International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 10 | Oct 2024 www.irjet.net p-ISSN: 2395-0072

Study The stability of a high-speed boat according to the recommendations of Maritime Classification Societies

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Abstract - *The research reviews the designs of high speed boats hulls and the features and characteristics of each one, leading to the selection and design of a suitable model using the Maxsurf program with dimensions suitable for the marine market and with a monohull type (Planning Hull), due to its good speed and maneuvering characteristics, lower resistance values, and less disturbance on the water surface. After that, a preliminary drawing of the general arrangement plan and the tank distribution plan was made, and stability calculations were conducted on the boat designed according to the recommendations of the Maritime Classification Society, to deduce the behavior of the hull and the resulting stability values under different loading cases.*

Key Words: high-speed boat, boat stability, general arrangement, monohull, planning hull.

1.INTRODUCTION

With the rapid development in ship design and construction, high-speed boats occupy an important place in development laboratories so that the studied structures achieve the required speeds with lower capacities by reducing the values of the resistances affecting the boat due to the better streamlined shape that is compatible with international classification rules, as modern models seek to achieve high quality and reliability. For this reason, many studies have addressed the topics related to fast boats and the difficulties facing designers in this field. Some of them discussed the initial hydrodynamic characteristics of slender structures and gave the schematic equations and experimental methods that show the values of the wetted surface areas, pressure centers, the angle of the ship's entry, and the longitudinal tilt resulting from the increase in speed, in addition to setting the predictive equations that achieve the horsepower requirements and appropriate operating values in accordance with the studied structure with a set of illustrative examples and digital diagrams [1]. Some of them also presented the problems facing designers in producing slender marine structures under the lowest values of effective resistance due to the complexity in determining the nature of fluid flow and its effect on the structure and the role of wet and free surfaces and the mutual influence between them, and did not Predicting resistance values was a simple matter, as a model was designed and placed in a test basin, and the results were collected within the research. A set of equations were extracted that give the initial prediction of resistance values and the relationship between the streamlined shape of the hull and achieving the highest possible speed in order to improve the actual operation of the ship under different sailing conditions [2]. The various investment conditions for high-speed boats were also discussed according to a studied model that achieves the required speed and economic efficiency, in addition to determining the appropriate size of the submerged part and presenting methods for improving flow. The author found that the Planning hull pressures increase in the front part of the hull, but decrease and become negative in the aft. He found that the thickness of the boundary layer increases in the direction of flow and decreases with increasing model speeds. He found that the measured speeds outside the boundary layer were greater than the free flow in the aft part of the hull, indicating acceleration from the front position. The research emphasized the importance of adding side fins to improve stability according to the results of the flow analysis around the studied hull [3]. Some research has dealt with developments in models of civil and military high-speed boat structures, where calculating speed and energy is a major topic for designing a model that achieves compatibility between structure and power. The research programmed both the Savitsky equations, which are the most widely used method, and the CAHI equations used in military models to predict resistance values. The study includes a set of variables related to the main dimensions, the movement of the boat, and the influence factors. The aim of this study is to present the CAHI method to the community of high-speed boat designers [4]. The relationship between the deadrise angle and the resulting resistance was studied, in addition to creating a database for the studied model structures. The initial results indicated that the design with a large deadrise angle showed less resistance compared to the reference boat design, as the hull resistance decreased by 16.87% at a deadrise angle of 30 degrees compared to the largest resistance at any other elevation angle [5]. The Syrian Arab Republic lacks this type of boats, except for some small fishing and pleasure boats. Therefore, it is necessary to determine the appropriate model for work in

Syrian territorial waters, while specifying the available capabilities and the type of materials used in construction and their role in improving the actual return and the required efficiency.

1.1 The importance of the research and its objectives

The importance of the research stems from the necessity of finding the appropriate model due to the urgent need to design and apply this model with appropriate dimensions from the economic and investment point of view, and with good stability characteristics, and to establish this model as a basic structure for establishing marine guard groups with national expertise to secure the mission of protecting territorial waters, and employing this model for various purposes such as:

• Combating smuggling operations

• Combating piracy operations

• Combating illegal immigration operations

• Search and rescue operations and rapid response (to assist boats and other ships or assist individuals in the water)

• Periodic coastal patrols to protect maritime borders.

1.2 Research methods and materials

The methods and materials used in this research are as follows:

- The Maxsurf program with its various sections, which are Maxsurf Modeler, Maxsurf Resistance, and Maxsurf Stability, to design the hull and conduct initial tests on it.

- The AutoCAD program to draw the General Arrangement plan for the designed boat.

- The Excel program to help draw some tables and clarify some graphs.

1.3 Research Methodology

The methodology followed in this research is analytical within the Maxsurf program environment.

