Analysis Of The Influence Of Ship Speed On Seakeeping Motion On The Ship

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A b s t r a c t

Ship motion (Seakeeping) is the ability of a ship to survive under any conditions. Therefore this capability is clearly an important aspect in terms of ship design (Ship Design). The shape of the hull greatly influences the characteristics of the movement and operability of the ship itself. Vessel operability is the amount of time at sea during which the structure can still operate according to established criteria and its correlation to the height at which the weather will occur. In this study, an analysis of 3 degrees of freedom of translational movement and heave roll and pitch rotation was carried out on the model of a fast ship type planing hull at regular waves with parameters of body mass, radius of gyration, damping and others presented in the form of Response Amplitude Operator (RAO) images.

1. Introduction

The population's need for goods from one island to another certainly varies and varies as do the goods they produce. Therefore, to distribute from one island to another, an economical means of sea transportation is needed, namely ships, where ships are capable of moving people and goods in large quantities. To meet all these needs, the Indonesian government is working on more adequate accommodation and transportation facilities. Nowadays ship planning designs are developing rapidly to create optimal ships, apart from economic and performance aspects, design processes.

Ships must also consider the comfort and safety of the ship when sailing which can be caused either by the ship's own movements or from outside (seakeeping). Movements originating from factors outside the ship, such as unfavorable climate and resulting in large waves, storms which are very dangerous for the crew and the ship. Therefore, there is a need for studies and research on its reliability, especially in terms of seakeeping performance. Speed and loaded from the ship greatly affects the performance of the ship when it is on the waves. Likewise, wave characteristics consisting of height, period and direction of wave propagation greatly determine the ship's motion response.

The response to rolling, pitching and heaving movements will ultimately affect the comfort and safety of crew and goods which transported. The shape of the ship has a big influence on characteristics operability movement. Ship operability is the amount of time at sea during which the structure is still able to operate according to the specified performance and its correlation with wave height Where criteria will be exceeded. Characteristics of a ship model that is able to emphasize the ship's response to operational

conditionsat sea is the main criterion that must be met by ships, which is closely related to the characteristics of the ship's movement.

2. Materials and Methods

a. Ship Model Making

Making a ship model with a length of 94 meters using Maxsurf software.
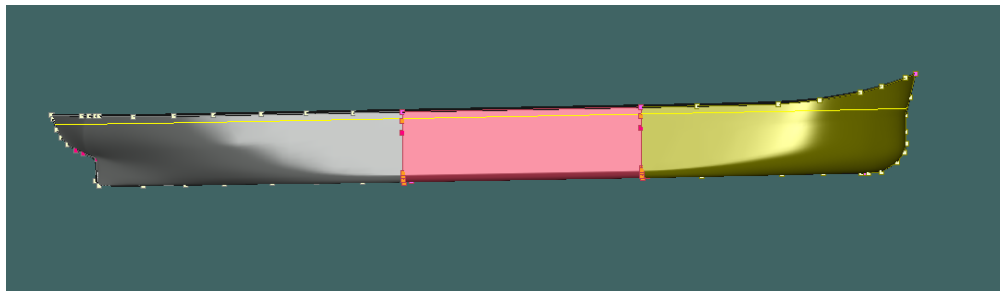
Fig.1. Ship modeller

b. Input Data

Fig.2. Ship data

In the picture above, calculating and making graphs, using the Seakeeper application. The data used is data on the main size of the ship as the subject of this experiment

When the data input stage is complete, the ship modeler that has been created is opened in the Maxsurf Motion Advance application, and the ship type and factor damping as follows:

c. Type of Ship andFactor Damping
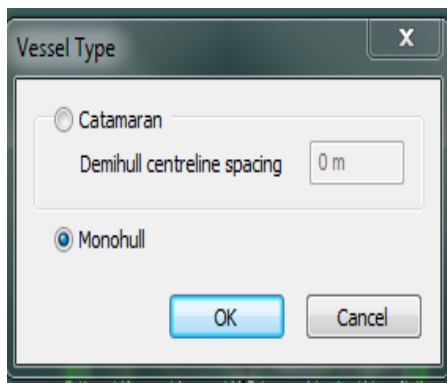
Fig. 3. Types of Ships
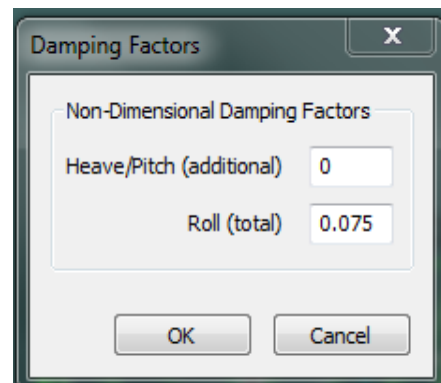
Fig. 4. Damping Factor

d. Ship Speed

The speed variations used in the ROA calculation experiment this time were 6 and 12 knots

	Name	Speed [kn]	Analyse
1	Kecepatan 1	6.000	✓
2	Kecepatan 2	12.000	✓

Fig. 5. Ship speed

e. Front Angle

The facing angles used in this calculation experiment are 4 angle variations: 0, 45, 90, 180 degrees.

	Name	Heading [deg]	Analyse
1	Following seas	0.00	✓
2	Beam Seas	45.00	✓
3	Quarter seas	90.00	✓
4	Head Seas	180.00	✓

Fig. 6. Front Angle

f. Wave Spectrum

In the table spectra menu, there are variations in wave height, namely: 1m, 2m, and 3m.

	Name	Type	Char. height [m	Modal period [	Average period	Zero crossing	Peak enhance
1	T. Gelombang 1	JONSWAP	1.000	7.056 s	5.908 s	5.561 s	3.30
2	T. Gelombang 2	JONSWAP	2.000	9.977 s	8.354 s	7.862 s	3.30
3	T. Gelombang 3	JONSWAP	3.000	9.993 s	8.367 s	7.875 s	3.30

Fig. 7. Wave Spectrum

g. Solve Seakeeping Analysis

After all the data above has been entered, the next step is the analysis menu and Solve seakeeping.

