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Contribution of Fishing Vessel Hullform on Ship Safety

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ABSTRACT

The research was conducted in June 2014 at Fishing Vessel Laboratory of Department of Fishing Technology, Faculty of Fisheries and Marine Science, University of Riau. The objective of the research is to compare the ship stability of a hull as a part of ship safety standart which is designed with hardchine and no hardchine. Both vessels will be kept in the same displacement with error no more than 5% of its modification. The hullform was modelled in Hydromax which is known as a powerfull software in marine vessel. The results show that chine effects the stability of a vessel around 4-7% and will be discussed clearly in this article.

Keywords: *hardchine, ship stabilty, Hydromax*

INTRODUCTION

Stability is a requirement to ensure that a ship is in sea wothiness condition. Adequate stability is one of the most important factors contributing to safety of a vessel (Fyson, 1985). The accidents that involve worst stability has occured in long time for vessel, both special ship as fishing vessel and commerce vessels as tanker, bulk carrier, etc for instance Titanic tragedy in 1912s, and Costa Corcondia disaster which capsized and sank after strinking an underwater obstruction on 13 January 2012, with the kiss of 32 lives. Other vessel which is attracted the world attention is tragedy of MV Cougar Ace. The Cougar Ace, a 654-foot Singapore flagged car carrier, sailed from Japan on July 22 with a load of 4, 813 cars. The vessel was traveling along a great circle route to two ports on the West Coast of Canada and the United States. The vessel capsizes in the North Pacific on a voyage from Japan to Vancouver. While re-ballasting the ship at sea the crew pumped too much ballast water to port, and the ship heeled over. Within minutes it's at 60 degrees, then 80 degrees. For three weeks the Cougar Ace lies precariously on its side as salvage teams carefully board it, then slowly tow it 400 miles to safety in the Aleutians. Worst stability not only brings casualties but also will effect the live of a vessel. Oleh karena itu, a good stability is the most important factor and be an attention to designer of vessel.

We can assume that a boat like a cars, often feature a shape that defines them, that makes their purpose expressly obvious. Vessel hull shapes can reveal subtler messages that help owner to choose the best one for their fishing methods for instance the width of the chines, the deadrise angle, and the presence of a pad and steps, will change the comfort and speed of the craft. The shape of the hull should match its weight is the general philosophy for any vessel. Effectiveness and efficiency is the main important factors in designning a vessel. It would be linked with cost over periode of ship's investment. Efficient hull will decrease fixed cost due to ship operating.

Stability against capsizing in heavy seas is one of the most fundamental requirements considered by naval architects when designing a ship (ITTC, 2002). Ship stability depends on a number of basic physical concepts where a ship is a floating body on the surface of the water. Thus, there is a significant relationship between the ship's gravity center and the water's gravity center due to floating (Ali, et al., 2002). In addition, when a ship is floating in calm water, the ship has six degress of freedom. In order to completely define the ship's motion, it is important to consider movements in all modes. Besides, allowance for certain and specific hull structure and a host of effect from non linearities must be made too. Many models of varying sophistication, have been produced the ship

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stability under variety condition of conditions. The ultimate goal is to find the best performance of ship while cruising in the ocean (Zjovanoski and Robinson, 2009).

A ship with different hull form will effect its stability. Lewis (1998) grouped vessel hull form in to vary types of ship namely aerostatic support, hydrodynamic support, hydrodynamics support and submerge support (Figure 2.). He then grouped High Speed Craft (HSC) and Advanced Marine Vehicles (AMV) into monohull, multihull, hydrofoil, and air supported craft (Figure 3).

Generally, fishing vessels is designed with hydrostatics support with conventional displacements, mainly if the materials constructed from woods. Fishing vessel for artificial fishing which is designed from woods, will be changed its form form conventional displacement hull form to be hydrodynamics support with planning hull. It is necessary to understanding its effect with differ hullform.

Figure 1. Costa Corcondia and Cougar Ace
http://blog.geogarage.com/2012/01/costa-concordia-why-navigation-might.html
http://www.bestphotos.us/photo/capsized-ship---cougar-ace-album-3170.php