2. CHOOSING THE INITIAL PROPORTIONS

The design process began with a major analysis of some similar boats that had been designed and built previously:

Table -1: List of similar designs analyzed

Vessel Name	Shipyard	LOA (m)	Beam (m)	Depth (m)	Draft (m)	Speed (Knot)	Disp (tons)
SPa4207	Damen	42.8	7.11	3	2.52	30	239
Sea Axe	Damen	30.53	7.07	3.22	2.2	22.5 to 31.5	146
Sea Axe5009	Damen	50.2	9.32	4.45	3.5	25 to 30	474
Sea Axe5509	Damen	58	9.55	4.4	2.9	26 to 30	500
Patrol38	Austal	38.2	7.2	4.5	2.4	24	174
Hercules140	Ares	43.5	8.3		1.81	45	201
Hercules150	Ares	47.95	8.4		1.84	30	245
SSC45	Kership	45.7	8.4		2.4	30	270
SSC52	Kership	52	9		2.7	27	440

After analyzing the values of the main dimensional ratios of the previous designs and identifying their characteristics, and based on the famous geometric similarity theory, it was assumed that the appropriate dimensions that achieve the required goal fall within the following areas (Table 2):

Table-2: Main dimensions of the designed boat

LOA	20-25	(m)
Speed	25-35	(kn)
Beam	4-6	(m)
Tmax	0.7-1.5	(m)

After researching the range of available high-speed boat designs, three different Displacement hull, Semi-displacement hull and Planning hull designs were selected for initial testing:

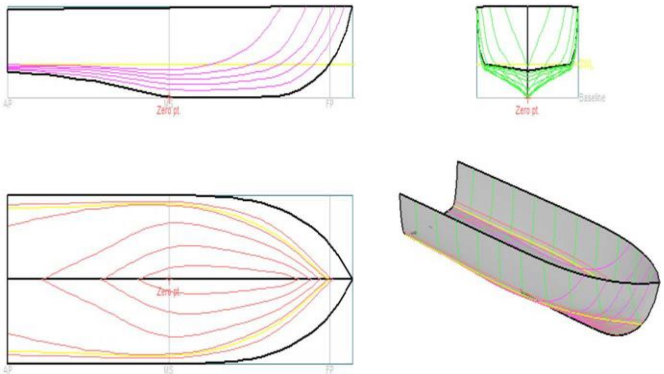

Fig-1: Displacement hull

http://trawlerschoolcharters.com/blog/wp-content/uploads/2013/09/boatlinessmall.jpg.

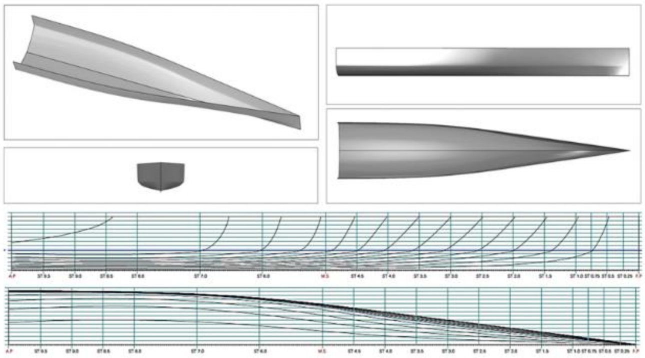

Fig-2: Semi-displacement hull

https://www.sciencedirect.com/science/article/pii/S2092678216304083

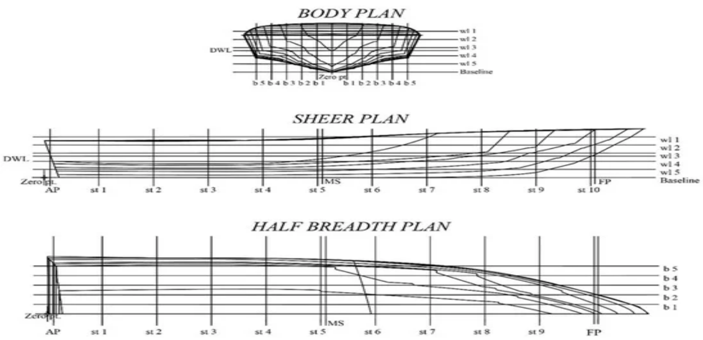

Fig-3: Planning V hull

https://www.mdpi.com/2411-9660/6/6/105

The generated wave field for each of the previous designs was calculated using the Resistance Maxsurf program. The results of the analysis are shown in chart (1). chart (1) shows that the Displacement hull creates waves with a higher height than its counterparts in the studied group, and thus greater turbulence on the water surface, while we note that the Planning V hull is more stable, which gives it good maneuvering characteristics in harsh conditions and lower resistance values, and the ability to reach higher speeds and create very low waves in the lower and medium speed range.

