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An Analyze Stability of Traditional Boat in Riau Island

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Abstract

Traditional boat are quite important means of transportation in the Riau Islands because of their natural contours consisting of islands. Boat is the main transportation and also lest costs because it only uses simple technology and simple maintenance. This paper is aims to investigate the traditional boat of Riau's curiosity. It is used to find the things that must be prepared with possible dangers arising from the stability of the boat. This research was conducted by collecting data on the main dimension of the traditional boats used in the Riau Islands. From the main dimensions, measurements are made of the shape of the vessel using digital equipment (infrared) combined with simple equipment to obtain maximum results. From the measurement results, then the simulation is carried out using software with several criteria to get the desired results. From the research results, it is found that the boat still has adequate stability on the: lightweight condition, lightweight with 1 person on board and engine, lightweight with one person onboard with engine and even load. In the future, research will continue to simulate loading when the boat will be used to transport people, luggage with variations in wave angle and boat direction.

Keywords*:* Traditional Boat, Stability, Riau Island

Abstrak

Kapal tradisional menjadi alat transportasi yang cukup penting di Kepulauan Riau karena kontur alamnya yang terdiri dari pulau-pulau. Transportasi dengan kapal merupakan transportasi yang utama dan juga mengeluarkan sedikit biaya karena hanya menggunakan teknologi sederhana serta perawatan yang sederhana. Belum adanya penelitian mengenai perahu kayu menjadi alasan penulis mencoba untuk meneliti perahu tradisional Kepulauan Riau. Penelitian ini dilakukan dengan cara mengumpulkan data ukuran utama kapal tradisional yang digunakan di Kepulauan Riau. Dari ukuran utama kemudian dilakukan pengukuran mengenai bentuk lambung kapal dengan menggunakan perlatan digital (infra merah) dipadukan dengan peralatan sederhana untuk mendapatkan hasil yang maksimal. Dari hasil pengukuran, kemudian dilakukan simulasi menggunakan perangkat lunak dengan beberapa kriteria untuk mendapatkan hasil yang diinginkan. Dari hasil simulasi, maka akan ditemukan hal-hal yang harus disiapkan untuk mengahadapi kemungkinan bahaya yang timbul dari kondisi stabilitas kapal. Dari hasil penelitian didapatkan bahwa kapal masih memiliki kestabilan yang memadai dengan kondisi kapal kosong, kapal dengan satu kru dan mesin yang terpasang, serta berat satu kapal, satu kru kapal, permesinan, dan perbekalan penuh dengan beban merata. Kedepan penelitian akan berlanjut pada simulasi pembebanan ketika kapal akan digunakan untuk mengangkut orang, barang bawaan dengan variasi sudat ombak dan arah gerak kapal

Kata Kunci: Kapal Tradisional, Stabilitas, Kepulauan Riau.

1. Introduction

Kepulauan Riau, the nearest Indonesia province from Singapore, still operate traditional boat for the transportation on certain place. Fishing, transporting, trading(Nur et al., 2019) are the most activity related with the traditional . The traditional characteristic of Kepulauan Riau are: made by wood(Mote et al., 2016), equipped with outboard engine, has 10-20 meter long and 0,8-2 meter wide. There are not need much special certificate to operate, habits and practice are common basic skill to operate the boat. Traditional boat are usually made by traditional engineering, document less and made by revealed expertise(Azis et al., 2017). Design evaluation are transmitted mouth to mouth and unrecorded. This condition made the traditional boat are hazardous. This paper is aim to write down stability characteristic of Kepulauan Riau traditional , (Nasty & Syahril2, 2019), kinds of hazardous condition, and how traditional engineering are meets with the regulation. This calculation will be brought by boat calculation software, and the design of the boat will use the existing model from existing research.

2. Methods

Numerical Computer Analytic is the method conducted to this research. Model of the boat will take from previous research (Satoto et al., 2019), analyst with boat design software and this paper will show the calculation result.