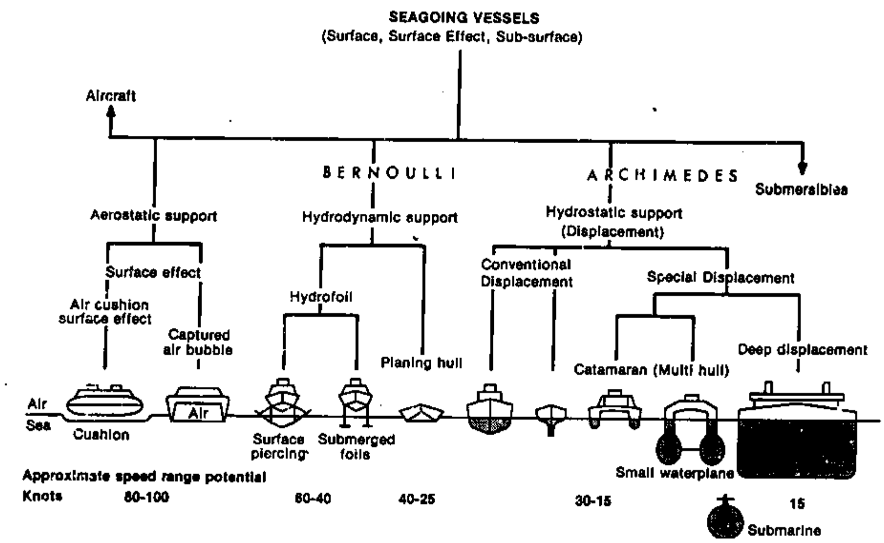

Figure 2. Type of Seagoing Vessels

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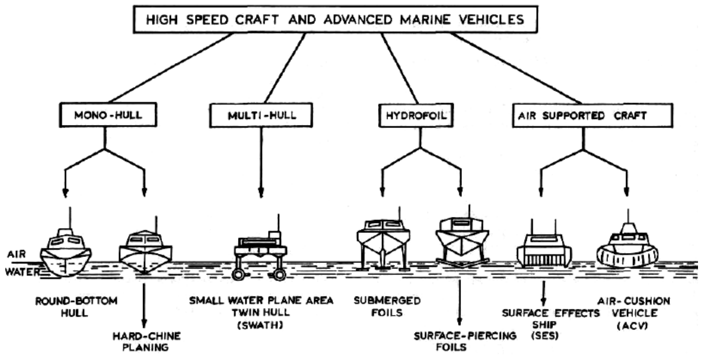

Figure 3. High Speed Craft and Advanced Marine Vehicles.

METHODS

A same displacement of vessel will be designed and divided into conventional displacement and planning hull. We have to make sure the transfrom from conventional displacement and planning hull must be less than 0,05%. When the constraint is satisfy, then the hull form will be tested towards its stability by using Hydromax software. The criteria of stability adopts Code of Intact of Stability A.749 (18) as follow:

GZ curve area. The area under the righting lever curve (GZ curve) is to be not less than 0,055 m.rad up to θ_f= 30° angle of heel and not less than 0,09 m.rad up to θ_f = 40° or the angle of down flooding θ_f if this angle is less than 40°. Additionally, the area under the righting lever curve (GZ curve) between the angles of heel of 30° and 40° or between 30°and θ_f, if this angle is less than 40°, is to be not less than 0,03 m.rad. Where θ_f is an angle of heel at which openings in the hull, superstructures or deckhouses which cannot be closed weathertight submerge. In applying this criterion, small openings through which progressive flooding cannot take place need not be considered as open.This interpretation is not intended to be applied to existing ships.

Minimum righting lever. The righting lever GZ is to be at least 0,20 m at an angle of heel equal to or greater than 30°.

Angle of maximum righting lever. The maximum righting arm is to occur at an angle of heel preferably exceeding 30° but not less than 25°. When the righting lever curve has a shape with two maximums, the first is to be located at a heel angle not less than 25°.

In cases of ships with a particular design and subject to the prior agreement of the flag Administration, the Society may accept an angle of heel θ_f max less than 25° but in no case less than 15°, provided that the area "A" below the righting

RESULTS AND DISCUSSIONS

The principal dimension of each vessel is LPP = 12,01 m; B = 2,47 m; T =0,76 m; C_M = 0,714; C_B = 0,57; C_P = 0,67; LCB aft of FP = 58,3% DWL, displacement = 7,70 tons (displacement hull); and LPP = 11,95 m; B = 2,67 m; T =0,76 m; CB = 0,53; C_P = 0,73; LCB aft of FP = 57,8% DWL, displacement = 7,72 tons (planning hull) (Figure 4).

We can conclude that both vessel is different for its size and dimension, but have the same displacement (<0,05%). From its form coefficient, it reveal that the hull form of displacement hull sligtly decrease than planning hull. It may be happent because of design of water line and bodyplan

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of vessels change when reach the top of vessels as increase of draft. Arrangement of compartment and room will effect the result of waterplane area, midship section area and block coefficient.