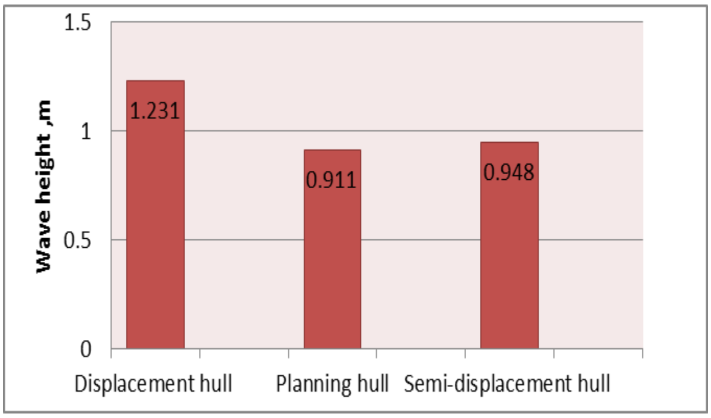

Chart-1 : Comparison of the height of the waves generated by the three models (EXCEL)

3. HULL DESIGN

After conducting the previous analysis, the boat was designed using the Maxsurf program with a relatively slender Planning hull with a V-shaped bow to achieve good speed and maneuverability suitable for various sailing conditions and coast guard missions within territorial waters. It is designed entirely from resistant fiber.

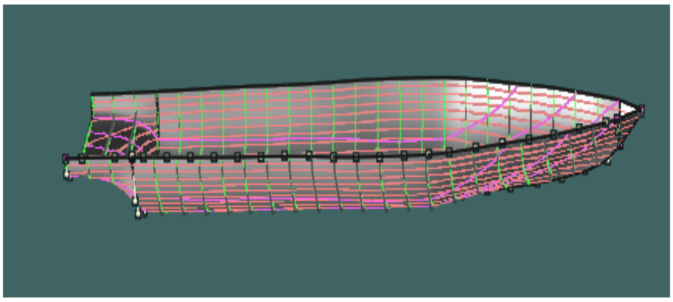

Fig-4: Boat hull (Maxsurf Modeler)

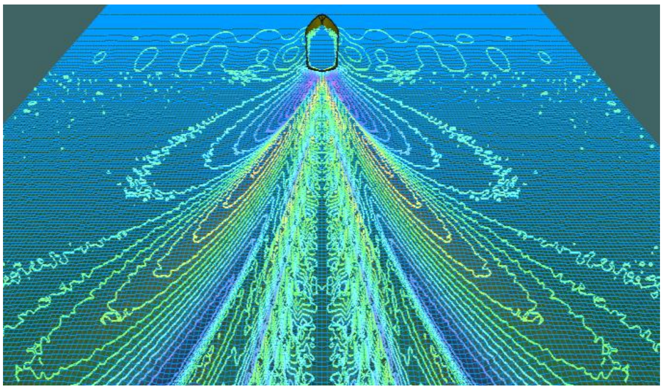

Fig-5: Wave field (turbulence pattern) behind the boat

(Maxsurf Resistance)

Table-3: Hydrostatic data of the boat

(Maxsurf Software)

1	**Displacement t**	**39.79**
2	Draft at FP m	**0,735**
3	Draft at AP m	**0.947**
4	Draft at LCF m	**0,863**
5	Trim (+ve by stern) m	**0,212**
6	WL Length m	**20.601**
7	Beam max extents on WL m	**4.468**
8	Wetted Area m^2	**78.835**
9	Waterpl. Area m^2	**71.050**
10	Prismatic coeff. (Cp)	**0.686**
11	Block coeff. (Cb)	**0.451**
12	Max Sect. area coeff. (Cm)	**0.692**
13	Waterpl. area coeff. (Cwp)	**0.772**
14	LCB from zero pt. (+ve fwd) m	**-2.896**
15	LCF from zero pt. (+ve fwd) m	**-2.276**
16	KB m	**0.535**
17	KG m	**1.000**
18	BMt m	**2.584**
19	BML m	**43.708**
20	GMt m	**2.091**
21	GML m	**43.215**
22	KMt m	**3.119**
23	KML m	**44.241**
24	Immersion (TPc) tonne/cm	**0.728**
25	MTc tonne.m	**0.797**
26	RM at 1deg = GMt.Disp.sin(1)tonne.m	**1.452**

4. GENERAL ARRANGEMENT

Figure (6) shows the general arrangement plan (GA) of the designed boat, which was drawn using AutoCAD software:

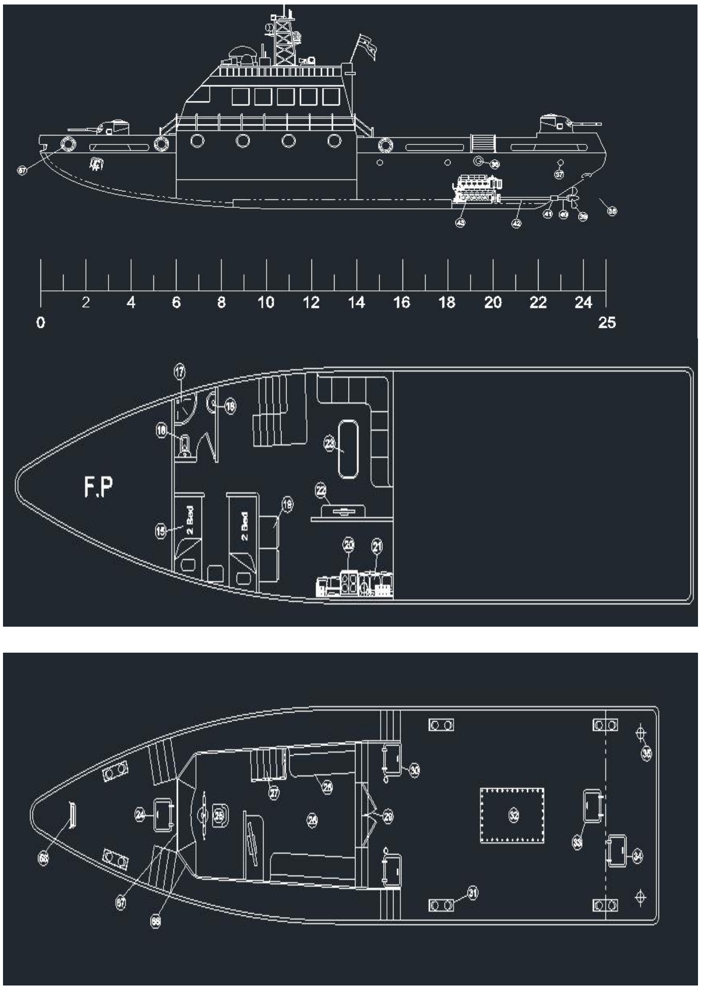

Fig-6: General arrangement plan

(AutoCAD Software)

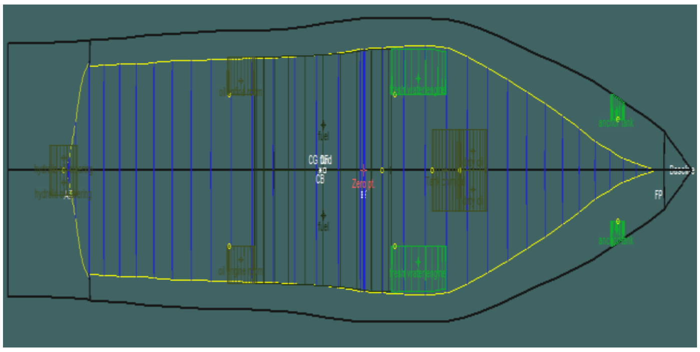

Fig-7: Tanks distribution plan (Maxsurf)

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 10 | Oct 2024 www.irjet.net p-ISSN: 2395-0072

5. STABILITY CALCULATIONS:

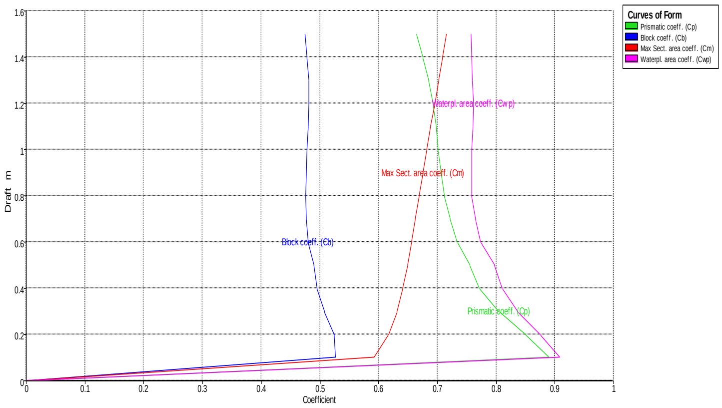

Fig-8: Body shape coefficient curves (Maxsurf Stability)

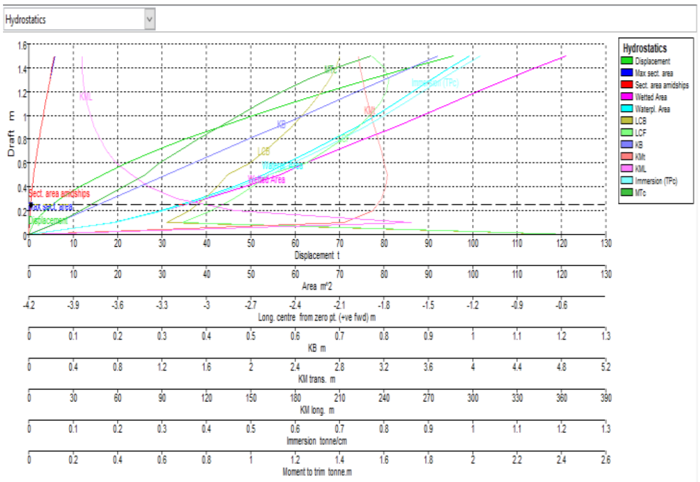

Fig-9: Hydrostatic curves of the boat (Maxsurf Stability)

