THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XI – SHIPBUILDING. ISSN 1221-4620, e-ISSN 2668-3156
DOI: https://doi.org/10.35219/AnnUgalShipBuilding/2024.47.15
2024

STABILITY FOR A PARALELIPIPEDAL CRANE USING AUTOSHIP SOFTWARE

Elisabeta Buzilă
"Mircea cel Bătrân" Naval Academy
Faculty of Navigation and Naval Management
Department of Navigation and Naval Transport
Fulgerului St., Nr. 1, 900218, Constanta, Romania,
E-mail: elisabeta.buzila@anmb.ro

Mihaela - Greti Manea
"Mircea cel Bătrân" Naval Academy
Faculty of Marine Engineering
Department of Tactics and Naval Armament,
Fulgerului St., Nr. 1, 900218, Constanta, Romania,
E-mail: mihaelagretimanea@gmail.com

ABSTRACT

The paper presents the stability analysis of a parallelepipedal crane barge, under operational and environmental scenarios, using the AutoShip software, specifically ModelMaker and AutoHydro packages. The characteristics of the crane are length of 42.59 m, breadth of 20.19 m, depth of 1.50 m and a construction height of 3.5 m. The design of the crane was imported from Rhinoceros using .IGES file to software package ModelMaker from AutoShip. The stability analysis wore made in AutoHydro software package from AutoShip. The main contribution of the paper is to highlight the usefulness and efficiency (in terms of rapidity and accuracy) of using software tools (AutoHydro from the package AutoShip) to study nautical qualities (buoyancy and stability) of a parallelepipedal crane barge in several exploitation scenario.

Keywords: AutoShip, ModelMaker, AutoHydro, nautical qualities, parallelepipedal crane

1. INTRODUCTION

In the maritime industry, stability analysis is paramount for ensuring the safety and reliability of vessels, particularly for specialized structures such as crane barges. The stability of these vessels under different operational and environmental conditions is critical, as instability can lead to severe accidents, endangering crew and cargo alike. Adherence to international standards, such as the ***Standards of Training, Certification, and Watchkeeping for Seafarers (STCW)***, emphasizes the importance of thorough stability assessments to ensure the safe operation of maritime equipment and vessels in compliance with global safety protocols, so different software's are installed abord ship.

With advancements in technology, software tools have become indispensable in performing complex stability analyses **with high accuracy and efficiency**. These tools enable engineers to simulate real world scenarios, assess structural behaviours under varying conditions, and identify potential risks early in the design phase or if we speak of the operational moment at the ship. In this study, we use the **AutoShip software package — specifically, ModelMaker for 3D modelling and AutoHydro for hydrostatic and stability analysis** - to evaluate the stability of a parallelepipedal crane barge. AutoShip's capabilities allow for detailed geometric modelling and comprehensive analysis of stability parameters across different scenarios. [1]

In addition to AutoShip, various other software tools, such as MaxSurf Stability, NAPA Stability, and Rhino with Orca3D, offer alternative or complementary approaches for naval architecture and stability testing. MaxSurf provides an intuitive interface for hull modelling and integrates stability analysis with a range of loading conditions. NAPA, widely used in ship design, allows for highly detailed hydrostatic and hydrodynamic simulations, while Orca3D, an add-on for Rhino, is used extensively for its flexible design interface and analytical capabilities tailored to smaller vessels and special purpose structures. By leveraging these technologies, naval architects and engineers can better understand and optimize vessel behaviour, ensuring safe operations under various conditions and challenging sea.

The AutoShip software package, provides tools for comprehensive vessel modelling and stability analysis, making it ideal for use onboard ship. ModelMaker offers a robust platform for creating detailed 3D models of vessel structures, including complex shapes like those found in parallelepipedal crane barges. This modelling capability enables precise geometric representations essential for accurate stability assessments. Once the 3D model is established in ModelMaker, it can be seamlessly transferred to AutoHydro, where hydrostatic and stability analyses are performed. AutoHydro excels in evaluating various loading conditions, ballast configurations, and environmental scenarios, allowing for in-depth assessments of stability parameters such as the metacentric height (GM), righting arm curves, critical angles of heel and longitudinal strength. Together, ModelMaker and AutoHydro enable engineers to simulate realistic operating environments and provide insights into potential stability risks, facilitating well informed design decisions that enhance vessel safety and performance. [1]

2. MODELLING AND USING THE PACKAGES MODELMAKER AND AUTOHYDRO

This paper investigates the stability of a parallelepipedal crane barge under various operational and environmental scenarios, utilizing the AutoShip software package, specifically AutoHydro. Given the unique structural and stability challenges posed by a parallelepipedal design, accurate modelling and analysis are essential to ensure the crane's safe deployment in marine environments. The study begins with creating a detailed 3D model of the crane barge in ModelMaker, capturing precise geometric characteristics that influence stability. For this specific model, the shell hull was made in Rhinoceros (fig. 1), and then imported like an .IGES file to ModelMaker. In the ModelMaker package the tanks, crane and other spaces abord the vessel wore modelled (table 2, figure 5).

Table. 1. Main data of the crane [2]

Length overall	$L_{OA}[mm]$	42590
Design breath	$B[mm]$	20190
Design height	$D[mm]$	3650
Design draft	$T[mm]$	1500

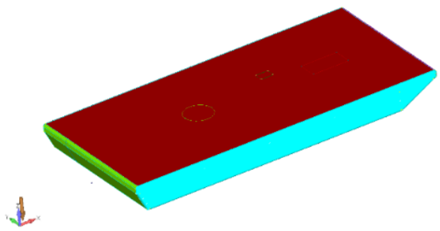

Fig. 1. Shell model of the crane ponton (Rinoceros capture) [2]

According to the *"Crane ponton construction plan" made by BV Scheepswerf in '87* (figures 2, 3 and 4), it is used for operations in the Black Sea harbours of Constanta. Table 1 presents the main characteristics of the crane. [2]

Subsequently, stability analyses are conducted in AutoHydro, where simulated scenarios consider factors such as varying load conditions (light ship), ballast adjustments (with 50 % and 100% tank full), but without external forces like wind, wave action or loads in the crane. Each scenario is analysed for key stability parameters, including metacentric height (GM), righting moments, and potential for capsizing under extreme conditions. Results highlight critical stability thresholds and provide insights into optimal configurations for safe operation. This analysis not only confirms the viability of the crane's design but also identifies best practices and design modifications that enhance stability across multiple operational conditions.