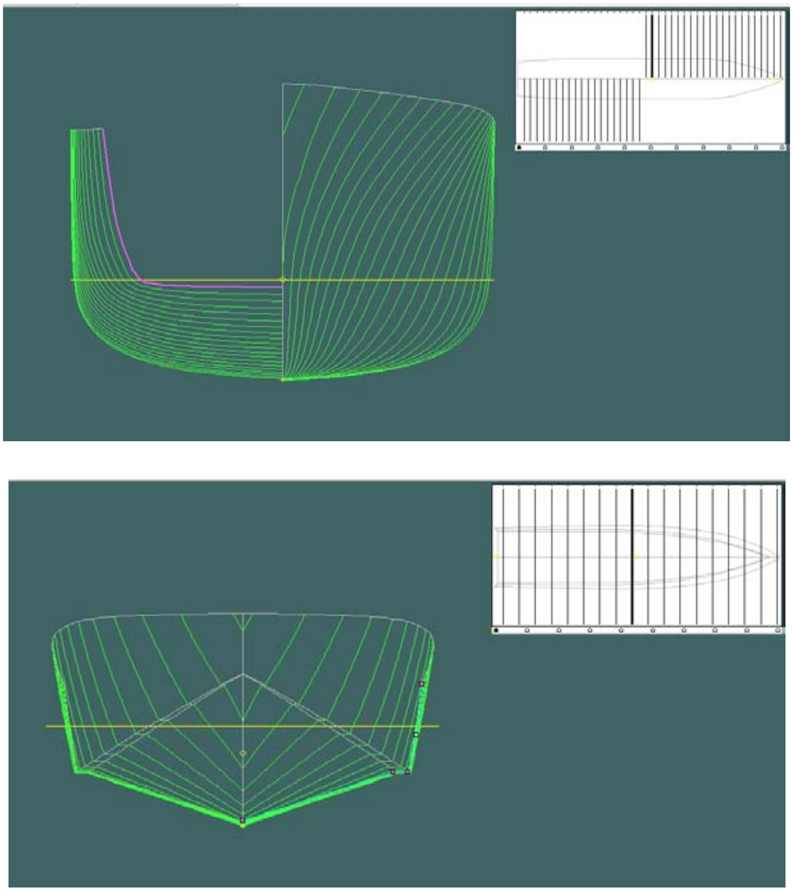

Figure 4. Body plan of displacement hull and planning hull

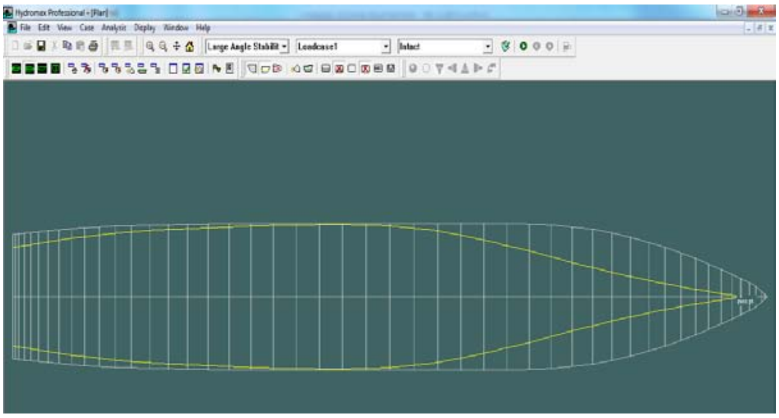

Figure 5. (A) Waterplane area of displacement hull.