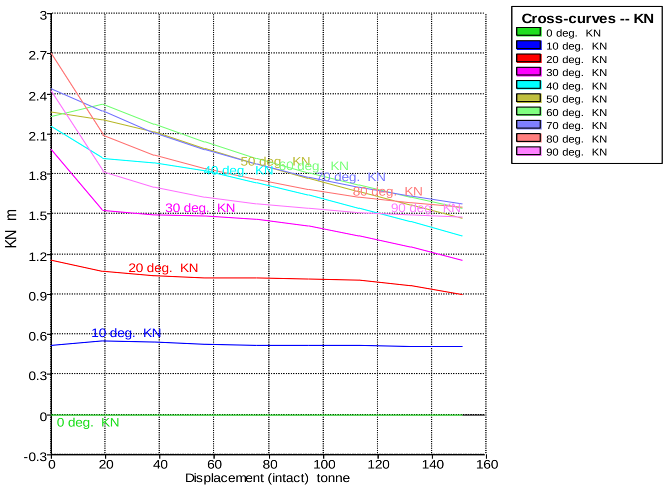

Fig-10: KN curves (Maxsurf Stability)

Stability studies were conducted on the boat designed in this research at four loading conditions (according to the recommendations of the classification societies):

1- Lightship Condition.

2- Mid-trip Condition.

3- Departure Condition.

4- Arrival Condition.

The resulting stability values were verified to be in line with the safe values of the International Maritime Organization (IMO) and the marine classification societies (CS) by comparing them with the IMO standard (A749) included implicitly in the Maxsurf program.

5.1 First case: Lightship Condition

Table-4: Lightship Load Case

(Maxsurf Stability)

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m
Lightship	1	19.489	19.489			-2.171	-0.010	2.122
Crew	0	0.000	0.000			0.000	0.000	0.000
Payload	0	0.000	0.000			0.000	0.000	0.000
fuel	0%	7.455	0.000	7.895	0.000	-0.689	0.000	0.000
fuel	0%	7.455	0.000	7.895	0.000	-0.689	0.000	0.000
fresh water engine	0%	0.658	0.000	0.642	0.000	1.123	1.284	0.358
fresh water engine	0%	0.658	0.000	0.642	0.000	1.123	-1.284	0.358
oil engine room	0%	0.235	0.000	0.256	0.000	-4.671	1.500	0.394
oil enfine room	0%	0.235	0.000	0.256	0.000	-4.671	-1.500	0.394
hydrolic oil steering	0%	0.138	0.000	0.150	0.000	-11.000	0.250	1.500
hydrolic oil steering	0%	0.138	0.000	0.150	0.000	-11.000	-0.250	1.500
dirty oil	0%	0.608	0.000	0.661	0.000	3.506	0.001	0.039
dirty oil	0%	0.608	0.000	0.661	0.000	3.506	-0.001	0.039
Tank chimical	0%	1.364	0.000	1.482	0.000	2.510	0.000	0.006
anchor tank	0%	0.074	0.000	0.073	0.000	9.185	1.084	2.000
anchor tank	0%	0.074	0.000	0.073	0.000	9.185	-1.084	2.000
Total Loadcase			**19.489**	**20.834**	**0.000**	**-2.171**	**-0.010**	**2.122**
FS correction								**0.000**
VCG fluid								**2.122**

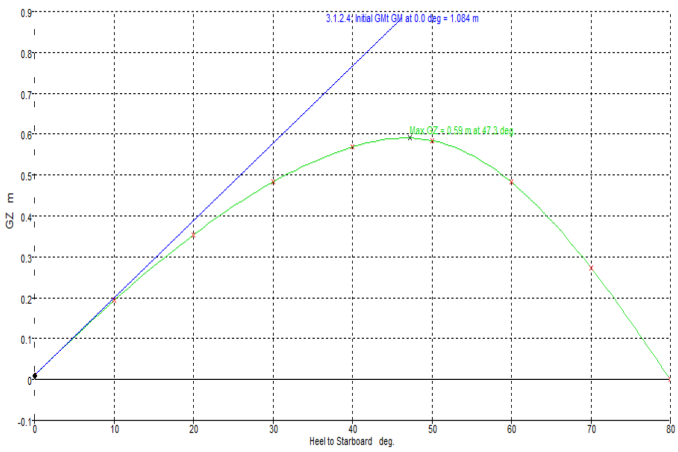

Fig-11: GZ curve at 0% load condition (Maxsurf Stability)

Table-5: IMO standards test for stability at 0% load condition(Maxsurf Stability)