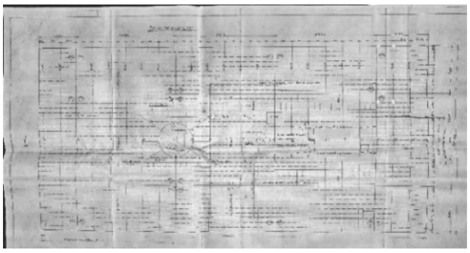

Fig. 2. Main deck of the "Crane ponton construction plan" [2]

3. SCENARIOS AND RESULTS

This section of the paper presents the scenarios and the result of the analysed cases.

At start, we will find the lightship displacement, using AutoHydro for a given waterline. So, for the draft of 1.5m the lightship weight is 1450.3MT, more of the hull data result are presented in tables 3 and 4, where the hydrostatic properties and characteristics in the analysed case are presented.

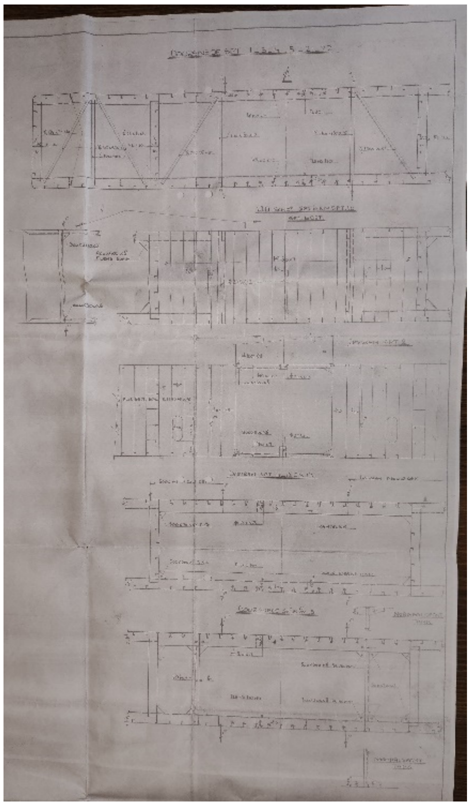

Fig. 3. Frames "Crane ponton construction plan" [2]

Table. 2. Parts and characteristics of the contending class elements on the ship.

Nr. Crt.	Contending	Fluid name / SPGR	Part name
1.	Displacer	0	HULL, Crane trunk, Engine room, Cofferdam_Ps, Cofferdam_Sb,
2.	Container	WB / 1.025	Tk1_cent, Tk2_cent, Tk3Ps, Tk3Sb, Tk4Ps, Tk4Sb, Tk5_cent, Tk7Ps, Tk7Sb, Tk8Ps_Inf, Tk8Ps_Sup, Tk8Sb_Inf, Tk8Sb_Sup, Tk9Ps, Tk9Sb
		FW / 1.000	Potable_whater_Ps, Potable_whater_Sb
		GAS / 0.740	Fuel_Ps, Fuel_Sb
		FO / 0.870	Fuel Oil
3.	Sail	-	-

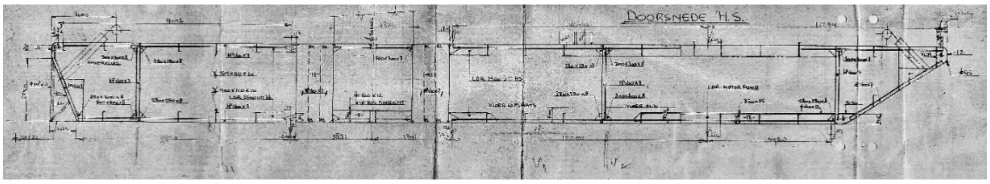

Fig. 4. C.L. section "Crane ponton construction plan" [2]

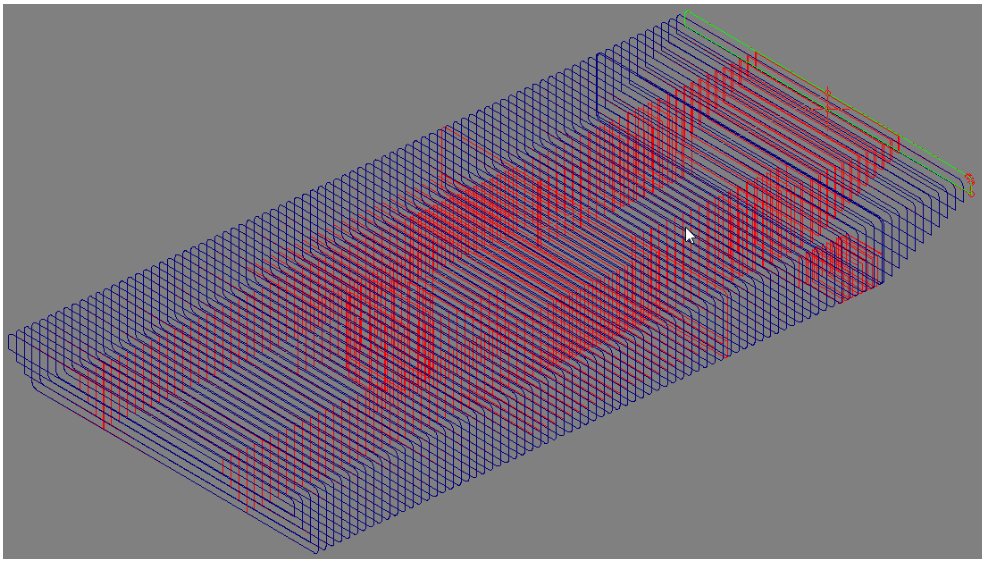

Fig. 5. 3D model of the crane (ModelMaker capture)