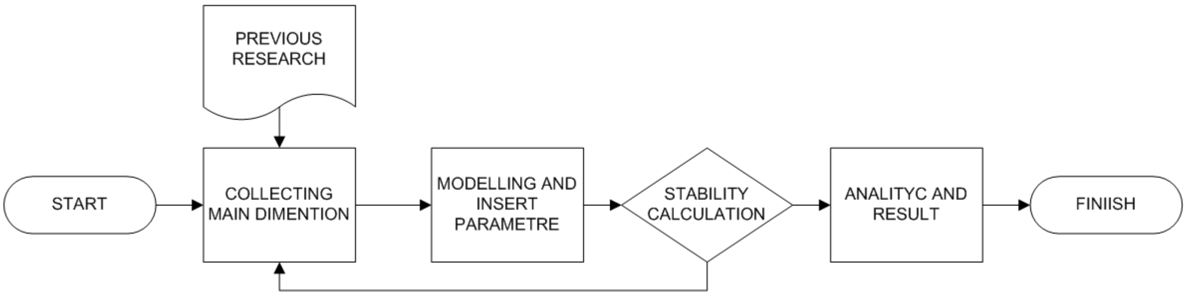

Figure 1: Research Flowchart

IMO Criteria, Code A.749 (18) Code on Intact Stability, Ch3 - design criteria applicable to all ships will be standard for the stability calculation of the boat.

Table 1: IMO Criteria, Code A.749 (18) Code on Intact Stability, Ch3

IMO Criteria, Code A.749 (18) , Ch3: Design Criteria Applicable to All ship	shall not be lessthan (>=)	unit
3.1.2.1: Area 0 to 30	315,1	cm.de
3.1.2.1: Area 0 to 40	515,6	cm.de
3.1.2.1: Area 30 to 40	171,8	cm.de
3.1.2.2: Max GZ at 30 or greater	200	cm.de
3.1.2.3: Angle of GZ maximum	25	deg
3.1.2.4. Initial GMt	15	cm

Even we use the standard, it cannot be conclude that it is precisely correct, because IMO criteria taken by experience and it will different if they are any differentiation on boat condition (Umeda et al., 1999). The boat will put on several condition so we can get some condition and can retract other point of view for condition when it is operated.

3. Result and discussion

3.1. Main Dimension

Main dimension is the dimension which is show the distance of boat from part to other part. The main dimension of boat usually consist of the length of the boat (LoA), breath (B), High (D) and Depth (T)(Kapal, n.d.)

Table 2: Boat Main Dimension

Main Dimension	Dimension (meter)
Length Over all	12,00
Length Between Perpendicular	9,50
Breath	2,20
High	1,10
Depth	0,25

Main dimension data collected by measure the boat on the location. (Hardiyanti & Eko, 2016). The process to take the main dimension is by using a measuring tape. LoA took by measure form the front until the aft part of the boat. Breath took by measure from the outside part of the portside and the starboard of the boat. High taken from the outside bottom until the top of the boat (not include the added part) and the Depth taken by measure from the bottom until the waterline or we can subtract the high and the freeboot (the dimension from waterline to the top part of hull). When we take dimension, we must make sure that the water is on the calm condition and not in the wavy condition. If we took the data on the un proper condition, we must add some correction to meet the near perfect measuring process

Figure 2: Measurement Process

Source: Laporan Tugas Kapal Khusus Kapal Non Baja, Hardiyanti Eko & Kurniawan (2016)

3.2. Redrawing to 3D Software

Data collected from the boat, are inserted to the parameter of 3D model software. The 3D model is used to calculate the stability of the boat by using software. Scenarios are put into the condition of the boat so we can know the effect of the scenario and we can analyst what are the result of the stability calculation.