1. **Speed 6 knots and 0, 45, 90, 180 degrees**

3. Results and discussion

Kecepatan 1, 6 kn; Following seas, 0 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelength m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.187	0.200	1533.838	0.994	-0.1	0.000	0.0	1.115	85.0	24.492
2	0.240	0.262	897.848	0.983	-0.3	0.000	0.0	1.156	82.6	40.391
3	0.291	0.324	587.419	0.961	-0.8	0.000	0.0	1.186	79.8	58.38
4	0.339	0.386	413.958	0.922	-1.5	0.000	0.0	1.199	76.9	75.952
5	0.385	0.448	307.354	0.863	-2.6	0.000	0.0	1.191	74.0	89.971
6	0.428	0.510	237.194	0.777	-4.2	0.000	0.0	1.155	71.3	97.584
7	0.469	0.572	188.577	0.663	-6.9	0.000	0.0	1.086	68.6	98.671
8	0.507	0.634	153.509	0.522	-11.3	0.000	0.0	0.980	66.1	99.518
9	0.543	0.695	127.385	0.363	-19.9	0.000	0.0	0.839	63.7	108.906
10	0.577	0.757	107.404	0.212	-40.6	0.000	0.0	0.670	61.5	120.121
11	0.608	0.819	91.780	0.142	-94.7	0.000	0.0	0.483	59.4	116.748
12	0.637	0.881	79.333	0.201	-139.3	0.000	0.0	0.295	57.7	94.717
13	0.663	0.943	69.256	0.259	-156.1	0.000	0.0	0.127	56.9	73.199
14	0.687	1.005	60.985	0.258	-165.1	0.000	0.0	0.004	161.9	74.705
15	0.709	1.067	54.111	0.189	-173.2	0.000	0.0	0.077	-131.0	61.59
16	0.728	1.129	48.337	0.075	166.9	0.000	0.0	0.098	-131.3	69.533
17	0.745	1.191	43.440	0.068	38.8	0.000	0.0	0.075	-131.7	70.196
18	0.759	1.253	39.251	0.151	18.9	0.000	0.0	0.029	-129.4	56.012
19	0.771	1.315	35.641	0.166	13.2	0.000	0.0	0.014	32.9	54.273
20	0.780	1.377	32.506	0.108	9.6	0.000	0.0	0.034	39.8	44.362
21	0.787	1.439	29.768	0.012	-11.3	0.000	0.0	0.028	40.4	44.891
22	0.792	1.501	27.361	0.072	-167.3	0.000	0.0	0.006	42.2	36.7
23	0.794	1.563	25.235	0.097	-168.3	0.000	0.0	0.013	-141.3	35.631
24	0.794	1.625	23.348	0.060	-166.6	0.000	0.0	0.016	-140.8	30.719
25	0.791	1.686	21.664	0.006	-17.9	0.000	0.0	0.006	-141.2	27.389
26	0.786	1.748	20.157	0.049	10.5	0.000	0.0	0.007	41.9	25.407
27	0.779	1.810	18.801	0.043	15.7	0.000	0.0	0.010	42.1	23.069
28	0.769	1.872	17.578	0.006	55.1	0.000	0.0	0.003	43.2	20.386
29	0.757	1.934	16.470	0.026	-170.0	0.000	0.0	0.005	-135.6	19.477
30	0.742	1.996	15.464	0.022	-160.1	0.000	0.0	0.006	-133.9	18.289

◀ ▶ **CG RAOs** ⋀ CG spectra ⋀ Remote location RAOs ⋀ Remote location spectra ⋀ Global hydrodynamic coeffs.

Kecepatan 1, 6 kn; Beam Seas, 45 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelength m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.191	0.200	1533.838	0.991	0.3	0.737	88.2	0.766	86.5	24.432
2	0.262	0.280	787.691	0.979	0.3	0.766	87.4	0.842	80.7	45.536
3	0.331	0.359	477.172	0.957	-0.1	0.805	86.6	0.903	74.9	69.735
4	0.396	0.439	319.694	0.919	-1.2	0.856	85.6	0.945	69.4	91.691
5	0.459	0.519	229.024	0.857	-3.6	0.923	84.5	0.962	64.2	104.659
6	0.519	0.598	172.095	0.765	-8.2	1.008	83.2	0.944	59.6	105.872
7	0.576	0.678	134.027	0.645	-16.4	1.117	81.7	0.887	55.6	109.146
8	0.630	0.758	107.323	0.512	-31.5	1.258	79.7	0.786	52.7	128.399
9	0.681	0.837	87.872	0.411	-57.0	1.445	77.2	0.648	51.3	132.985
10	0.730	0.917	73.267	0.387	-89.1	1.698	73.8	0.483	52.5	98.259
11	0.776	0.997	62.022	0.401	-114.5	2.049	69.0	0.314	58.8	67.055
12	0.819	1.076	53.180	0.345	-131.7	2.546	62.0	0.169	78.0	77.067
13	0.859	1.156	46.103	0.161	-147.4	3.248	51.1	0.099	127.8	65.3
14	0.896	1.236	40.350	0.120	36.9	4.115	33.9	0.105	176.8	59.739
15	0.930	1.315	35.610	0.351	21.8	4.708	9.6	0.106	-153.5	49.797
16	0.962	1.395	31.659	0.379	14.7	4.450	-15.5	0.091	-124.1	54.828
17	0.991	1.475	28.330	0.197	18.9	3.724	-33.8	0.069	-93.5	49.88
18	1.017	1.554	25.501	0.090	128.9	3.065	-45.5	0.038	-49.9	29.047
19	1.040	1.634	23.075	0.185	156.3	2.583	-52.8	0.035	27.7	29.822
20	1.060	1.714	20.979	0.100	160.9	2.244	-57.6	0.038	57.8	30.685
21	1.078	1.793	19.157	0.054	-38.7	2.005	-60.9	0.014	94.6	16.46
22	1.092	1.873	17.562	0.086	-32.9	1.834	-63.2	0.018	-151.0	19.929
23	1.104	1.953	16.158	0.013	131.6	1.714	-64.8	0.014	-137.3	15.773
24	1.113	2.032	14.916	0.071	146.1	1.631	-65.9	0.006	17.6	13.77
25	1.119	2.112	13.812	0.015	-130.1	1.578	-66.6	0.009	24.2	13.424
26	1.123	2.192	12.826	0.060	-41.5	1.550	-66.9	0.003	-140.4	12.019
27	1.123	2.271	11.942	0.033	42.6	1.546	-67.0	0.005	-158.4	11.556
28	1.121	2.351	11.146	0.050	122.3	1.564	-66.7	0.003	34.2	11.85
29	1.116	2.431	10.428	0.052	-129.2	1.608	-66.2	0.002	47.2	10.404
30	1.108	2.511	9.776	0.038	-75.0	1.679	-65.2	0.004	-175.7	12.175