3.1. Hydrostatic properties at draft 1.5m. For this case, we used the light ship, and the characteristics are shown from draft 0m to draft 2m, with a step of 0.25m. Table 3 presents the hydrostatic values calculated of displacement – Displ [MT], the longitudinal centre of buoyancy LCB [m], the vertical centre of buoyancy – VCB [m], longitudinal centre of flotation - LCF [m], tonnage per centimetre - TPcm [MT/cm], Moment to trim one - MTcm [MT m / deg], longitudinal metacentric height of the ship at the moment - KML [m], transversal metacentric height of the ship at the moment - KMT [m]. Figure 2, present the hydrostatic diagram for these above. The draft is measured from the baseline of the ship, we do not have trim or heel angle and the density of the water used for the calculus was 1.025kg/m^3.

Table 3. Hydrostatic properties at scenario 3.1.

Draft [m]	Displ [MT]	LCB [m]	VCB [m]	LCF [m]	TPcm [MT/cm]	MTcm [MT m/deg]	KML [m]	KMT [m]
0.000	0	-	-	-	-	-	-	-
0.250	232.257	0.404	0.126	0.464	9.410	1639.559	404.424	110.747
0.500	469.241	0.468	0.252	0.597	9.546	1713.908	209.252	56.014
0.750	709.542	0.534	0.379	0.731	9.678	1791.578	144.656	37.878
1.000	953.150	0.602	0.506	0.867	9.811	1873.317	112.598	28.883
1.250	1200.067	0.671	0.633	1.004	9.943	1959.112	93.526	23.539
1.500	1450.291	0.740	0.761	1.143	10.075	2049.135	80.946	20.020
1.750	1703.821	0.810	0.890	1.282	10.207	2143.485	72.073	17.541
2.000	1960.661	0.881	1.019	1.423	10.340	2242.177	65.516	15.714

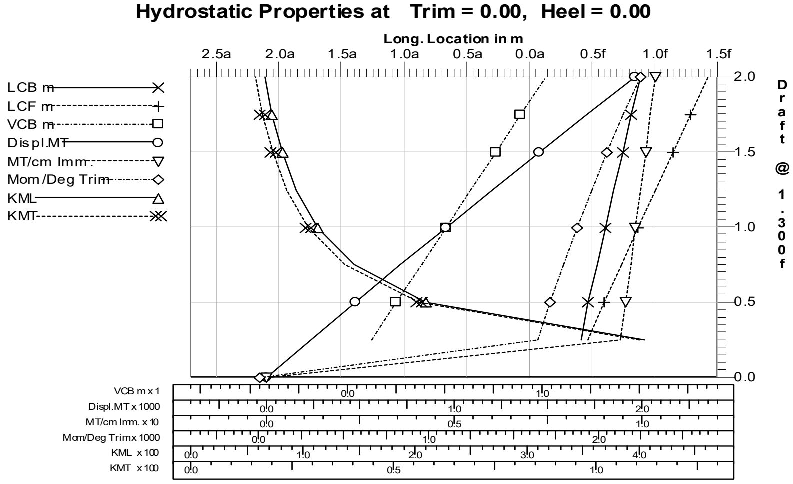

Fig. 6. Hydrostatic properties at scenario 3.1. (AutoHydro capture)

Table 4. Hull characteristics at scenario 3.1.

Dimensions	L_{WL} [m]	41.918	Areas	Waterplane [m^2]	982.927
	Volume [m^3]	1414.911		Wetted surface [m^2]	886.447
	Displacement [MT]	1450.291		Under water lateral plane [m^2]	103.501
Coefficients	Prismatic	1.127		Above water lateral plane [m^2]	157.293
	Block	1.125	Centroids	LCB [m]	0.074
	Midship	0.999		TCB [m]	0.000
	Waterplane	1.172		VCB [m]	0.761
Ratios	L/B	2.130		LCF [m]	1.143
	Displacement / Length	548.742		Under water LP = 1.447 of origin 0.743 below waterline	
	Beam / Depth	13.333		Above LP = 2.062 of origin 1.084 above waterline	
	MT / cm immersion	10.075			

Table 5. Hydrostatic properties at scenario 3.2.

Draft [m]	Displ [MT]	LCB [m]	VCB [m]	LCF [m]	TPcm [MT/cm]	MTcm [MT m/deg]	KML [m]	KMT [m]
0.000	36.261	-11.421	0.054	7.909a	4.731	269.526	426.573	368.766
0.250	239.457	-2.877	0.143	0.313	9.368	1618.663	388.010	106.674
0.500	475.455	-1.257	0.263	0.453	9.507	1689.932	204.381	55.025
0.750	714.765	-0.663	0.387	0.583	9.638	1762.626	142.033	37.423
1.000	957.345	-0.330	0.512	0.715	9.769	1839.193	110.818	28.619
1.250	1203.192	-0.103	0.638	0.848	9.900	1919.744	92.165	23.364
1.500	1452.305	0.071	0.765	0.982	10.030	2004.306	79.822	19.893
1.750	1704.684	0.216	0.893	1.117	10.161	2093.044	71.099	17.444
2.000	1960.330	0.343	1.021	1.254	10.292	2186.022	64.643	15.636

3.2. Calculus for scenario with the weight of 1450.3MT distributed along the length of the ship. For this case we used the weight of 1450.3MT, and distributed along the length of the ship (from 20a to 22.6f). The hydrostatics, wore calculated, and are presented in table 5, and figure 7. In this case we do not have heel, but the trim angle is at aft 0.48 deg. Table 6 presents the hull characteristics for this case.