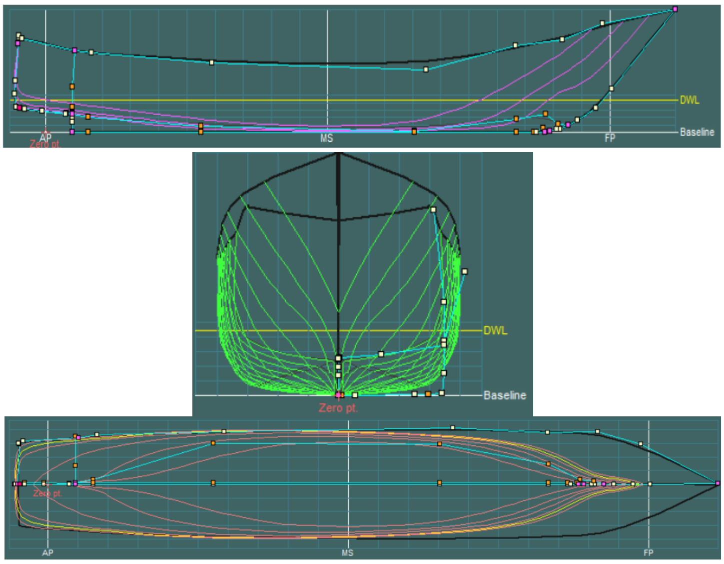

Figure 3: Lines Plan Modelling

Source: Laporan Tugas Kapal Khusus Kapal Non Baja, Hardiyanti Eko & Kurniawan (2016)

Lines plan are basic drawing needed for analytical process. We can assume and get conclusion from several by analyzed the lines plan (Hasegawa & Karim, 2008).

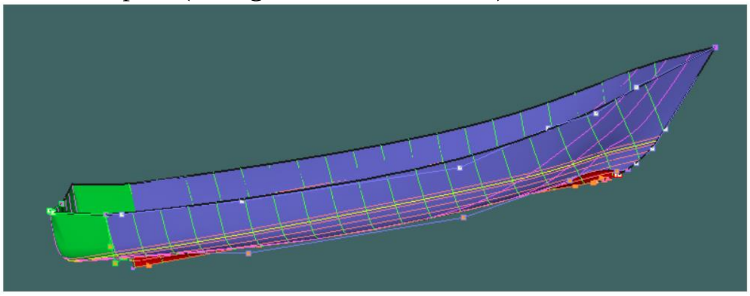

Figure 4: Boat Modelling

Source: Laporan Tugas Kapal Khusus Kapal Non Baja, Hardiyanti Eko & Kurniawan (2016)

3.3. Stability Calculation

Stability calculation started by giving condition or scenario on the boat. There are 3 scenarios regarded with the condition of the boat: Light Weight Condition, Light Weight with 1 person on board and engine, Light weight with one person onboard with engine and equivalent load as long as the boat. There are several conditions effected by every condition and we can show after we run the software.

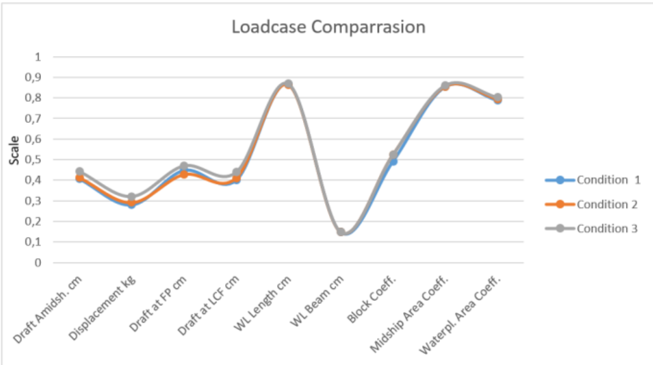

Figure 5: Loadcase Comparrasion

a. Lightweight Condition

Light condition means here is the weight condition of the structure of the (Christensen, 2014). We can assume the weight of boat by calculate the area of shell thickness and structure, and divine the type of the shell whether is it by steel or wood. Is it important to knowing the lightweight condition so that we can estimate and calculate the basic condition of the boat.

Table 3: Condition 1

Item	Quantity	Weight (kg)	Long. Ar (cm)	Vert. Arm (cm)	Trans. Ar (cm)	FS	FSM
Lightboat	1	2808	389.00	40.00	0.00	0.00	
	Total	**2808**	**LCG=389.0**	**VCG=40.00**	**TCG=0.00**	**0**	

Draft Amidsh. cm	40.705
Displacement kg	2808
Draft at FP cm	44.828
Draft at AP cm	36.581

From the table it showed that the total weight of the boat is 2808 kg, and the condition of the boat isn't even keel (trim by bow) where the condition draft at AP is 36,581cm and the FP is 44.828cm.