◀ ▶ ⋀ **CG RAOs** ⋀ CG spectra ⋀ Remote location RAOs ⋀ Remote location spectra ⋀ Global hydrodynamic coeffs.

Kecepatan 1, 6 kn; Quarter seas, 90 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelength m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.400	0.400	385.106	0.992	0.1	1.216	85.6	0.242	29.4	85.26
2	0.409	0.409	368.544	0.992	0.0	1.228	85.4	0.252	28.6	88.099
3	0.418	0.418	353.029	0.993	-0.2	1.241	85.3	0.262	27.8	90.881
4	0.427	0.427	338.472	0.993	-0.4	1.253	85.1	0.271	27.0	93.596
5	0.436	0.436	324.798	0.994	-0.6	1.267	85.0	0.281	26.3	96.231
6	0.444	0.444	311.936	0.995	-0.8	1.281	84.8	0.290	25.5	98.773
7	0.453	0.453	299.823	0.996	-1.0	1.296	84.6	0.299	24.7	101.209
8	0.462	0.462	288.402	0.996	-1.3	1.311	84.5	0.308	24.0	103.527
9	0.471	0.471	277.622	0.997	-1.6	1.327	84.3	0.317	23.3	105.712
10	0.480	0.480	267.435	0.998	-1.9	1.343	84.1	0.325	22.5	107.751
11	0.504	0.504	242.449	1.001	-2.9	1.392	83.6	0.348	20.6	112.437
12	0.528	0.528	220.808	1.004	-4.1	1.448	83.0	0.369	18.7	115.669
13	0.552	0.552	201.940	1.007	-5.5	1.510	82.4	0.389	16.9	117.18
14	0.577	0.577	185.392	1.011	-7.3	1.582	81.7	0.407	15.1	116.759
15	0.601	0.601	170.797	1.016	-9.4	1.663	80.8	0.424	13.3	114.277
16	0.625	0.625	157.860	1.023	-11.8	1.757	79.9	0.438	11.6	109.722
17	0.649	0.649	146.339	1.032	-14.7	1.867	78.9	0.451	10.0	103.269
18	0.673	0.673	136.035	1.044	-18.0	1.995	77.7	0.461	8.5	95.39
19	0.697	0.697	126.782	1.060	-21.9	2.146	76.2	0.470	7.0	87
20	0.721	0.721	118.442	1.083	-26.4	2.328	74.5	0.476	5.7	79.719
21	0.745	0.745	110.898	1.116	-31.6	2.548	72.4	0.480	4.4	75.902
22	0.770	0.770	104.053	1.160	-37.4	2.819	69.8	0.482	3.2	77.106
23	0.794	0.794	97.823	1.219	-43.9	3.158	66.5	0.481	2.0	82.449
24	0.818	0.818	92.136	1.297	-51.2	3.586	62.2	0.477	0.8	89.343
25	0.842	0.842	86.931	1.394	-59.2	4.132	56.4	0.471	-0.5	95.517
26	0.866	0.866	82.155	1.509	-68.1	4.819	48.4	0.463	-2.2	99.717
27	0.890	0.890	77.762	1.636	-77.8	5.625	37.1	0.453	-4.6	101.786
28	0.914	0.914	73.712	1.757	-88.4	6.378	21.8	0.437	-8.1	102.643
29	0.938	0.938	69.970	1.845	-99.6	6.684	3.0	0.411	-13.1	103.683
30	0.963	0.963	66.506	1.873	-110.7	6.275	-15.9	0.372	-19.9	105.304

CG RAOs / CG spectra / Remote location RAOs / Remote location spectra / Global hydrodynamic coeffs.

