typical propellers this might be of the order of 50% – 70%

Outboard Engine

The efficiency of outboard engine value is 55%.

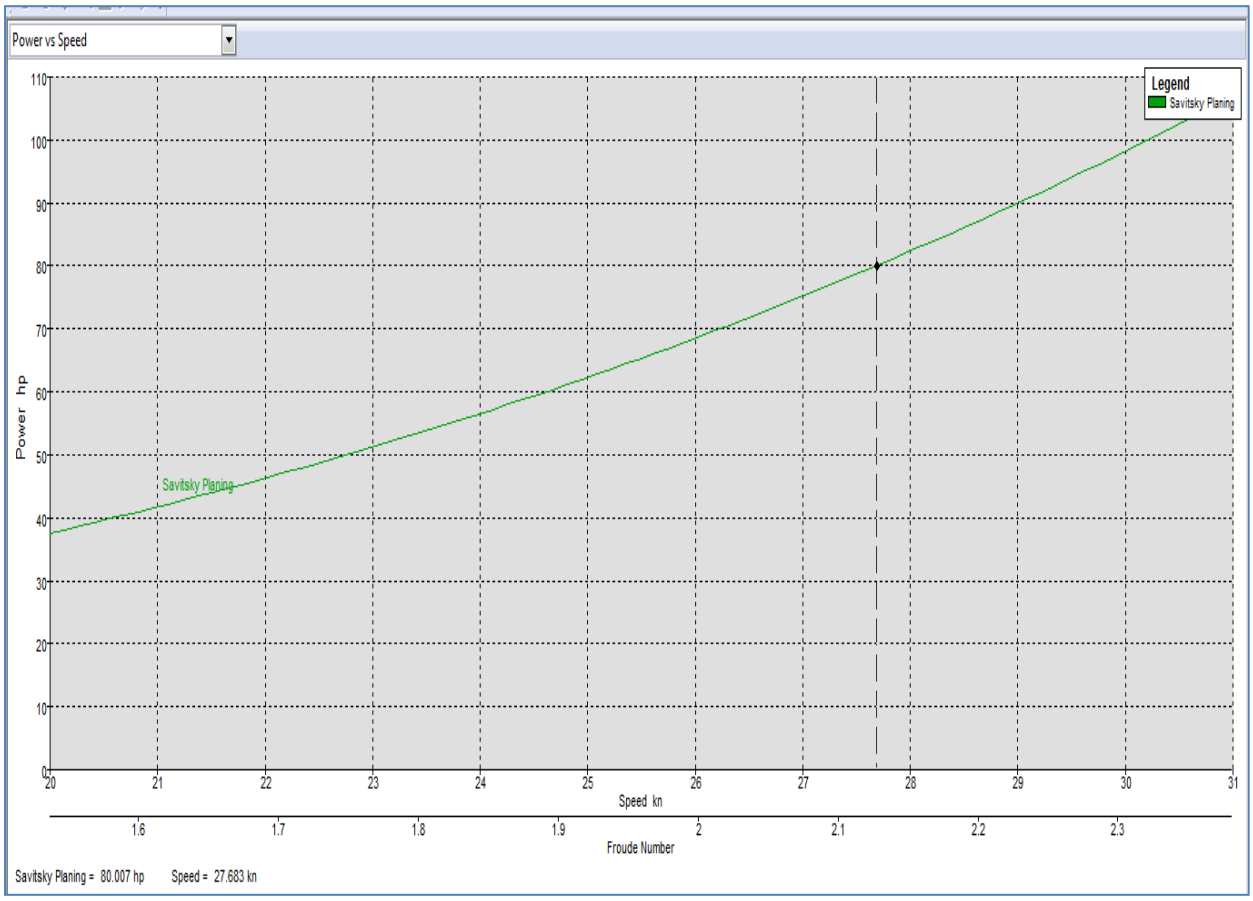

Figure 7. Correlation Power and speed on outboard engine propulsion

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Table 1. Correlation Power and speed on outboard engine propulsion