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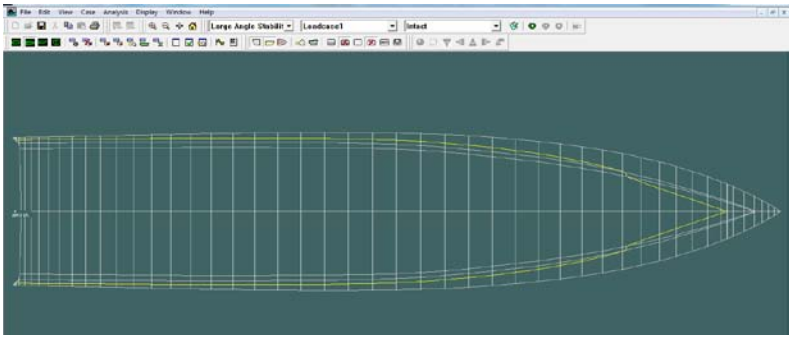
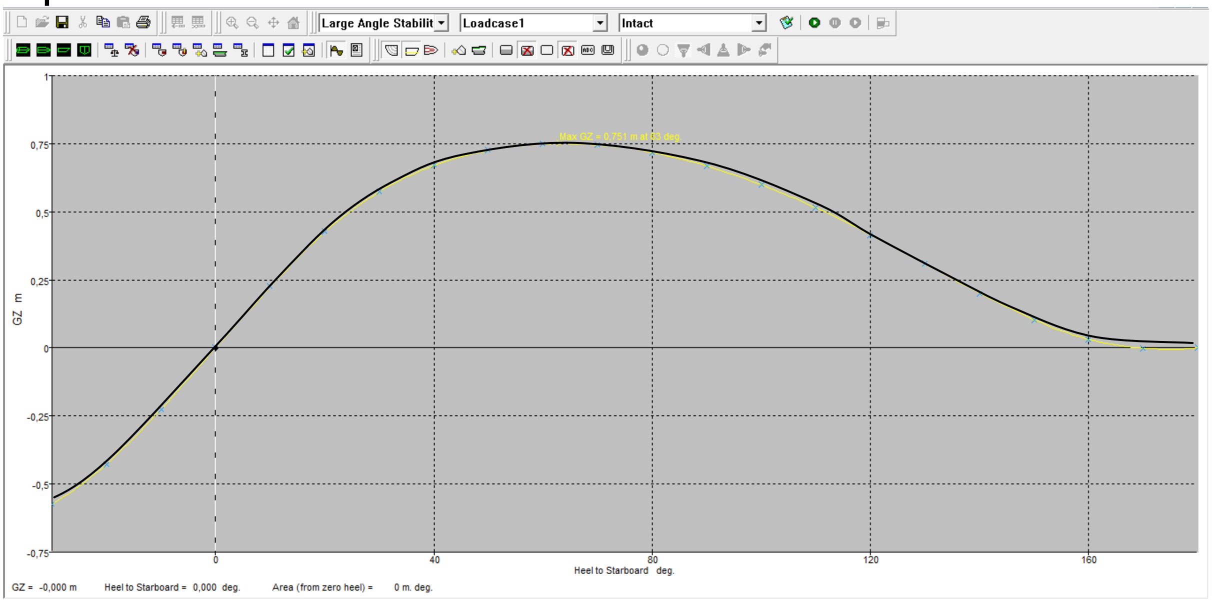


Figure 5. (B) Waterplane area of planning hull.

Displacemen Hull



Planning

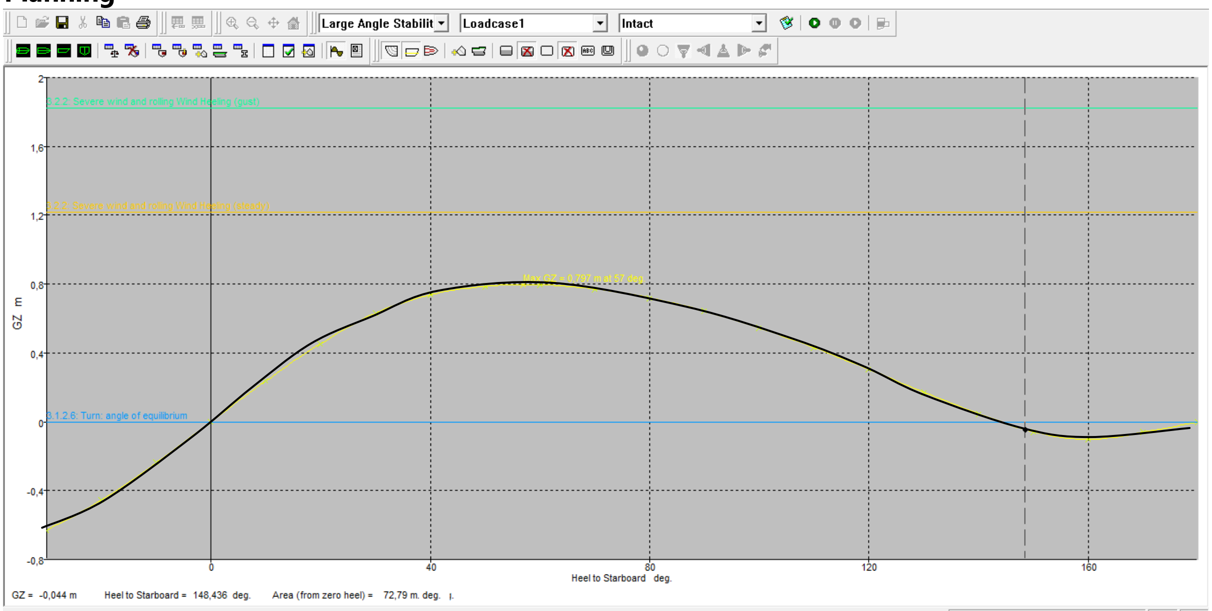


Figure 6. GZ curve for each vessels

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Table 1. Stability conclusion (A) Displasmen Hull (B) Planning Hull