Kecepatan 1, 6 kn; Head Seas, 180 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelength m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.400	0.359	477.149	0.986	-0.9	0.000	85.6	1.005	-93.4	71.746
2	0.409	0.367	458.500	0.984	-0.9	0.000	85.4	1.005	-93.6	74.01
3	0.418	0.374	440.986	0.982	-1.0	0.000	85.3	1.006	-93.8	76.24
4	0.427	0.381	424.515	0.980	-1.1	0.000	85.1	1.006	-94.1	78.431
5	0.436	0.388	409.005	0.978	-1.2	0.000	85.0	1.006	-94.3	80.576
6	0.444	0.395	394.381	0.976	-1.2	0.000	84.8	1.006	-94.6	82.672
7	0.453	0.402	380.576	0.973	-1.3	0.000	84.6	1.006	-94.8	84.712
8	0.462	0.409	367.529	0.971	-1.4	0.000	84.5	1.006	-95.1	86.692
9	0.471	0.417	355.184	0.968	-1.5	0.000	84.3	1.006	-95.4	88.606
10	0.480	0.424	343.491	0.965	-1.6	0.000	84.1	1.006	-95.7	90.451
11	0.504	0.442	314.687	0.957	-1.8	0.000	83.6	1.005	-96.6	95.068
12	0.528	0.461	289.581	0.948	-2.1	0.000	83.0	1.003	-97.6	99.053
13	0.552	0.480	267.553	0.937	-2.4	0.000	82.4	1.001	-98.7	102.33
14	0.577	0.498	248.112	0.925	-2.7	0.000	81.7	0.999	-99.8	104.853
15	0.601	0.517	230.859	0.912	-3.0	0.000	80.8	0.995	-101.1	106.614
16	0.625	0.535	215.472	0.899	-3.3	0.000	79.9	0.991	-102.5	107.635
17	0.649	0.553	201.686	0.884	-3.6	0.000	78.9	0.987	-104.1	107.966
18	0.673	0.571	189.281	0.869	-3.9	0.000	77.7	0.981	-105.8	107.733
19	0.697	0.588	178.075	0.854	-4.3	0.000	76.2	0.975	-107.7	107.11
20	0.721	0.606	167.914	0.839	-4.6	0.000	74.5	0.969	-109.8	106.347
21	0.745	0.623	158.669	0.826	-5.0	0.000	72.4	0.962	-112.3	105.807
22	0.770	0.640	150.231	0.816	-5.5	0.000	69.8	0.953	-115.0	105.727
23	0.794	0.658	142.506	0.810	-6.1	0.000	66.5	0.944	-118.2	106.337
24	0.818	0.675	135.414	0.809	-7.1	0.000	62.2	0.933	-121.8	107.711
25	0.842	0.691	128.886	0.816	-8.8	0.000	56.4	0.920	-126.0	109.684
26	0.866	0.708	122.861	0.830	-11.6	0.000	48.4	0.902	-130.8	111.791
27	0.890	0.725	117.289	0.848	-16.1	0.000	37.1	0.879	-136.4	113.32
28	0.914	0.741	112.123	0.861	-23.1	0.000	21.8	0.846	-142.7	113.579
29	0.938	0.758	107.324	0.851	-32.8	0.000	3.0	0.804	-149.9	112.456
30	0.963	0.774	102.857	0.802	-45.2	0.000	-15.9	0.751	-157.7	110.792

CG RAOs / CG spectra / Remote location RAOs / Remote location spectra / Global hydrodynamic coeffs.

Chart
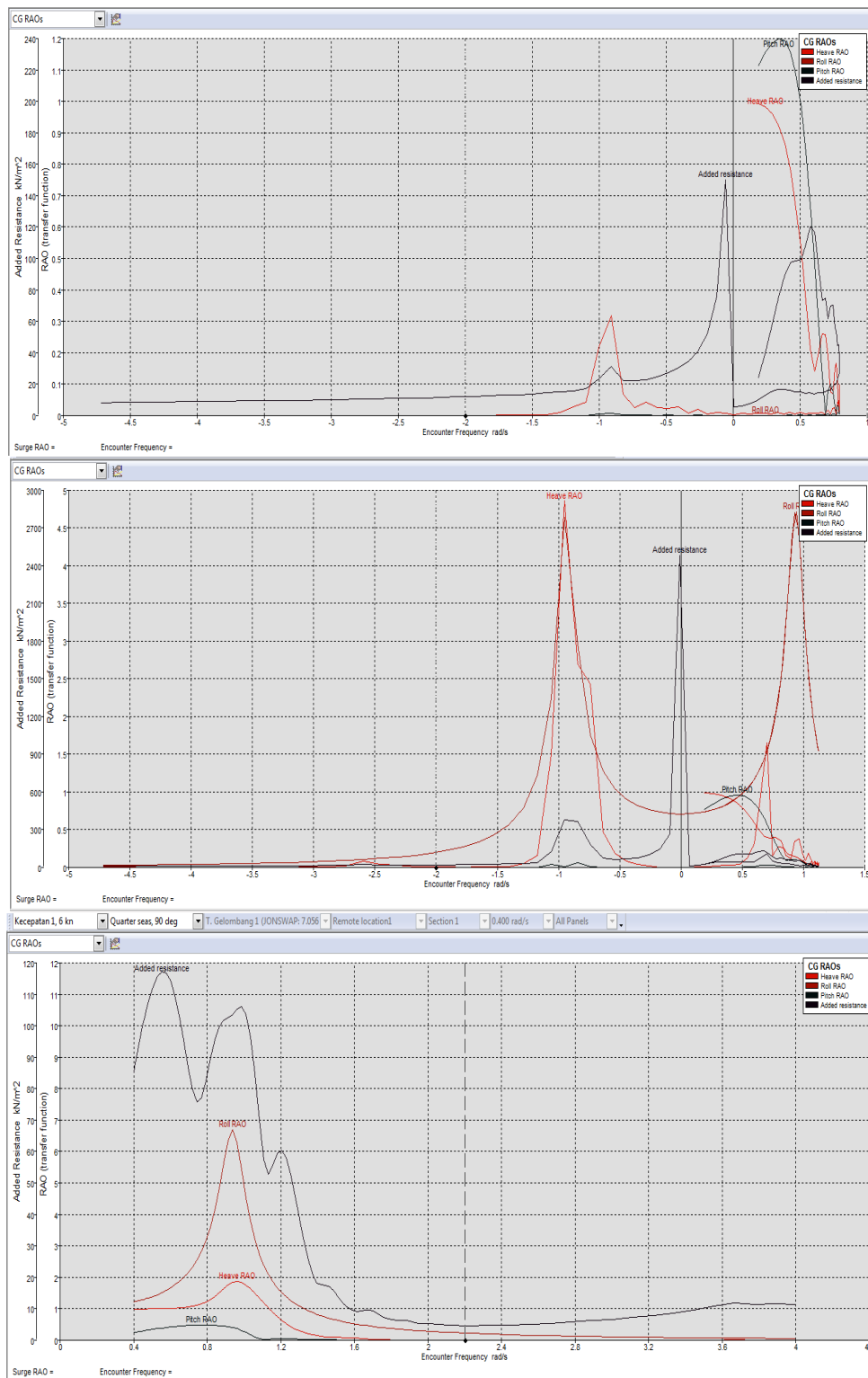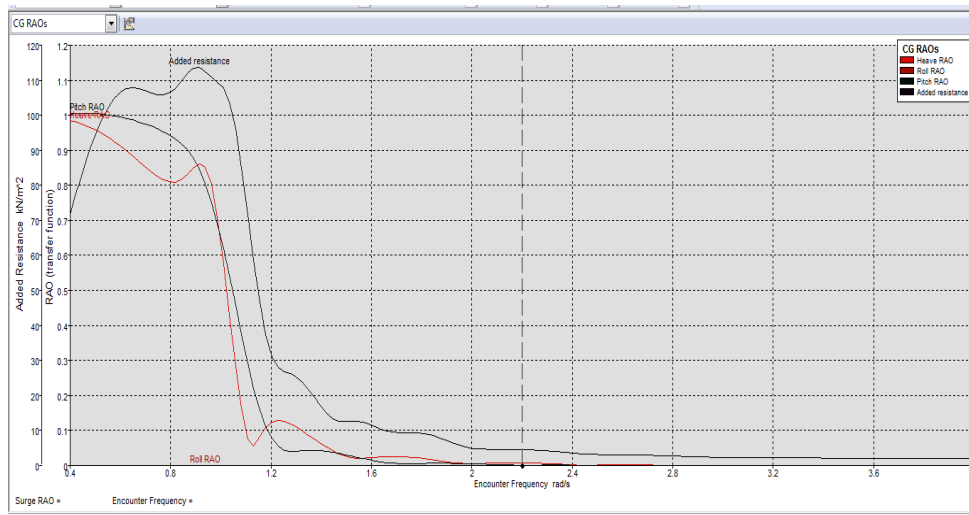
Based on calculation data and graphs at a speed of 6 knots, it can be concluded as follows:

a. The ROA roll value is 0 when the ship experiences head sea and following sea

b. Heave and pitch values all occur in all ship conditions

c. Pitch and heave ROA are almost the same size   when the ship is at an angle of 180 degrees and the Roll ROA value is 0

2.   Speed 12 knots and 0, 45, 90, 180 degrees

Kecepatan 2, 12 kn; Following seas, 0 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelen gth m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.175	0.200	1533.838	0.991	-0.2	0.000	0.0	1.126	84.1	24.378
2	0.203	0.238	1084.385	0.983	-0.3	0.000	0.0	1.144	83.0	33.693
3	0.228	0.277	805.476	0.970	-0.5	0.000	0.0	1.159	81.5	44.011
4	0.252	0.315	621.570	0.953	-0.8	0.000	0.0	1.168	80.0	54.837
5	0.275	0.353	494.114	0.928	-1.2	0.000	0.0	1.171	78.6	65.585
6	0.295	0.391	402.186	0.896	-1.7	0.000	0.0	1.165	77.2	75.596
7	0.313	0.430	333.715	0.855	-2.4	0.000	0.0	1.150	75.9	84.183
8	0.330	0.468	281.349	0.805	-3.2	0.000	0.0	1.125	74.7	90.72
9	0.345	0.506	240.408	0.745	-4.2	0.000	0.0	1.088	73.6	94.791
10	0.358	0.545	207.794	0.676	-5.6	0.000	0.0	1.038	72.6	96.397
11	0.369	0.583	181.392	0.599	-7.4	0.000	0.0	0.977	71.7	96.216
12	0.378	0.621	159.721	0.514	-9.8	0.000	0.0	0.903	70.9	95.887
13	0.386	0.659	141.713	0.425	-13.2	0.000	0.0	0.819	70.2	97.85
14	0.391	0.698	126.588	0.336	-18.5	0.000	0.0	0.725	69.5	103.762
15	0.395	0.736	113.761	0.251	-27.0	0.000	0.0	0.624	68.9	112.268
16	0.397	0.774	102.789	0.178	-42.1	0.000	0.0	0.519	68.3	119.792
17	0.397	0.813	93.331	0.132	-68.1	0.000	0.0	0.413	67.7	123.252
18	0.395	0.851	85.121	0.125	-100.2	0.000	0.0	0.311	66.8	121.451
19	0.391	0.889	77.949	0.144	-123.3	0.000	0.0	0.216	65.5	115.34
20	0.386	0.927	71.646	0.164	-136.2	0.000	0.0	0.131	62.8	107.93
21	0.379	0.966	66.078	0.173	-143.6	0.000	0.0	0.061	55.0	105.65
22	0.369	1.004	61.134	0.168	-148.3	0.000	0.0	0.016	-6.6	111.828
23	0.358	1.042	56.726	0.148	-151.7	0.000	0.0	0.038	-87.2	114.864
24	0.346	1.081	52.777	0.116	-154.9	0.000	0.0	0.059	-96.4	113.083
25	0.331	1.119	49.227	0.075	-159.8	0.000	0.0	0.066	-99.2	113.969
26	0.314	1.157	46.024	0.034	-174.6	0.000	0.0	0.062	-100.5	119.528
27	0.296	1.195	43.123	0.018	85.3	0.000	0.0	0.049	-101.8	121.048
28	0.276	1.234	40.488	0.046	49.4	0.000	0.0	0.032	-104.7	118.243
29	0.254	1.272	38.087	0.066	43.7	0.000	0.0	0.014	-116.1	113.54
30	0.230	1.310	35.894	0.073	42.4	0.000	0.0	0.006	153.0	111.724

◄ ► \ **CG RAOs** \ CG spectra \ Remote location RAOs \ Remote location spectra \ Global hydrodynamic coeffs.