	Speed (kn)	Froude No. LWL	Froude No. Vol.	Savitsky Planing Resist. (kN)	Savitsky Planing Power (hp)	Slender body Resist. (kN)	Slender body Power (hp)
1	20.000	1.537	3.494	1.5	37.577	calc.	calc.
2	20.275	1.558	3.542	1.5	38.689	calc.	calc.
3	20.550	1.579	3.590	1.5	39.828	calc.	calc.
4	20.825	1.600	3.638	1.6	40.993	calc.	calc.
5	21.100	1.621	3.686	1.6	42.185	calc.	calc.
6	21.375	1.643	3.734	1.6	43.404	calc.	calc.
7	21.650	1.664	3.782	1.6	44.652	calc.	calc.
8	21.925	1.685	3.830	1.7	45.929	calc.	calc.
9	22.200	1.706	3.878	1.7	47.234	calc.	calc.
10	22.475	1.727	3.926	1.7	48.569	calc.	calc.
11	22.750	1.748	3.974	1.7	49.934	calc.	calc.
12	23.025	1.769	4.022	1.8	51.329	calc.	calc.
13	23.300	1.790	4.070	1.8	52.756	calc.	calc.
14	23.575	1.812	4.118	1.8	54.214	calc.	calc.
15	23.850	1.833	4.166	1.9	55.703	calc.	calc.
16	24.125	1.854	4.214	1.9	57.225	calc.	calc.
17	24.400	1.875	4.262	1.9	58.780	calc.	calc.
18	24.675	1.896	4.310	2.0	60.368	calc.	calc.
19	24.950	1.917	4.358	2.0	61.989	calc.	calc.
20	25.225	1.938	4.406	2.0	63.644	calc.	calc.
21	25.500	1.960	4.454	2.0	65.333	calc.	calc.
22	25.775	1.981	4.502	2.1	67.058	calc.	calc.
23	26.050	2.002	4.550	2.1	68.817	calc.	calc.
24	26.325	2.023	4.598	2.1	70.612	calc.	calc.
25	26.600	2.044	4.647	2.2	72.443	calc.	calc.
26	26.875	2.065	4.695	2.2	74.310	calc.	calc.
27	27.150	2.086	4.743	2.2	76.214	calc.	calc.
28	27.425	2.107	4.791	2.3	78.155	calc.	calc.
29	27.700	2.129	4.839	2.3	80.133	calc.	calc.
30	27.975	2.150	4.887	2.3	82.149	calc.	calc.
31	28.250	2.171	4.935	2.4	84.204	calc.	calc.
32	28.525	2.192	4.983	2.4	86.297	calc.	calc.
33	28.800	2.213	5.031	2.4	88.429	calc.	calc.
34	29.075	2.234	5.079	2.5	90.600	calc.	calc.
35	29.350	2.255	5.127	2.5	92.812	calc.	calc.
36	29.625	2.277	5.175	2.6	95.063	calc.	calc.
37	29.900	2.298	5.223	2.6	97.354	calc.	calc.
38	30.175	2.319	5.271	2.6	99.687	calc.	calc.

2. Water Jet Engine

Water Jet : Hamilton seri 751

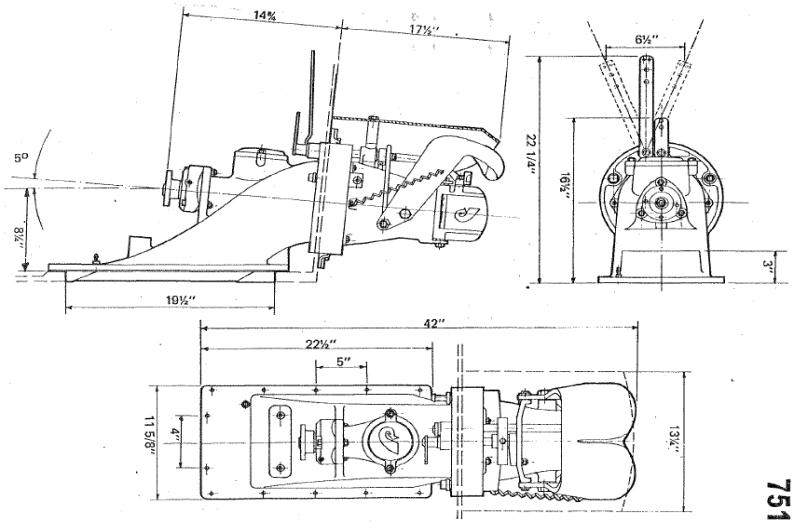

Figure 8. Water Jet Propulsion

Table 2. Waterjet Characteristics

MODEL	751
No. of Stages	1
Impeller Diameter	190mm (7 1/2")
Nozzle Numbers (Std.)	No. 16
Nozzle Range (to order)	No. 15
Engine Size	1 - 3.3 litres 60-200 CID
Horse Power Range	50 - 150
Maximum RPM (Normal)	5,000
Drive Coupling Flange for: Hardy Spicer Hamilton 'Close Kit'	1300
Jet Unit Weight	41kg (90 lb)
Boat Size	3.7 - 6m (12'-20')
Unladen Boat Weight (Maximum)	800 kg (1750 lb)

Jet construction Aluminium / Stainless Steel

Compton

This algorithm is designed for resistance prediction of typical coastal patrol, training or recreational powerboat type hull forms with transom sterns operating in the displacement and semi - planning regimes.