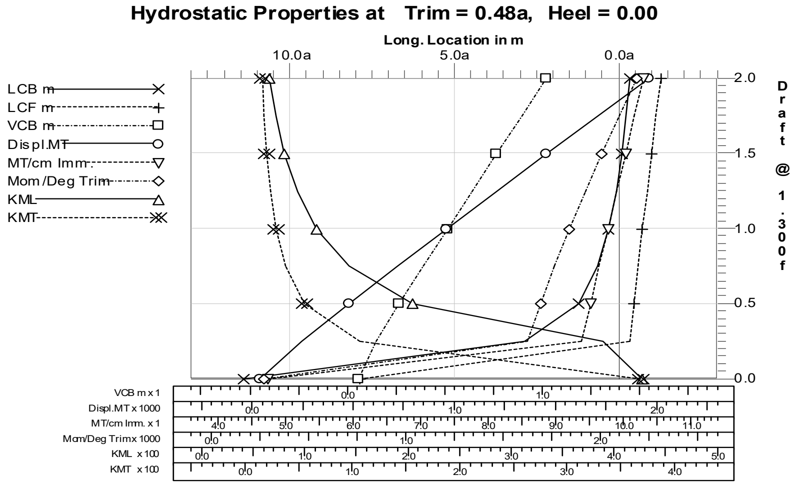

Fig. 7. Hydrostatic properties at scenario 3.2. (AutoHydro capture)

Table 6. Hull characteristics at scenario 3.2.

<table>
<tr><td rowspan="3">Dimensions</td><td>L_{WL} [m]</td><td>42.012</td><td rowspan="4">Areas</td><td>Waterplane [m^2]</td><td>978.441</td></tr>
<tr><td>Volume [m^3]</td><td>1414.922</td><td>Wetted surface [m^2]</td><td>884.072</td></tr>
<tr><td>Displacement [MT]</td><td>1450.302</td><td>Under water lateral plane [m^2]</td><td>103.131</td></tr>
<tr><td rowspan="4">Coefficients</td><td>Prismatic</td><td>1.016</td><td>Above water lateral plane [m^2]</td><td>157.663</td></tr>
<tr><td>Block</td><td>1.012</td><td rowspan="7">Centroids</td><td>LCB [m]</td><td>0.070</td></tr>
<tr><td>Midship</td><td>0.996</td><td>TCB [m]</td><td>0.000</td></tr>
<tr><td>Waterplane</td><td>1.164</td><td>VCB [m]</td><td>0.764</td></tr>
<tr><td rowspan="4">Ratios</td><td>L/B</td><td>2.130</td><td>LCF [m]</td><td>0.980</td></tr>
<tr><td>Displacement / Length</td><td>545.073</td><td colspan="2">Under water LP = 0.875 of origin 0.744 below waterline</td></tr>
<tr><td>Beam / Depth</td><td>12014</td><td colspan="2" rowspan="2">Above LP = 2.409 of origin 1.091 above waterline</td></tr>
<tr><td>MT / cm immersion</td><td>10.029</td></tr>
</table>

3.3. Calculus for scenario with the weight of 1450.3MT distributed along the length of the ship, 100% full of the oil, and fuel tank, and 50 % of the ballast tanks.

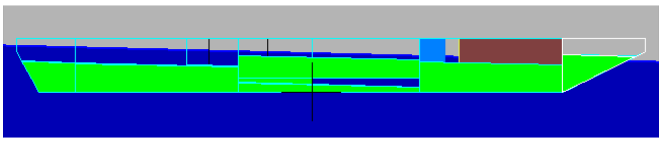

Fig. 8. Tank filling side view of scenario 3.3. (AutoHydro capture)

For this case we used the weight modelled at point 3.2. For the scenario of the tank percent of filling, and the characteristics for these in the scenario, table 7 presents all the values characteristics for these. All tanks are assumed to be with *intact status*. Figures 8 and 9 present the filling of the tanks on the side view and on the plan view of AutoHydro program. For this case, parameters of the hydrostatic values modified according table 8. Next, the hydrostatics are calculated (table 9 and figure 10). Table 10 presents the hull data characteristics for the scenario.

Table 7. Tank characteristics for the assumed scenarios

Crt. No.	Name	Weight [MT]	Volume [m^3]	LCG [m]	TCG [m]	VCG [m]	Fill [%]
1	TK1_CENT	63.3	61.7	17.546	0.000	1.093	50
2	TK2_CENT	138.2	134.8	12.250	0.000	0.912	50
3	TK3PS.P	16.1	15.7	6.750	-3.750	0.912	50
4	TK3SB.S	16.1	15.7	6.750	3.750	0.912	50
5	TK4PS.P	23.0	22.5	2.500	-3.750	0.912	50
6	TK4SB.S	23.0	22.5	2.500	3.750	0.912	50
7	TK5_CENT	64.3	62.7	-18.698	0.000	1.669	50
8	POT_WHA_PS.P	10.5	10.5	-8.150	-4.150	1.825	100
9	POT_WHA_SB.S	10.5	10.5	-8.150	4.150	1.825	100
10	FUEL.P	31.7	42.8	-13.500	4.150	1.825	100
11	FUEL.S	31.7	42.8	-13.500	4.150	1.25	100
12	FUEL_OIL.s	11.2	12.9	-15.500	8.745	0.879	100
13	TK7_PS.P	102.7	100.2	10.500	-7.495	0.914	50
14	TK7_SB.S	102.7	100.2	10.500	7.495	0.914	50
15	TK8_PS_INF.P	30.9	30.2	-1.150	-7.481	0.252	50
16	TK8_PS_SUP.P	83.4	81.4	-1.150	-7.500	1.662	50
17	TK8_SB_INF.S	30.9	30.2	-1.150	7.481	0.252	50
18	TK8_SB_SUP.S	83.4	81.4	-1.150	7.500	1.662	50
19	TK9_PS.P	90.5	88.3	-12.150	-7.495	0.914	50
20	TK9_SB.S	83.3	81.2	-11.589	7.271	1.007	50
21	TK6_PS.P	31.6	30.8	17.547	-7.495	1.094	50
22	TK6_SB.S	31.6	30.8	17.547	7.495	1.094	50
23	TK10_PS.P	32.1	31.3	-18.697	-7.500	1.668	50
24	TK10_SB.S	32.1	31.3	-18.697	7.500	1.668	50

Table 8. Hydrostatic properties at scenario 3.3.