Kecepatan 2, 12 kn; Beam Seas, 45 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelen gth m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.182	0.200	1533.838	0.989	0.3	0.734	88.3	0.729	89.9	24.375
2	0.221	0.249	997.075	0.981	0.3	0.748	87.9	0.785	85.1	36.507
3	0.258	0.297	698.194	0.969	0.1	0.764	87.5	0.830	80.7	50.288
4	0.292	0.346	515.885	0.951	-0.2	0.781	87.1	0.867	76.7	64.784
5	0.325	0.394	396.657	0.926	-0.9	0.801	86.6	0.893	73.1	78.821
6	0.355	0.443	314.448	0.893	-1.9	0.823	86.2	0.909	69.8	90.998
7	0.384	0.491	255.379	0.850	-3.4	0.846	85.8	0.914	66.8	99.88
8	0.410	0.540	211.516	0.796	-5.5	0.870	85.4	0.904	64.1	104.413
9	0.434	0.588	178.055	0.733	-8.5	0.894	85.0	0.880	61.7	104.757
10	0.456	0.637	151.949	0.662	-12.5	0.920	84.6	0.840	59.6	103.494
11	0.476	0.685	131.189	0.585	-18.0	0.945	84.2	0.783	57.9	105.887
12	0.494	0.734	114.411	0.508	-25.2	0.970	83.8	0.710	56.7	114.993
13	0.510	0.782	100.657	0.435	-34.5	0.994	83.5	0.625	56.1	125.67
14	0.524	0.831	89.242	0.372	-46.1	1.016	83.1	0.529	56.2	129.662
15	0.535	0.879	79.664	0.320	-59.4	1.036	82.8	0.429	57.3	122.519
16	0.545	0.928	71.550	0.278	-73.6	1.053	82.6	0.330	59.9	105.655
17	0.552	0.977	64.614	0.242	-87.7	1.067	82.4	0.238	64.6	85.726
18	0.557	1.025	58.641	0.206	-101.5	1.078	82.2	0.159	73.2	83.217
19	0.561	1.074	53.459	0.165	-115.7	1.084	82.1	0.097	89.0	89.744
20	0.562	1.122	48.934	0.124	-133.1	1.087	82.1	0.058	119.0	87.17
21	0.561	1.171	44.961	0.088	-158.8	1.084	82.1	0.045	161.6	84.514
22	0.558	1.219	41.453	0.073	164.9	1.078	82.2	0.046	-164.3	84.838
23	0.552	1.268	38.340	0.078	133.5	1.068	82.4	0.046	-140.4	80.412
24	0.545	1.316	35.564	0.085	115.9	1.054	82.6	0.043	-119.6	71.099
25	0.536	1.365	33.080	0.081	106.6	1.037	82.8	0.037	-97.7	68.248
26	0.524	1.413	30.847	0.062	101.2	1.017	83.1	0.031	-73.1	68.646
27	0.511	1.462	28.833	0.032	94.5	0.995	83.4	0.025	-46.0	65.991
28	0.495	1.510	27.010	0.007	-8.3	0.971	83.8	0.021	-17.7	61.243
29	0.477	1.559	25.354	0.031	-60.0	0.946	84.2	0.016	13.6	54.744
30	0.457	1.607	23.846	0.044	-59.6	0.921	84.6	0.012	54.0	48.908

CG RAOs / CG spectra / Remote location RAOs / Remote location spectra / Global hydrodynamic coeffs.

Kecepatan 2, 12 kn; Quarter seas, 90 deg

	Encounter freq. rad/s	Wave freq. rad/s	Wavelen gth m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
1	0.400	0.400	385.106	0.987	-0.2	1.216	85.6	0.239	26.5	85.194
2	0.409	0.409	368.544	0.987	-0.4	1.228	85.4	0.251	25.5	88
3	0.418	0.418	353.029	0.987	-0.6	1.241	85.3	0.263	24.6	90.744
4	0.427	0.427	338.472	0.986	-0.8	1.253	85.1	0.275	23.6	93.413
5	0.436	0.436	324.798	0.986	-1.0	1.267	85.0	0.287	22.7	95.995
6	0.444	0.444	311.936	0.986	-1.3	1.281	84.8	0.298	21.8	98.475
7	0.453	0.453	299.823	0.985	-1.6	1.296	84.6	0.309	21.0	100.842
8	0.462	0.462	288.402	0.985	-1.9	1.311	84.5	0.320	20.1	103.079
9	0.471	0.471	277.622	0.984	-2.2	1.327	84.3	0.331	19.2	105.173
10	0.480	0.480	267.435	0.983	-2.6	1.343	84.1	0.342	18.4	107.109
11	0.504	0.504	242.449	0.982	-3.7	1.392	83.6	0.369	16.2	111.449
12	0.528	0.528	220.808	0.979	-5.0	1.448	83.0	0.395	14.0	114.219
13	0.552	0.552	201.940	0.976	-6.6	1.510	82.4	0.420	11.8	115.129
14	0.577	0.577	185.392	0.974	-8.5	1.582	81.7	0.442	9.7	113.945
15	0.601	0.601	170.797	0.971	-10.7	1.663	80.8	0.463	7.6	110.515
16	0.625	0.625	157.860	0.968	-13.4	1.757	79.9	0.482	5.6	104.81
17	0.649	0.649	146.339	0.967	-16.5	1.867	78.9	0.499	3.5	96.993
18	0.673	0.673	136.035	0.968	-20.1	1.995	77.7	0.513	1.5	87.589
19	0.697	0.697	126.782	0.971	-24.3	2.146	76.2	0.526	-0.6	77.761
20	0.721	0.721	118.442	0.980	-29.1	2.328	74.5	0.536	-2.7	69.985
21	0.745	0.745	110.898	0.995	-34.7	2.548	72.4	0.544	-4.9	68.314
22	0.770	0.770	104.053	1.020	-41.0	2.819	69.8	0.548	-7.3	74.423
23	0.794	0.794	97.823	1.055	-47.9	3.158	66.5	0.549	-9.9	85.055
24	0.818	0.818	92.136	1.105	-55.5	3.586	62.2	0.546	-12.8	96.476
25	0.842	0.842	86.931	1.168	-63.6	4.132	56.4	0.538	-16.3	106.475
26	0.866	0.866	82.155	1.245	-72.0	4.819	48.4	0.523	-20.4	113.938
27	0.890	0.890	77.762	1.329	-80.7	5.625	37.1	0.500	-25.5	118.571
28	0.914	0.914	73.712	1.414	-89.5	6.378	21.8	0.467	-31.8	120.819
29	0.938	0.938	69.970	1.490	-98.1	6.684	3.0	0.423	-39.5	121.589
30	0.963	0.963	66.506	1.551	-106.3	6.275	-15.9	0.367	-48.9	121.573