Efficiency for typical propellers this might be of the order of 50% – 70%.

Water Jet

The efficiency of waterjet value is 58%.

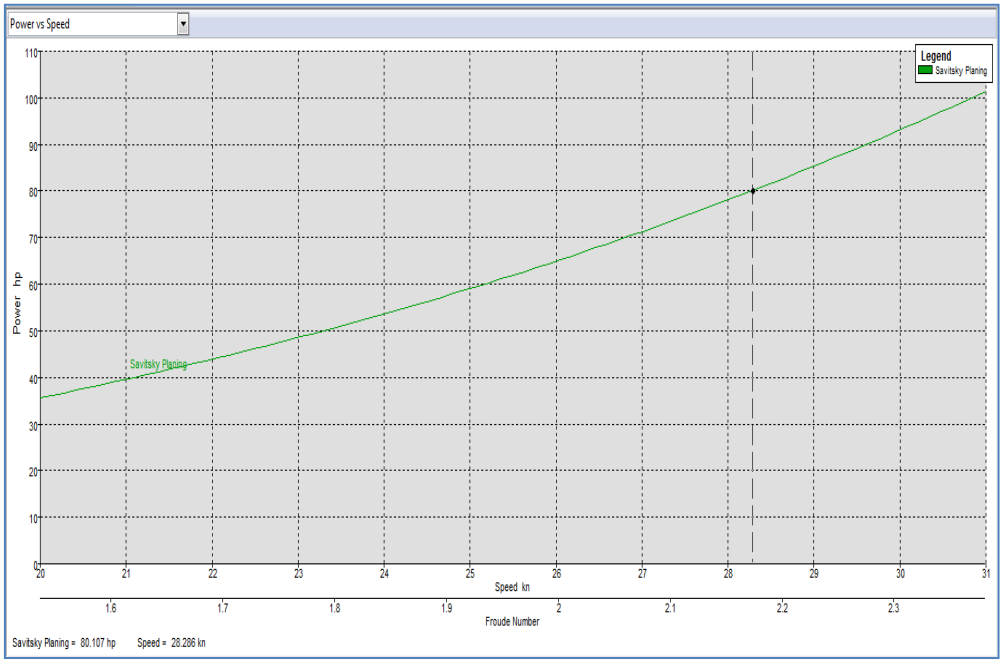

Figure 9. Correlation Power and Speed on Water Jet Propulsion

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Table 3. Correlation Power and Speed on Water Jet Propulsion

	Speed (kn)	Froude No. LWL	Froude No. Vol.	Savitsky Planing Resist. (kN)	Savitsky Planing Power (hp)	Slender body Resist. (kN)	Slender body Power (hp)
1	20.000	1.537	3.494	1.5	35.633	calc.	calc.
2	20.275	1.558	3.542	1.5	36.688	calc.	calc.
3	20.550	1.579	3.590	1.5	37.768	calc.	calc.
4	20.825	1.600	3.638	1.6	38.872	calc.	calc.
5	21.100	1.621	3.686	1.6	40.003	calc.	calc.
6	21.375	1.643	3.734	1.6	41.159	calc.	calc.
7	21.650	1.664	3.782	1.6	42.343	calc.	calc.
8	21.925	1.685	3.830	1.7	43.553	calc.	calc.
9	22.200	1.706	3.878	1.7	44.791	calc.	calc.
10	22.475	1.727	3.926	1.7	46.057	calc.	calc.
11	22.750	1.748	3.974	1.7	47.351	calc.	calc.
12	23.025	1.769	4.022	1.8	48.675	calc.	calc.
13	23.300	1.790	4.070	1.8	50.027	calc.	calc.
14	23.575	1.812	4.118	1.8	51.410	calc.	calc.
15	23.850	1.833	4.166	1.9	52.822	calc.	calc.
16	24.125	1.854	4.214	1.9	54.265	calc.	calc.
17	24.400	1.875	4.262	1.9	55.740	calc.	calc.
18	24.675	1.896	4.310	2.0	57.245	calc.	calc.
19	24.950	1.917	4.358	2.0	58.782	calc.	calc.
20	25.225	1.938	4.406	2.0	60.352	calc.	calc.
21	25.500	1.960	4.454	2.0	61.954	calc.	calc.
22	25.775	1.981	4.502	2.1	63.589	calc.	calc.
23	26.050	2.002	4.550	2.1	65.258	calc.	calc.
24	26.325	2.023	4.598	2.1	66.960	calc.	calc.
25	26.600	2.044	4.647	2.2	68.696	calc.	calc.
26	26.875	2.065	4.695	2.2	70.466	calc.	calc.
27	27.150	2.086	4.743	2.2	72.272	calc.	calc.
28	27.425	2.107	4.791	2.3	74.112	calc.	calc.
29	27.700	2.129	4.839	2.3	75.988	calc.	calc.
30	27.975	2.150	4.887	2.3	77.900	calc.	calc.
31	28.250	2.171	4.935	2.4	79.849	calc.	calc.
32	28.525	2.192	4.983	2.4	81.833	calc.	calc.
33	28.800	2.213	5.031	2.4	83.855	calc.	calc.
34	29.075	2.234	5.079	2.5	85.914	calc.	calc.
35	29.350	2.255	5.127	2.5	88.011	calc.	calc.
36	29.625	2.277	5.175	2.6	90.146	calc.	calc.
37	29.900	2.298	5.223	2.6	92.319	calc.	calc.
38	30.175	2.319	5.271	2.6	94.531	calc.	calc.