Draft [m]	Displ [MT]	LCB [m]	VCB [m]	LCF [m]	TPcm [MT/cm]	MTcm [MT m/deg]	KML [m]	KMT [m]
0.000	104.717	-11.482	0.155	7.988	4.795	277.307	152.430	131.535
0.250	264.416	-7.496	0.233	-2.426	7.916	1014.401	220.484	82.192
0.500	489.826	-4.259	0.320	0.192	9.441	1661.053	194.981	52.962
0.750	727.432	-2.784	0.428	0.319	9.572	1731.994	137.127	36.503
1.000	968.252	-1.997	0.545	0.443	9.699	1805.420	107.553	28.088
1.250	1212.267	-1.493	0.665	0.569	9.827	1882.633	89.705	23.016
1.500	1459.478	-1.133	0.788	0.695	9.955	1963.749	77.822	19.645
1.750	1709.884	-0.856	0.913	0.823	10.083	2048.768	69.385	17.257
2.000	1963.485	-0.631	1.039	0.952	10.211	2137.846	63.120	15.489

Table 9. Hydrostatic values at scenario 3.3.

Displacement	2625.2MT		
Deadweight	1174.8MT		
Draft status	3.15a	2.64m	2.13f
Heel	0.05s deg		
Trim	1.37a deg		
LCG	-0.193m		
VCG	0.939m		

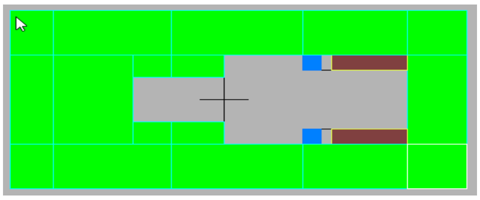

Fig. 9. Tank filling plan view of scenario 3.3. (AutoHydro capture)

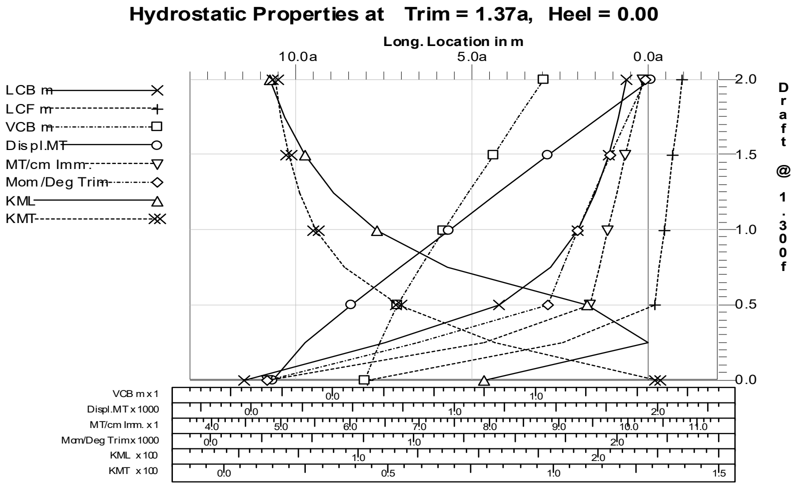

Fig. 10. Hydrostatic properties at scenario 3.3. (AutoHydro capture)

Table 10. Hull characteristics at scenario 3.2.

Dimensions	L_{WL} [m]	42.600	Areas	Waterplane [m^2]	1022.056
	Volume [m^3]	2561.110		Wetted surface [m^2]	1025.980
	Displacement [MT]	2625.152		Under water lateral plane [m^2]	185.082
Coefficients	Prismatic	0.971		Above water lateral plane [m^2]	76.606
	Block	0.963	Centroids	LCB [m]	-0.182
	Midship	0.992		TCB [m]	0.010 in Sb
	Waterplane	1.200		VCB [m]	1.363
Ratios	L/B	2.130		LCF [m]	1.347
	Displacement / Length	946.330		Under water LP = 0.600 of origin 1.312 below waterline	
	Beam / Depth	6.408		Above LP = 4.607 of origin 0.552 above waterline	
	MT / cm immersion	10.476			

Also, the cross curves are generated for this case scenario (table 1, figure 11). For the stability table, the values for the cases of heeling angles from 0 to 60 degrees are presented. The maximum arm value is in the range of 20 to 30 degrees. Figure 12 presents the righting arm diagram.

Table 11. Cross curves of stability at scenario 3.2.