Code	Criteria	Value	Units	Actual	Status	Margin %
A.749	3.1.2.1: Area 0 to 30				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	30.0	deg	30.0		
	angle of vanishing stability	80.0	deg			
	shall not be less than (>=)	3.1513	m.deg	7.9889	Pass	+153.51
A.749	3.1.2.1: Area 0 to 40				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	80.0	deg			
	shall not be less than (>=)	5.1566	m.deg	13.2863	Pass	+157.66
A.749	3.1.2.1: Area 30 to 40				Pass	
	from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	80.0	deg			
	shall not be less than (>=)	1.7189	m.deg	5.2974	Pass	+208.19
A.749	3.1.2.2: Max GZ at 30 or greater				Pass	
	in the range from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	90.0	deg			
	angle of max. GZ	47.3	deg	47.3		
	shall not be less than (>=)	0.200	m	0.590	Pass	+195.00
	Intermediate values					
	angle at which this GZ occurs		deg	47.3		
A.749	3.1.2.3: Angle of maximum GZ				Pass	
	shall not be less than (>=)	25.0	deg	47.3	Pass	+89.09
A.749	3.1.2.4: Initial GMt				Pass	
	spec. heel angle	0.0	deg			
	shall not be less than (>=)	0.150	m	1.084	Pass	+622.67

5.2 Case 2: Mid-trip Load Condition

Table-6: Mid-trip Load Case (Maxsurf Stability)

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m
Lightship	1	19.489	19.489			-2.171	-0.010	2.122
Crew	10	0.075	0.750			-1.344	0.000	1.237
Payload	1	0.750	0.750			-1.344	0.000	1.237
fuel	50%	7.455	3.728	7.895	3.948	-1.478	0.721	0.381
fuel	50%	7.455	3.728	7.895	3.948	-1.478	-0.721	0.381
fresh water engine	50%	0.658	0.329	0.642	0.321	1.969	1.739	0.647
fresh water engine	50%	0.658	0.329	0.642	0.321	1.969	-1.739	0.647
oil engine room	50%	0.235	0.118	0.256	0.128	-4.500	1.698	0.661
oil enfine room	50%	0.235	0.118	0.256	0.128	-4.500	-1.698	0.661
hydrolic oil steering	50%	0.138	0.069	0.150	0.075	-11.000	0.250	1.575
hydrolic oil steering	50%	0.138	0.069	0.150	0.075	-11.000	-0.250	1.575
dirty oil	50%	0.608	0.304	0.661	0.330	3.972	0.365	0.373
dirty oil	50%	0.608	0.304	0.661	0.330	3.972	-0.365	0.373
Tank chimical	50%	1.364	0.682	1.482	0.741	2.991	0.000	0.303
anchor tank	50%	0.074	0.037	0.073	0.036	9.213	1.132	2.174
anchor tank	50%	0.074	0.037	0.073	0.036	9.213	-1.132	2.174
Total Loadcase			30.839	20.834	10.417	-1.669	-0.006	1.538
FS correction								0.330
VCG fluid								1.869

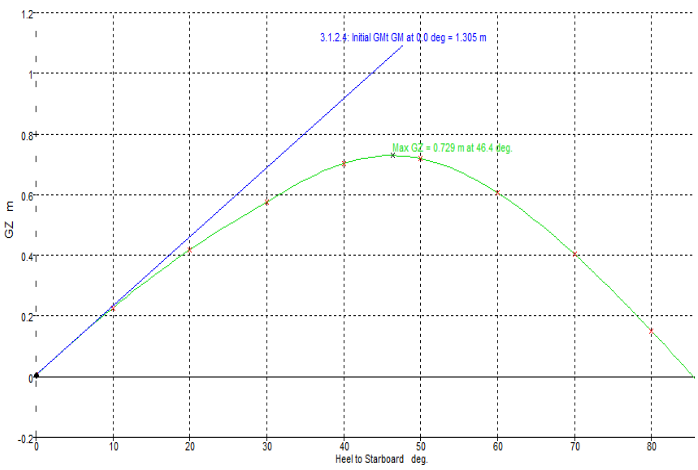

Fig-12: GZ curve at 50% load condition (Maxsurf Stability)

Table-7: IMO standards test for stability at 50% load condition (Maxsurf Stability)

Code	Criteria	Value	Units	Actual	Status	Margin %
A.749	3.1.2.1: Area 0 to 30				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	30.0	deg	30.0		
	angle of vanishing stability	85.5	deg			
	shall not be less than (>=)	3.1513	m.deg	9.4336	Pass	+199.35
A.749	3.1.2.1: Area 0 to 40				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	85.5	deg			
	shall not be less than (>=)	5.1566	m.deg	15.8939	Pass	+208.22
A.749	3.1.2.1: Area 30 to 40				Pass	
	from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	85.5	deg			
	shall not be less than (>=)	1.7189	m.deg	6.4603	Pass	+275.84
A.749	3.1.2.2: Max GZ at 30 or greater				Pass	
	in the range from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	90.0	deg			
	angle of max. GZ	46.4	deg	46.4		
	shall not be less than (>=)	0.200	m	0.729	Pass	+264.50
	Intermediate values					
	angle at which this GZ occurs		deg	46.4		
A.749	3.1.2.3: Angle of maximum GZ				Pass	
	shall not be less than (>=)	25.0	deg	46.4	Pass	+85.46
A.749	3.1.2.4: Initial GMt				Pass	
	spec. heel angle	0.0	deg			
	shall not be less than (>=)	0.150	m	1.305	Pass	+770.00