3. Shaft and Propeller Machine

Marine diesel engine datasheet
Usage: Boat
Fuel oil : Diesel
Stroke: 4 stroke
Cylinder: Multi-cylinder
Cooled type : Air cooled
Start system : electric
Place of Origin : Jiangsu, China (Mainland)
Brand name: JD, small 20hp diesel engine marine engine
Model Number: JD2110, small 20hp diesel engine marine engine
Dimensions (l * w * h): 690 * 600 * 731 (mm)
Weight: 220 kg
Certification: ISO9001
Warranty: 12 Months
After-sale service provided: No services abroad available
product name: 40hp small diesel marine diesel engine
type: vertical, 4-cycle
burning: Direct injection
Bore * Stroke: 102 * 105 (mm)
displacement: 3.432 (L)
Compression ratio: 18: 1
Output / Speed: 29.5 / 1800 33.1 / 2000 44.1 / 2600 (kw / rpm

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Lubrication system: Combined pressure and spark
Method start: Start Motor (kg) 29
Yancheng Shunyu Machinery Co., Ltd.- Shanghai Model JD2110

Figure 10. Inboard engine propulsion

Compton

This algorithm is designed for resistance prediction of typical coastal patrol, training or recreational powerboat type hull forms with transom sterns operating in the displacement and semi - planning regimes.

Efficiency for typical propellers this might be of the order of 50% – 70%

Shaft and Propeller

The efficiency of Shaft and propeller value is 50%

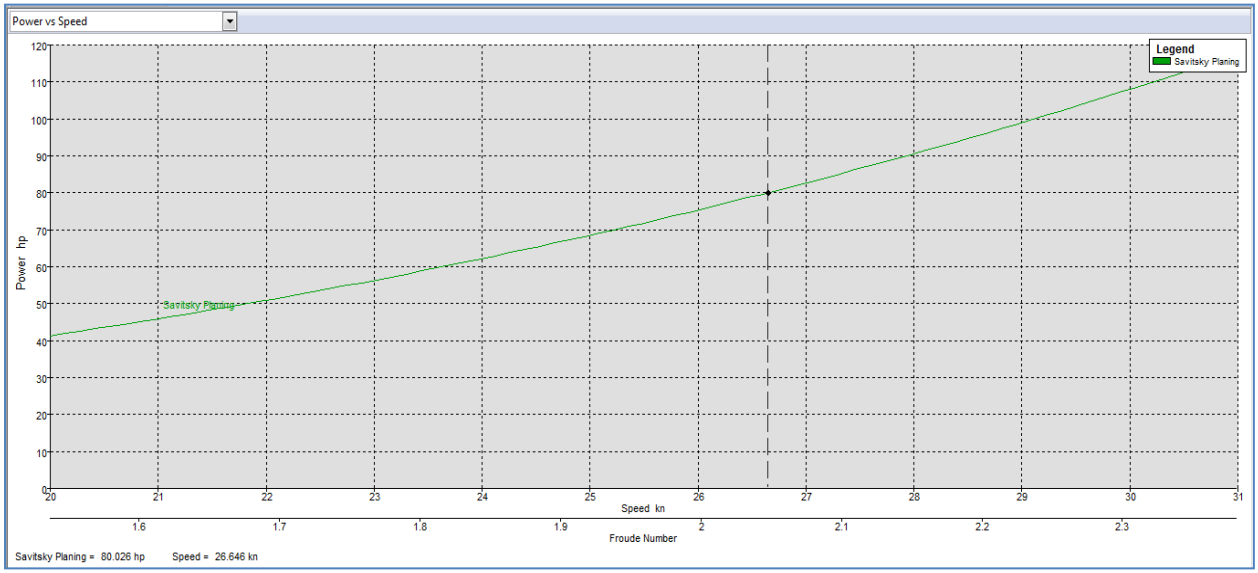

Figure 11. Correlation Power and Speed on Inboard Engine Propulsion

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Table 4. Correlation Power and Speed on Inboard Engine Propulsion