Dspl [MT]	104.717	264.416	489.826	727.432	968.252	1212.267	1459.478	1709.884	1963.485
5.000s	6.066s	4.844s	3.831s	2.984s	2.381s	1.955s	1.660s	1.449s	1.293s
10.000s	7.134s	6.357s	5.494s	4.749s	4.147s	3.645s	3.226s	2.858s	2.523s
15.000s	7.493s	6.952s	6.297s	5.656s	5.112s	4.630s	4.165s	3.707s	3.256s
20.000s	7.600s	7.191s	6.710s	6.158s	5.609s	5.071s	4.552s	4.048s	3.561s
25.000s	7.557s	7.245s	6.863s	6.357s	5.791s	5.221s	4.676s	4.168s	3.684s
30.000s	7.414s	7.164s	6.831s	6.351s	5.785s	5.210s	4.670s	4.172s	3.703s
35.000s	7.187s	6.974s	6.672s	6.211s	5.659s	5.100s	4.581s	4.102s	3.654s
40.000s	6.883s	6.695s	6.413s	5.974s	5.448s	4.920s	4.429s	3.977s	3.553s
45.000s	6.510s	6.339s	6.075s	5.664s	5.171s	4.682s	4.227s	3.807s	3.414s
50.000s	6.075s	5.919s	5.673s	5.295s	4.841s	4.396s	3.982s	3.599s	3.239s
55.000s	5.584s	5.442s	5.216s	4.876s	4.466s	4.069s	3.701s	3.358s	3.036s
60.000s	5.044s	4.916s	4.713s	4.415s	4.054s	3.708s	3.389s	3.089s	2.807s

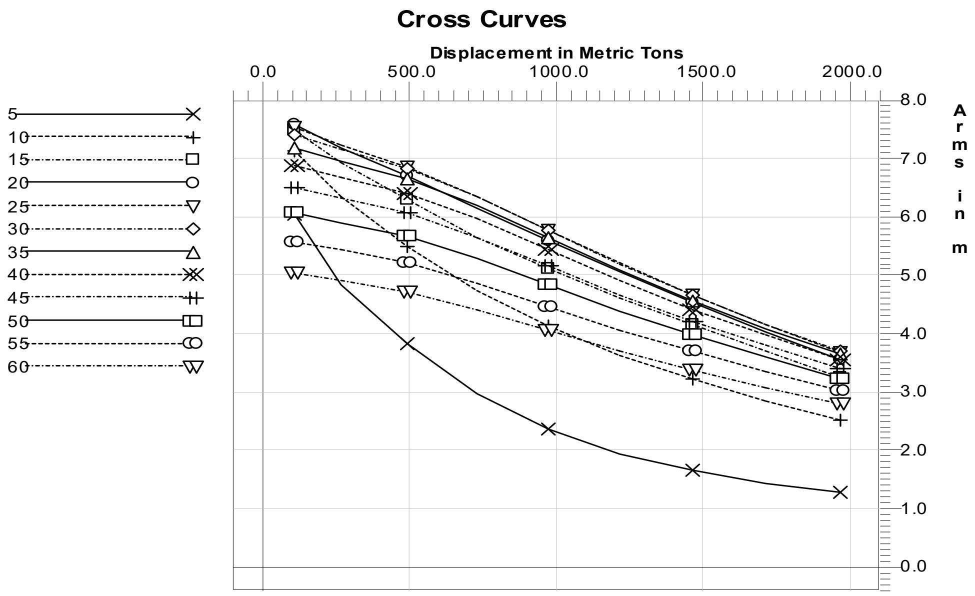

Fig. 11. Cross curves at scenario 3.3. (AutoHydro capture)

The last calculus that is made for the scenarios is presented below, in figure and table 13, the longitudinal strength. In this case the values for weight, buoyancy, shear force and bending moment are presented in figure below. Table 13 presents all the values. We can see that maximum shear force has the value of -188.47MT at longitudinal value 17.000 forward part of the ship, and the maximum bending moment has the value of 2312MTm at longitudinal value 3.000 forward part of the ship, with a hogging characteristic.

Table 12. Righting arms vs heel angle at scenario 3.2.

Heel angle [deg]	Trim angle [deg]	Origin depth [m]	Righting arm [m]
0.05s	-1.37	2.669	0.000
5.05s	-1.46	2.661	0.910
10.05s	-2.01	2.732	1.515
15.05s	-2.67	2.891	1.829
20.05s	-3.50	3.087	1.960
25.05s	-4.21	3.236	1.989
30.05s	-5.45	3.472	1.967
35.05s	-6.45	3.643	1.914
40.05s	-7.43	3.793	1.843
45.05s	-8.37	3.919	1.756
50.05s	-9.29	4.018	1.656
55.05s	-10.17	4.089	1.545
60.05s	-11.00	4.129	1.425

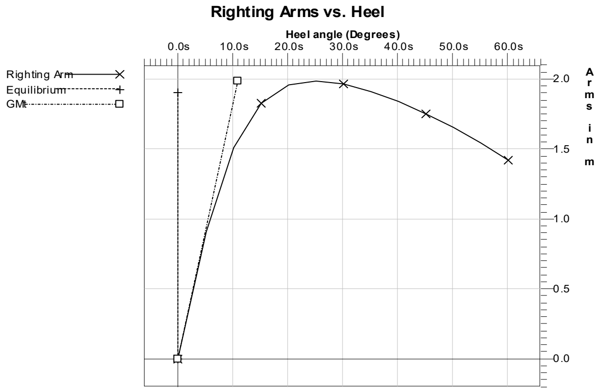

Fig. 12. Righting arms vs. heel at scenario 3.3. (AutoHydro capture)