5.3 Case 3: Departure Condition

Table-8: Departure Load Case (Maxsurf Stability)

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m
Lightship	1	19.489	19.489			-2.171	-0.010	2.122
Crew	10	0.075	0.750			-1.344	0.000	2.237
Payload	1	0.750	0.750			-1.344	0.000	2.237
fuel	98%	7.455	7.306	7.895	7.737	-1.473	0.887	0.592
fuel	98%	7.455	7.306	7.895	7.737	-1.473	-0.887	0.592
fresh water engine	98%	0.658	0.645	0.642	0.629	1.979	1.816	0.770
fresh water engine	98%	0.658	0.645	0.642	0.629	1.979	-1.816	0.770
oil engine room	98%	0.235	0.230	0.256	0.250	-4.500	1.762	0.780
oil enfine room	98%	0.235	0.230	0.256	0.250	-4.500	-1.762	0.780
hydrolic oil steering	98%	0.138	0.135	0.150	0.147	-11.000	0.250	1.647
hydrolic oil steering	98%	0.138	0.135	0.150	0.147	-11.000	-0.250	1.647
dirty oil	20%	0.608	0.122	0.661	0.132	3.932	0.312	0.239
dirty oil	20%	0.608	0.122	0.661	0.132	3.932	-0.312	0.239
Tank chimical	98%	1.364	1.336	1.482	1.453	2.995	0.000	0.527
anchor tank	98%	0.074	0.073	0.073	0.071	9.221	1.162	2.287
anchor tank	98%	0.074	0.073	0.073	0.071	9.221	-1.162	2.287
Total Loadcase			39.347	20.834	19.386	-1.577	-0.005	1.430
FS correction								0.002
VCG fluid								1.432

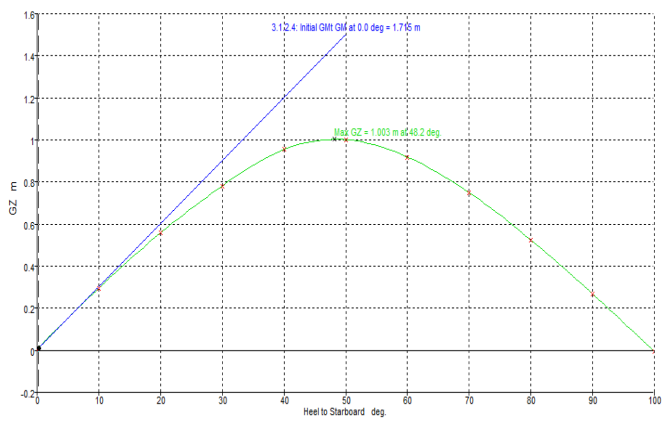

Fig-13: GZ curve at departure status (Maxsurf Stability)

Table-9: IMO stability standards test at departure status (Maxsurf Stability)

Code	Criteria	Value	Units	Actual	Status	Margin %
A.749	3.1.2.1: Area 0 to 30				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	30.0	deg	30.0		
	angle of vanishing stability	99.8	deg			
	shall not be less than (>=)	3.1613	m.deg	12.6382	Pass	+297.87
A.749	3.1.2.1: Area 0 to 40				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	99.8	deg			
	shall not be less than (>=)	5.1566	m.deg	21.2843	Pass	+312.76
A.749	3.1.2.1: Area 30 to 40				Pass	
	from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	99.8	deg			
	shall not be less than (>=)	1.7189	m.deg	8.7461	Pass	+408.82
A.749	3.1.2.2: Max GZ at 30 or greater				Pass	
	in the range from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	90.0	deg			
	angle of max. GZ	48.2	deg	48.2		
	shall not be less than (>=)	0.200	m	1.003	Pass	+401.50
	Intermediate values					
	angle at which this GZ occurs		deg	48.2		
A.749	3.1.2.3: Angle of maximum GZ				Pass	
	shall not be less than (>=)	25.0	deg	48.2	Pass	+92.73
A.749	3.1.2.4: Initial GMt				Pass	
	spec. heel angle	0.0	deg			
	shall not be less than (>=)	0.150	m	1.716	Pass	+1043.3

5.4 Case 4: Arrival Condition

Table-10: Arrival Load Case (Maxsurf Stability)