A

Code	Criteria	Value	Units	Actual	Status
A.749(18) C	3.1.2.1: Are				Pass
	from the gre				
	spec. heel a	0,0	deg	0,0	
	to the lesser				
	spec. heel a	30,0	deg	30,0	
	angle of van	169,3	deg		
	shall not b	**3,151**	**m.deg**	**9,471**	**Pass**
A.749(18) C	3.1.2.1: Are				Pass
	from the gre				
	spec. heel a	0,0	deg	0,0	
	to the lesser				
	spec. heel a	40,0	deg	40,0	
	first downfl	n/a	deg		
	angle of van	169,3	deg		
	shall not b	**5,157**	**m.deg**	**15,729**	**Pass**
A.749(18) C	3.1.2.1: Are				Pass
	from the gre				
	spec. heel a	30,0	deg	30,0	
	to the lesser				
	spec. heel a	40,0	deg	40,0	
	first downfl	n/a	deg		
	angle of van	169,3	deg		
	shall not b	**1,719**	**m.deg**	**6,258**	**Pass**
A.749(18) C	3.1.2.2: Max				Pass
	in the range				
	spec. heel a	30,0	deg	30,0	
	to the lesser				
	spec. heel a	90,0	deg		
	angle of ma	63,0	deg	63,0	
	shall not b	**0,200**	**m**	**0,751**	**Pass**
	Intermediate				
	angle at whi		deg	63,0	

Tank cal. / Criteria / Key pts.

B

Code	Criteria	Value	Units	Actual	Status
A.749(18) C	3.1.2.1: Are				Pass
	from the gre				
	spec. heel a	0,0	deg	0,0	
	to the lesser				
	spec. heel a	30,0	deg	30,0	
	angle of van	144,0	deg		
	shall not b	**3,151**	**m.deg**	**10,157**	**Pass**
A.749(18) C	3.1.2.1: Are				Pass
	from the gre				
	spec. heel a	0,0	deg	0,0	
	to the lesser				
	spec. heel a	40,0	deg	40,0	
	first downfl	n/a	deg		
	angle of van	144,0	deg		
	shall not b	**5,157**	**m.deg**	**17,052**	**Pass**
A.749(18) C	3.1.2.1: Are				Pass
	from the gre				
	spec. heel a	30,0	deg	30,0	
	to the lesser				
	spec. heel a	40,0	deg	40,0	
	first downfl	n/a	deg		
	angle of van	144,0	deg		
	shall not b	**1,719**	**m.deg**	**6,895**	**Pass**
A.749(18) C	3.1.2.2: Max				Pass
	in the range				
	spec. heel a	30,0	deg	30,0	
	to the lesser				
	spec. heel a	90,0	deg		
	angle of ma	57,0	deg	57,0	
	shall not b	**0,200**	**m**	**0,797**	**Pass**
	Intermediate				
	angle at whi		deg	57,0	

Input data to calculate and to check the vessels stability is its weight. Weight of vessels obtained from its construction, namely light weight tonnage (LWT) and dead weigth tonnage (DWT). LWT consists of weight of hull (deck construction, bottom construction, hull construction), weight of machinery, weight of outfitting, weight of fishing gear, meanwhile DWT consists of weight of crew (including weight of luggage), weight of consumable (weight of fuel oil, weight auxiliary engine fuel, weight of lubricants oil, weight of provisions, weight of fresh water, weight of ice and weight of payload (weight of fishing hold). All these center of gravity is estimated according to design of general arrangement of the vessel, and its position on deck. Center of gravity is calculated against transverse, longitudinal and its height. After all inputs has been entered to the program, the next step is to determine stability criteria on the vessel. Code of Intact of Stability A.749 (18) which is issued by IMO (2010) is the best criteria and aplicable to all vessels including fishing vessel. The results of GZ curved each depicted in Figure 6, on the other hand analysis results is given in Table 1.

According to Figure 6 and data shown in Table 1, both of the vessels have satisfied the IMO criteria. It's mean both vessels have a good condition and contribution in ships safety. Both of them is worthy to cruise the ocean. All the data pass the requirements of IMO. But, planning hull stability is better than displacement hull. It means, hull form have a contribution around 5% to improve ship stability during operate in ocean/water.

CONCLUSIONS

Both of the vessels, displacement and planning vessel satisfy IMO Criteria on stability, but planning vessel has better stability than conventional vessel because its GZ curve higher 5% than displacement vessel.

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