	Speed (kn)	Froude No. LWL	Froude No. Vol.	Savitsky Planing Resist. (kN)	Savitsky Planing Power (hp)	Slender body Resist. (kN)	Slender body Power (hp)
1	20.000	1.537	3.494	1.5	41.334	calc.	calc.
2	20.275	1.558	3.542	1.5	42.558	calc.	calc.
3	20.550	1.579	3.590	1.5	43.811	calc.	calc.
4	20.825	1.600	3.638	1.6	45.092	calc.	calc.
5	21.100	1.621	3.686	1.6	46.403	calc.	calc.
6	21.375	1.643	3.734	1.6	47.745	calc.	calc.
7	21.650	1.664	3.782	1.6	49.117	calc.	calc.
8	21.925	1.685	3.830	1.7	50.521	calc.	calc.
9	22.200	1.706	3.878	1.7	51.957	calc.	calc.
10	22.475	1.727	3.926	1.7	53.426	calc.	calc.
11	22.750	1.748	3.974	1.7	54.927	calc.	calc.
12	23.025	1.769	4.022	1.8	56.462	calc.	calc.
13	23.300	1.790	4.070	1.8	58.032	calc.	calc.
14	23.575	1.812	4.118	1.8	59.635	calc.	calc.
15	23.850	1.833	4.166	1.9	61.274	calc.	calc.
16	24.125	1.854	4.214	1.9	62.948	calc.	calc.
17	24.400	1.875	4.262	1.9	64.658	calc.	calc.
18	24.675	1.896	4.310	2.0	66.404	calc.	calc.
19	24.950	1.917	4.358	2.0	68.188	calc.	calc.
20	25.225	1.938	4.406	2.0	70.008	calc.	calc.
21	25.500	1.960	4.454	2.0	71.867	calc.	calc.
22	25.775	1.981	4.502	2.1	73.763	calc.	calc.
23	26.050	2.002	4.550	2.1	75.699	calc.	calc.
24	26.325	2.023	4.598	2.1	77.673	calc.	calc.
25	26.600	2.044	4.647	2.2	79.687	calc.	calc.
26	26.875	2.065	4.695	2.2	81.741	calc.	calc.
27	27.150	2.086	4.743	2.2	83.835	calc.	calc.
28	27.425	2.107	4.791	2.3	85.970	calc.	calc.
29	27.700	2.129	4.839	2.3	88.146	calc.	calc.
30	27.975	2.150	4.887	2.3	90.364	calc.	calc.
31	28.250	2.171	4.935	2.4	92.624	calc.	calc.
32	28.525	2.192	4.983	2.4	94.927	calc.	calc.
33	28.800	2.213	5.031	2.4	97.272	calc.	calc.
34	29.075	2.234	5.079	2.5	99.661	calc.	calc.
35	29.350	2.255	5.127	2.5	102.093	calc.	calc.
36	29.625	2.277	5.175	2.6	104.569	calc.	calc.
37	29.900	2.298	5.223	2.6	107.090	calc.	calc.
38	30.175	2.319	5.271	2.6	109.655	calc.	calc.

Analysis

Table 5. Summary of ship propulsion types with power, speed, efficiency and weight

No.	Type of Propulsion	Power	M/E	Speed	Efficiency	Weight M/E
		HP		knot	%	kg
1	Out board engine	80	Yamaha 2x40 HP	27.6	55	194
2	Water Jet	80	1x80 HP Hamilton Model No.751	28.3	58	41
3	Shaft and Propulsion	80	2x40HP Yancheng Shunyu Machinery	26.6	50	440

Selected :

Selected propulsion system with water jet, because of greater speed, higher efficiency and lighter weight.

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CONCLUSIONS

Selected propulsion system with water jet, because of greater speed, higher efficiency and lighter weight.

RECOMMENDATIONS

It is suggested that it may not be operated in a polluted environment with lots of rubbish and twigs.

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