CG RAOs / CG spectra / Remote location RAOs / Remote location spectra / Global hydrodynamic coeffs.

	Encounter freq. rad/s	Wave freq. rad/s	Wavelen gth m	Heave RA	Heave Phase deg	Roll RA	Roll Phase deg	Pitch R	Pitch Phase deg	Added resistance kN/m^2
	Kecepatan 2, 12 kn; Head Seas, 180 deg									
1	0.400	0.331	562.321	1.011	-0.8	0.000	85.6	1.019	-92.8	63.932
2	0.409	0.337	541.653	1.011	-0.9	0.000	85.4	1.021	-93.0	66.041
3	0.418	0.344	522.208	1.012	-0.9	0.000	85.3	1.023	-93.2	68.142
4	0.427	0.350	503.889	1.012	-1.0	0.000	85.1	1.025	-93.5	70.232
5	0.436	0.356	486.608	1.012	-1.0	0.000	85.0	1.027	-93.7	72.31
6	0.444	0.362	470.287	1.013	-1.1	0.000	84.8	1.029	-94.0	74.372
7	0.453	0.368	454.852	1.013	-1.2	0.000	84.6	1.030	-94.3	76.416
8	0.462	0.374	440.240	1.013	-1.3	0.000	84.5	1.032	-94.6	78.439
9	0.471	0.380	426.391	1.014	-1.3	0.000	84.3	1.034	-94.9	80.439
10	0.480	0.386	413.251	1.014	-1.4	0.000	84.1	1.036	-95.2	82.412
11	0.504	0.402	380.785	1.015	-1.6	0.000	83.6	1.042	-96.1	87.62
12	0.528	0.418	352.361	1.016	-1.8	0.000	83.0	1.047	-97.1	92.575
13	0.552	0.434	327.316	1.018	-2.1	0.000	82.4	1.053	-98.2	97.232
14	0.577	0.449	305.118	1.020	-2.4	0.000	81.7	1.059	-99.3	101.558
15	0.601	0.465	285.338	1.022	-2.7	0.000	80.8	1.066	-100.6	105.537
16	0.625	0.480	267.627	1.026	-3.0	0.000	79.9	1.072	-102.0	109.161
17	0.649	0.495	251.695	1.031	-3.3	0.000	78.9	1.079	-103.6	112.426
18	0.673	0.510	237.304	1.038	-3.7	0.000	77.7	1.086	-105.2	115.366
19	0.697	0.524	224.255	1.048	-4.1	0.000	76.2	1.094	-107.1	118.027
20	0.721	0.539	212.380	1.061	-4.6	0.000	74.5	1.101	-109.1	120.498
21	0.745	0.553	201.536	1.080	-5.3	0.000	72.4	1.109	-111.4	122.939
22	0.770	0.567	191.604	1.106	-6.1	0.000	69.8	1.117	-113.9	125.435
23	0.794	0.581	182.480	1.141	-7.3	0.000	66.5	1.125	-116.8	128.095
24	0.818	0.595	174.075	1.187	-8.9	0.000	62.2	1.132	-119.9	130.965
25	0.842	0.609	166.312	1.246	-11.3	0.000	56.4	1.137	-123.4	133.933
26	0.866	0.622	159.125	1.320	-14.8	0.000	48.4	1.141	-127.3	136.591
27	0.890	0.636	152.456	1.405	-19.7	0.000	37.1	1.142	-131.6	138.098
28	0.914	0.649	146.255	1.493	-26.3	0.000	21.8	1.141	-136.2	137.159
29	0.938	0.662	140.476	1.569	-35.0	0.000	3.0	1.141	-141.3	132.339
30	0.963	0.675	135.080	1.613	-45.7	0.000	-15.9	1.143	-147.1	122.871

◄ ► λ **CG RAOs** λ CG spectra λ Remote location RAOs λ Remote location spectra λ Global hydrodynamic coeffs