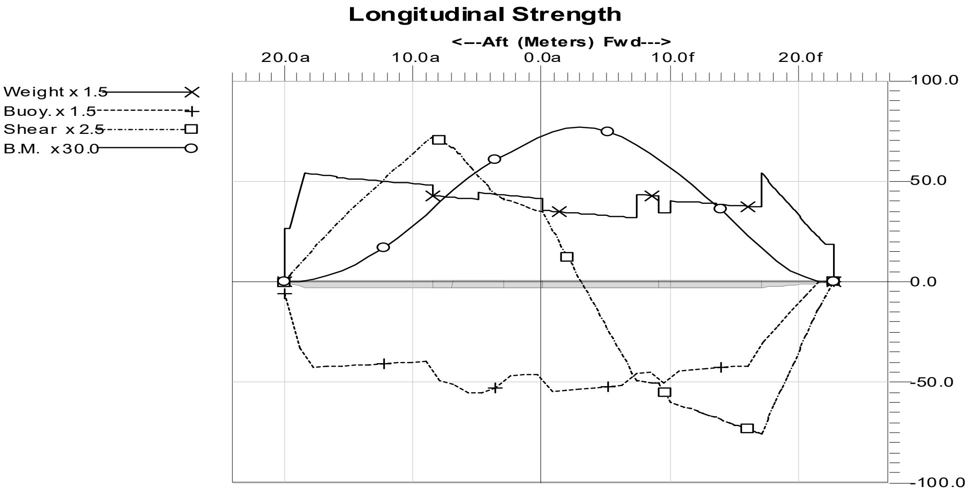

Fig. 13. Longitudinal strength at scenario 3.3. (AutoHydro capture)

Table 13. Longitudinal strength

Location [m]	Weight [MT]	Buoyancy [MT/m]	Shear [MT]	Bending [MT-m]
22.600f	0.000	0.000	0.00	0
22.600f	28.139	-	-	-
21.981f	28.310	0.000	-17.46	6
21.974f	28.352	0.000	-17.68	6
21.600f	32.283	0.000	-29.01	15
21.501f	33.334	0.000	-32.27	18
21.411f	34.290	0.000	-35.30	21
21.100f	37.607	3.101	-45.99	34
21.001f	38.667	4.150	-49.42	39
20.600f	42.945	8.381	-63.27	62
20.501f	44.002	9.427	-66.69	68
20.100f	48.280	13.655	-80.56	98
20.001f	49.338	14.701	-83.99	106
19.600f	53.619	18.935	-97.89	143
19.501f	54.673	19.978	-101.32	153
19.100f	58.957	24.215	-115.24	196
19.001f	60.011	25.257	-118.68	208
18.600f	64.291	29.489	-132.63	259
18.501f	65.345	30.531	-136.06	272
18.100f	69.629	34.769	-150.05	330
18.001f	70.679	35.807	-153.48	345
17.600f	74.964	40.042	-167.49	409
17.502f	76.011	41.077	-170.93	426
17.100f	80.282	45.301	-184.97	498
17.000f	81.330	46.337	-188.47	517
17.000f	60.670	-	-	-
16.997f	56.209	61.644	-188.46	517
16.792f	56.326	61.778	-187.34	556
16.788f	56.328	61.780	-187.32	556

16.695f	56.377	61.841	-186.81	574
16.500f	56.479	61.968	-185.75	610
16.390f	56.536	62.040	-185.14	631
16.086f	56.695	62.239	-183.46	687
16.000f	56.740	62.294	-182.99	703
15.781f	56.854	62.437	-181.76	743
15.500f	57.001	62.620	-180.19	794
15.476f	57.013	62.636	-180.06	798
15.171f	57.172	62.835	-178.34	853
15.000f	57.262	62.947	-177.37	884
14.866f	57.332	63.034	-176.60	908
14.562f	57.491	63.233	-174.86	961
14.501f	57.523	63.273	-174.51	972
14.001f	57.784	63.599	-171.62	1059
14.000f	54.053	63.599	-171.61	1059
13.952f	54.508	63.631	-171.17	1067
13.501f	58.768	63.925	-167.94	1144
13.500f	58.777	63.926	-167.94	1144
13.342f	58.859	64.028	-167.13	1171
13.001f	59.037	64.251	-165.35	1228
12.733f	59.177	64.426	-163.95	1272
12.501f	59.298	64.577	-162.73	1310
12.123f	59.496	64.824	-160.73	1371
12.001f	59.559	64.903	-160.08	1391
11.514f	59.814	65.222	-157.45	1469
11.501f	59.820	65.230	-157.39	1471
11.001f	60.081	65.556	-154.67	1549
10.502f	60.342	65.882	-151.92	1626
10.002f	60.603	66.208	-149.13	1701
10.000f	60.604	66.209	-149.12	1702
10.000f	51.562	-	-	-
9.502f	51.822	75.043	-137.58	1773
9.500f	51.823	75.044	-137.54	1774
9.002f	52.083	75.411	-125.95	1840
9.000f	52.084	75.412	-125.90	1840
9.000f	64.473	-	-	-
8.768f	64.610	67.013	-125.35	1869
8.502f	64.749	67.187	-124.70	1903
8.500f	64.750	67.188	-124.70	1903
8.002f	65.010	67.513	-123.47	1965
8.000f	65.011	67.514	-123.46	1965
7.502f	65.271	67.839	-122.20	2027
7.500f	65.272	67.840	-122.20	2027
7.303f	65.375	67.969	-121.69	2051
7.300f	65.377	76.577	-121.67	2051
7.300f	47.963	-	-	-
7.000f	48.193	76.884	-113.06	2087
6.997f	48.195	76.886	-112.97	2087
6.800f	48.345	77.031	-107.32	2109
6.500f	48.575	77.252	-98.71	2140
6.300f	48.727	77.399	-92.99	2159
6.000f	48.956	77.620	-84.38	2186
5.800f	49.109	77.767	-78.66	2203
5.500f	49.338	77.988	-70.06	2225
5.300f	49.491	78.135	-64.34	2239