Item Name	Quantity	Unit Mass tonne	Total Mass tonne	Unit Volume m^3	Total Volume m^3	Long. Arm m	Trans. Arm m	Vert. Arm m
Lightship	1	19.489	19.489			-2.171	-0.010	2.122
Crew	10	0.075	0.750			-1.344	0.000	2.237
Payload	1	0.750	0.750			-1.344	0.000	2.237
fuel	10%	7.455	0.746	7.895	0.790	-1.487	0.419	0.138
fuel	10%	7.455	0.746	7.895	0.790	-1.487	-0.419	0.138
fresh water engine	10%	0.658	0.066	0.642	0.064	1.927	1.616	0.487
fresh water engine	10%	0.658	0.066	0.642	0.064	1.927	-1.616	0.487
oil engine room	10%	0.235	0.024	0.256	0.026	-4.500	1.596	0.508
oil enfine room	10%	0.235	0.024	0.256	0.026	-4.500	-1.596	0.508
hydrolic oil steering	10%	0.138	0.014	0.150	0.015	-11.000	0.250	1.515
hydrolic oil steering	10%	0.138	0.014	0.150	0.015	-11.000	-0.250	1.515
dirty oil	98%	0.608	0.596	0.661	0.648	3.986	0.382	0.575
dirty oil	98%	0.608	0.596	0.661	0.648	3.986	-0.382	0.575
Tank chimical	10%	1.364	0.136	1.482	0.148	2.955	0.000	0.110
anchor tank	10%	0.074	0.007	0.073	0.007	9.197	1.096	2.046
anchor tank	10%	0.074	0.007	0.073	0.007	9.197	-1.096	2.046
Total Loadcase			24.029	20.834	3.247	-1.728	-0.008	1.905
FS correction								0.421
VCG fluid								2.326

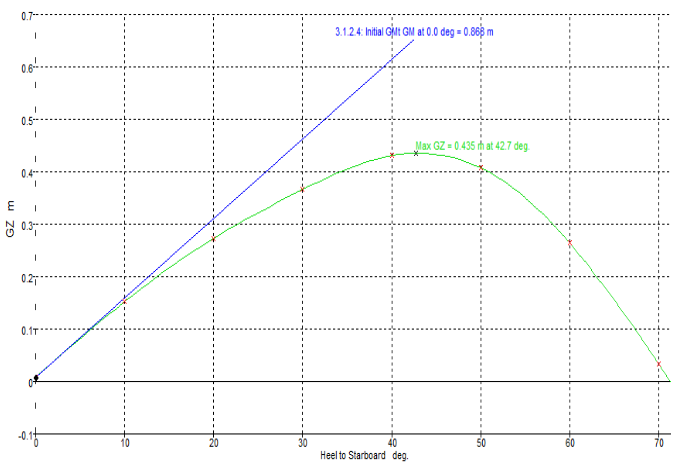

Fig-14: GZ curve at arrival status (Maxsurf Stability)

Table-11: IMO stability standards test at arrival status (Maxsurf Stability)

Code	Criteria	Value	Units	Actual	Status	Margin %
A.749	3.1.2.1: Area 0 to 30				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	30.0	deg	30.0		
	angle of vanishing stability	71.3	deg			
	shall not be less than (>=)	3.1613	m.deg	6.1772	Pass	+96.02
A.749	3.1.2.1: Area 0 to 40				Pass	
	from the greater of					
	spec. heel angle	0.0	deg	0.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	71.3	deg			
	shall not be less than (>=)	5.1566	m.deg	10.2079	Pass	+97.96
A.749	3.1.2.1: Area 30 to 40				Pass	
	from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	40.0	deg	40.0		
	first flooding angle of the Downflooding	n/a	deg			
	angle of vanishing stability	71.3	deg			
	shall not be less than (>=)	1.7189	m.deg	4.0306	Pass	+134.49
A.749	3.1.2.2: Max GZ at 30 or greater				Pass	
	in the range from the greater of					
	spec. heel angle	30.0	deg	30.0		
	to the lesser of					
	spec. heel angle	90.0	deg			
	angle of max. GZ	42.7	deg	42.7		
	shall not be less than (>=)	0.200	m	0.435	Pass	+117.50
	Intermediate values					
	angle at which this GZ occurs		deg	42.7		
A.749	3.1.2.3: Angle of maximum GZ				Pass	
	shall not be less than (>=)	25.0	deg	42.7	Pass	+70.98
A.749	3.1.2.4: Initial GMt				Pass	
	spec. heel angle	0.0	deg			
	shall not be less than (>=)	0.150	m	0.868	Pass	+478.67

6. CONCLUSIONS

- Displacement hull create higher waves and cause greater disturbance on the water surface compared to other models studied.

- Tests according to IMO and CS rules programmed within MAXSURF software showed the safety of the designed boat.

- We conclude from the resulting stability ratios of the boat the importance of the parameter values that were chosen and the correctness of choosing the Planning hull, which showed good stability properties under different loading conditions.

- It is recommended in future studies to conduct stability calculations in case of damage, so that the hull is divided into several sectors, in order to know the behavior of the hull when a sinking occurs in one of the sectors.

- It is recommended to study the effect of installing lateral stabilization wings on the boat's stability.

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