Chart
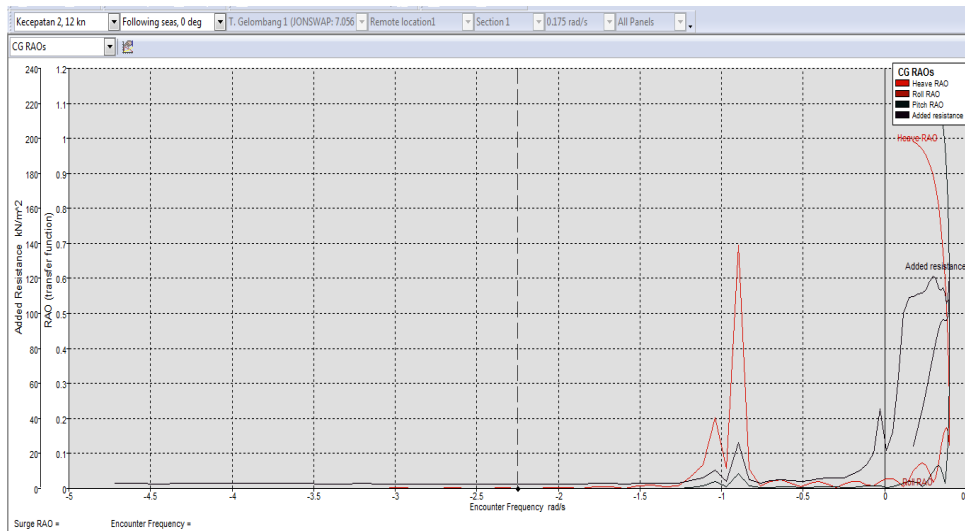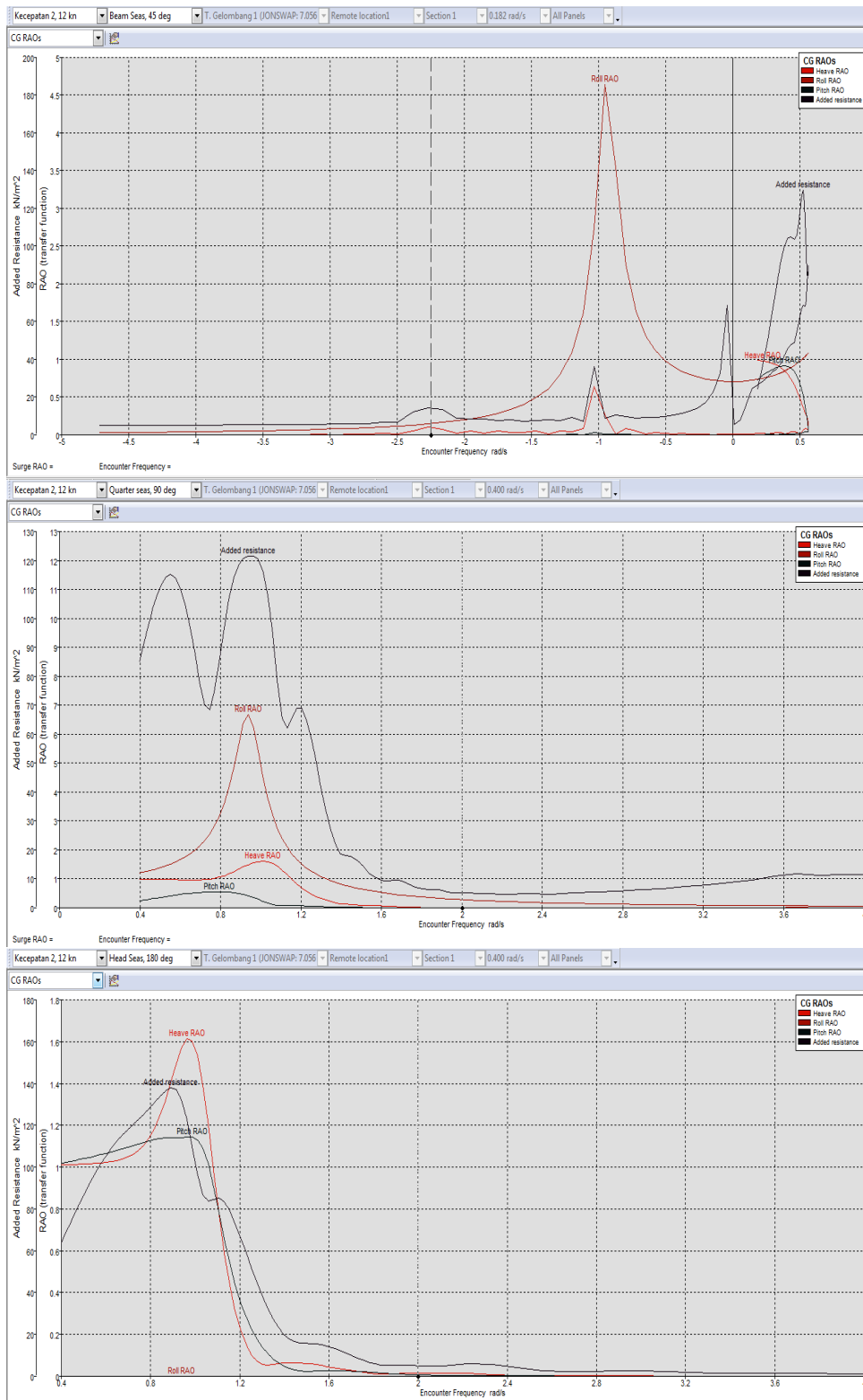
Based on the calculation data and graph above at a speed of 12 knots it can be concluded:

a.   The ROA roll value is 0 when the ship experiences head sea and following sea

b.   Heave and pitch values all occur in all ship conditions

c.   A larger RAO roll occurs at a beam seas angle (45 degrees). And there is no roll at a 180 degree angle.

4. Conclusions

Based on calculations that have been carried out using Maxsurf Seakeeper Motion software. In different speed conditions, namely 6 and 12 knots with wave heights of 1 – 3 meters. At a speed of 12 knots, the heave ROA occurs greater than at 6 knots. And at a speed of 6 knots, Roll ROA occurs greater than 12 knots. So it can be concluded that the greater the speed of the ship, the more likely it is that a very high heave will occur but there will be minimal roll.

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