5.000f	49.720	78.356	-55.73	2257
4.801f	49.872	78.503	-50.02	2268
4.500f	50.102	78.724	-41.42	2282
4.301f	50.254	78.870	-35.71	2289
4.000f	50.484	79.092	-27.11	2299
3.801f	50.636	79.238	-21.41	2304
3.500f	50.866	79.460	-12.81	2309
3.301f	51.018	79.606	-7.12	2311
3.000f	51.247	79.827	1.48	2313
2.801f	51.399	79.974	7.17	2312
2.500f	51.629	80.196	15.77	2309
2.301f	51.781	80.342	21.45	2305
2.000f	52.011	80.563	30.05	2297
1.801f	52.163	80.710	35.72	2291
1.500f	52.393	80.931	44.33	2279
1.301f	52.545	81.077	49.99	2270
1.000f	52.775	81.299	58.59	2254
0.802f	52.926	81.445	64.25	2242
0.500f	53.157	81.667	72.85	2221
0.000	53.539	82.035	87.10	2182
0.000	62.447	-	-	-
0.500a	62.889	68.663	90.02	2138
1.000a	63.331	68.969	92.87	2092
1.500a	63.773	69.276	95.66	2045
2.000a	64.216	69.582	98.38	1997
2.500a	64.658	69.889	101.02	1948
2.974a	65.077	70.180	103.47	1900
2.994a	65.095	70.932	103.58	1898
3.000a	65.100	70.936	103.62	1897
3.128a	65.214	74.636	104.60	1884
3.500a	65.543	78.018	108.67	1844
3.567a	65.602	78.633	109.53	1837
4.000a	65.985	80.566	115.50	1789
4.225a	66.184	81.577	118.87	1762
4.500a	66.427	82.083	123.14	1729
5.000a	66.869	83.005	131.09	1666
5.000a	62.089	-	-	-
5.500a	62.410	82.791	141.41	1598
5.775a	62.587	82.670	146.98	1559
6.000a	62.732	81.963	151.40	1525
6.432a	63.010	80.591	159.36	1458
6.500a	63.053	80.055	160.52	1448
6.872a	63.292	77.074	166.25	1387
7.000a	63.375	73.409	167.78	1366
7.006a	63.378	73.413	167.83	1365
7.026a	63.391	72.664	168.03	1361
7.500a	63.696	72.955	172.42	1281
8.000a	64.018	73.262	177.05	1194
8.500a	64.339	73.568	181.66	1105
8.500a	72.432	-	-	-
9.000a	72.814	59.092	174.84	1016
9.500a	73.195	59.337	167.94	930
10.000a	73.577	59.582	160.98	849
10.500a	73.959	59.828	153.95	770
11.000a	74.341	60.073	146.85	695

11.500a	74.723	60.318	139.68	624
12.000a	75.105	60.564	132.44	556
12.500a	75.487	60.809	125.14	492
13.000a	75.868	61.054	117.77	432
13.500a	76.250	61.300	110.33	375
14.000a	76.632	61.545	102.81	322
14.500a	77.014	61.790	95.24	273
15.000a	77.396	62.036	87.59	228
15.500a	77.778	62.281	79.88	186
16.000a	78.160	62.526	72.10	148
16.000a	79.265	-	-	-
16.500a	79.645	62.771	63.69	115
17.000a	80.025	63.017	55.22	85
17.500a	80.405	63.262	46.68	60
18.000a	80.785	63.507	38.08	39
18.497a	81.163	63.751	29.46	23
18.500a	81.165	63.753	29.40	23
19.000a	63.083	45.255	20.59	11
19.500a	44.955	26.711	11.58	3
19.641a	39.880	21.485	9.00	2
19.642a	39.862	21.460	8.98	2
19.643a	39.832	21.399	8.95	2
20.000a	39.931	8.176	0.00	0
20.000a	0.000	-	-	-

3 CONCLUDING REMARKS

The paper presents the results of hydrostatic and stability calculus, using AutoHydro software from the package AutoShip.

The hull of the crane was imported from Rhinoceros in ModelMaker software of the package AutoShip. All the tanks and the spaces provided for the crane hull, according to the general arrangement, wore then modelled using ModelMaker commands. The next step was opening the model with AutoHydro.

In AutoHydro result like calculating the hydrostatics, the cross curves and the hull data for specified drafts wore generated using specific commands. Also for cases of different percent of tank filling the right arm and the longitudinal strength wore provided. [3]

In conclusion, AutoHydro offers robust capabilities for analysing the hydrostatic characteristics of virtually any vessel across diverse conditions. The Modelmaker module is designed for modelling a wide range of vessel types with precision. AutoHydro performs detailed hydrostatic and stability calculations, evaluates hydrostatic and stability characteristics under various loading scenarios — including damage conditions — and generates graphical and textual outputs for reports, such as stability books and tank sounding tables. [3]

Future studies will provide analyses for this crane with different statuses for the tanks (intact, damaged, frozen, spill), with different hazard conditions (wave, wind) and with scenarios of different weights in the crane, in different positions.

Acknowledgements

The research was made in "Mircea cel Bătrân" Naval Academy, Constanta, Romania, Faculty of Navigation and Naval Management, room L243.

REFERENCES

[1] **Oncică Valentin**, **Scurtu Ionuț Cristian**," Modern autoship analysis for" Academic star" cutter status, SeaConf 2015- https://www.researchgate.net/publication/301553524_MODERN_AUTOSHIP_ANALYSIS_FOR_ACADEMIC_STAR_CUTTER_STATUS.

[2] **Buzilă Elisabeta**, " 3D-FEM MODELING OF A PARALLELIPIPEDIC CRANE FOR HEAD AND OBLIQUE DESIGN WAVES TESTING", The 10th International Scientific Conference SEACONF 2024, May 16-18, 2024 - Constantza, Romania, The Scientific Bulletin of Naval Academy (SBNA), Series C: Navigation, Transport and Management, Vol. XXVII 2024, pg. 8-19, ISSN: 2392-8956; ISSN-L: 1454-864X; DOI: 10.21279/1454-864X-24-I2-001; CNCSIS Code: 884, https://www.anmb.ro/buletinstiintific/eng/index.php?mod=arhive., https://www.anmb.ro/buletinstiintific/buletine/2024_Issue2/01_MES/8-19.pdf.

[3]. *** http: www.autoship.com

Paper received on November 8th, 2024