GZ max and angel of GZ max is the largest moment created by internal moment of the boat (Stability et al., n.d.). From this number we can't knew the maximum angle and moment of the boat so that we can prepare to handle if there are any force from the outside of the boat which is hazardous for the boat

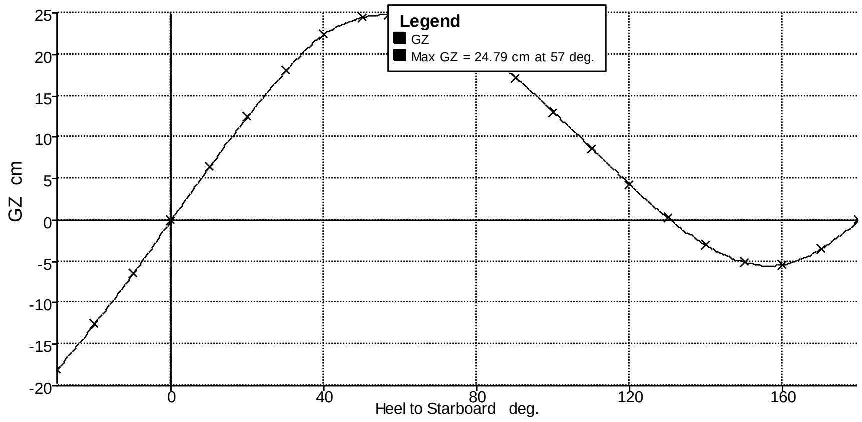

Figure 6: Condition 1

Picture show that the max GZ is 24,79cm and the maximum angle of GZ is 57deg. It can be concluded that on the lightweight condition, maximum righting moment happened at 24,79cm distance and the angle 57. It means, at the 24,79 distance and 57 deg angel, if the boat get force from the outside of the boat whether it will cause the boat get rolling, the boat has a maximum moment produce by the boat to handle those force. If the boat can handle the force at 24,79cm distance and 57 deg, so it will get the minimum probability to capsize if they are any force less than the force. In the first criteria the result related with IMO criteria, Code A.749 (18) Code on Intact Stability, Ch3 - design criteria applicable to all ships are: Area 0-30: 557,2 cm. de, Area 0-40: 967 cm.de, Area 30-40: 409,8 cm.de, Max GZ: 574cm, Angle of Max GZ 70,9 deg and initial GMt 73,6cm

b. Lightweight with 1 person on board and engine

This condition to simulate one person operate the boat. In the real condition, the boat usually operate by one person and the position is behind the boat. This position related with the location of the outboard engine which is the location is behind the

Table 4: Condition 2

Item	Quantity	Weight (kg)	Long. Ar (cm)	Vert. Arm (cm)	Trans. Ar (cm)	FS	FSM
Lightboat	1	2808	389.00	40.00	0.00	0.00	
Engine	1	40.00	30.00	50.00	0.00	0.00	
Crew	1	70.00	100.00	60.00	0.00	0.00	
	Total	**2918**	**LCG=37**	**VSG=40.62**	**TCG=0.00**	**0**	

Draft Amidsh. cm	41.325
Displacement kg	2918
Draft at FP cm	42.836
Draft at AP cm	39.815

At 2918 displacement, the condition of the boat isn't even keel. This trim by bow condition can effect of the resistance of the boat. On the operation condition, usually on the planning or pre planning condition which is the bow are slightly raised

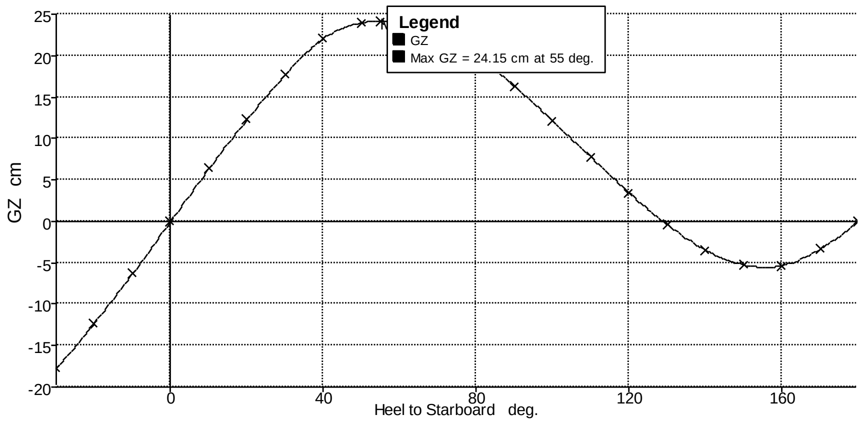

Figure 7: Condition 2

Picture show the condition of max GZ happened at 24.15 and 55 deg. From this data it can conclude that the max gz will decrease by 1.29 distance and 2 deg. Added some load to a floating structure will affect to the stability. In the second criteria the result related with IMO criteria, Code A.749 (18) Code on Intact Stability, Ch3 - design criteria applicable to all ships are: Area 0-30: 537,3 cm. de, Area 0-40:936,6 cm.de, Area 30-40: 399,3 cm.de, Max GZ: 537 cm, Angle of Max GZ 70 deg and initial GMt 68,7 cm.

c. Light weight with one person onboard with engine and even load

Condition applied on this scheme related with the function of the bot itself. The traditional boat usually uses by the sailor to catch the fish on the sea.

Table 5: Condition 3

Item	Quantity	Weight (kg)	Long. Ar (cm)	Vert. Arm (cm)	Trans. Ar (cm)	FS	FS
Lightboat	1	2808	389.00	40.00	0.00	0.00	
Engine	1	40.00	30.00	50.00	0.00	0.00	
Crew	1	70.00	100.00	60.00	0.00	0.00	
Accomodation	1	300.0	389.00	120.00	0.00	0.00	
	Total	**3218**	**LCG=378.**	**VCG=48.02**	**TCG=0.00**	**0**	

Draft Amidsh. cm	44.372
Displacement kg	3218
Draft at FP cm	47.073
Draft at AP cm	41.671

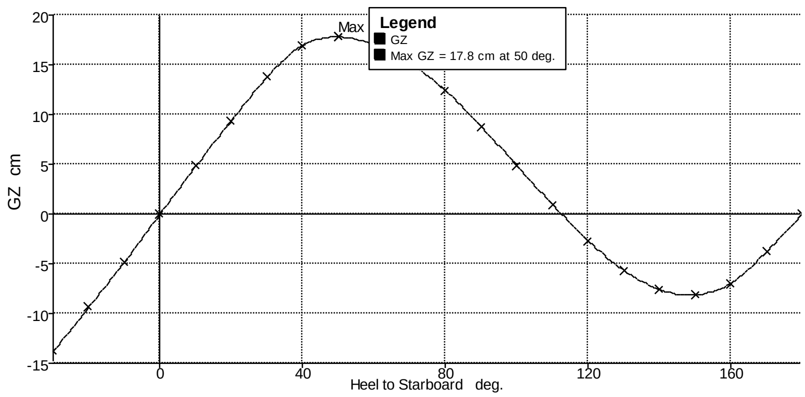

Figure 8: Condition 3

Picture show the condition of max GZ happened at 17,8 and 50 deg. From this data it can conclude that the max GZ will decrease by 6,35 distance and 5 deg. In the third criteria the result related with IMO criteria, Code A.749 (18) Code on Intact Stability, Ch3 - design criteria applicable to all ships are: Area 0-30: 537,3 cm. de, Area 0-40:912,7 cm.de, Area 30-40: 385,3cm.de, Max GZ: 522 cm, Angle of Max GZ 70,9 deg and initial GMt 67,8cm.

4. Conclusion

From the calculation we can conclude the result below:

1. GZ maximum is on the lightweight condition (24,79 cm 57 degree) and the lowest base on criteria are on the lightweight with engine and even load
2. Analysis results show that the boat is pass all IMO criteria. The biggest number happened in first condition based on IMO criteria, Code A.749 (18) Code on Intact Stability, Ch3 - design criteria applicable to all ships are: Area 0-30: 557,2 cm.de, Area 0-40: 967 cm.de, Area 30-40: 409,8 cm.de, Max GZ: 57,4cm, Angle of Max GZ 70,9 deg and initial GMt 73,6cm
3. Draft FP of the boat in every condition are 42.836m (cond.1), 44.828 (cond.2), 47.073 (cond.3). Based on data, it is saw that the boat is on the trim by bow condition. The bow is more weight because the waterplane area are wider than the afterpeak of the boat

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