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LAMPIRAN

Lampiran 1 Hasil *wall calculator drag force* model kapal

- Trim Haluan -1,441 m

Summary			

Total area	19867	cm^2	
TOTAL FX	-6.044	Newton	
TOTAL FY	-0.189008	Newton	
TOTAL FZ	-30.3169	Newton	
Center of Force about X-Axis (Y-Z)	416.863	283.063	cm
Center of Force about Y-Axis (X-Z)	364.381	281.794	cm
Center of Force about Z-Axis (X-Y)	390.059	416.705	cm

- Trim Haluan -1 m

Summary			

Total area	19963.1	cm^2	
TOTAL FX	-5.926	Newton	
TOTAL FY	-0.0355198	Newton	
TOTAL FZ	-29.9126	Newton	
Center of Force about X-Axis (Y-Z)	416.736	283.208	cm
Center of Force about Y-Axis (X-Z)	270.021	285.136	cm
Center of Force about Z-Axis (X-Y)	389.162	416.789	cm

- Trim Haluan -0,5 m

Summary			

Total area	20019.3	cm^2	
TOTAL FX	-5.822	Newton	
TOTAL FY	-0.0280283	Newton	
TOTAL FZ	-29.5605	Newton	
Center of Force about X-Axis (Y-Z)	416.582	283.159	cm
Center of Force about Y-Axis (X-Z)	142.761	268.036	cm
Center of Force about Z-Axis (X-Y)	387.268	416.82	cm

- Even Keel

Summary			

Total area	20082.7	cm^2	
TOTAL FX	-5.740	Newton	
TOTAL FY	-0.0245411	Newton	
TOTAL FZ	-29.0037	Newton	
Center of Force about X-Axis (Y-Z)	416.641	283.103	cm
Center of Force about Y-Axis (X-Z)	327.007	272.433	cm
Center of Force about Z-Axis (X-Y)	384.812	416.845	cm

- Trim Buritan 0,5 m

Summary			

Total area	20152.7	cm^2	
TOTAL FX	-5.674	Newton	
TOTAL FY	0.111884	Newton	
TOTAL FZ	-28.6855	Newton	
Center of Force about X-Axis (Y-Z)	416.534	283.034	cm
Center of Force about Y-Axis (X-Z)	497.734	282.938	cm
Center of Force about Z-Axis (X-Y)	382.558	416.87	cm

- Trim Buritan 1 m

Summary			

Total area	20222.4	cm^2	
TOTAL FX	-5.690	Newton	
TOTAL FY	-0.0473916	Newton	
TOTAL FZ	-28.3387	Newton	
Center of Force about X-Axis (Y-Z)	416.866	283.106	cm
Center of Force about Y-Axis (X-Z)	501.861	293.776	cm
Center of Force about Z-Axis (X-Y)	380.255	416.86	cm

- Trim Buritan 1,441 m

Summary			

Total area	20233.2	cm^2	
TOTAL FX	-5.846	Newton	
TOTAL FY	0.00419925	Newton	
TOTAL FZ	-27.9344	Newton	
Center of Force about X-Axis (Y-Z)	416.73	283.081	cm
Center of Force about Y-Axis (X-Z)	924.844	375.465	cm
Center of Force about Z-Axis (X-Y)	377.401	416.796	cm

Lampiran 2 Penentuan Skala Model

Prosedur pembuatan model kapal mengikuti rekomendasi ITTC. Ukuran model uji menyesuaikan ukuran fasilitas uji towing tank di UPT BPPH – BPPT yang berukuran panjang kolam Tarik 235,4 m, lebar 11 m dan kedalaman 5,5 m.

Penentuan skala dilakukan untuk menghindari terjadinya ombak pada dinding tangki atau yang disebut *blockage effect*, dimana model harus disesuaikan dengan ukuran tangki serta tinggi air dalam tangki dengan sarat model. Menurut Harvald, penentuan lebar model (Bm) adalah sebagai berikut:

$$Bm < (1/10)\ B\ Tangki$$

Diketahui:

B tangki = 11 m

= (1/10) x 11

= 1,1 m

Maka lebar model yang digunakan agar tidak menimbulkan *blockage effect* dan dapat digunakan untuk pengujian model di towing tank yaitu:

$$Bm < 1{,}1$$

Berdasarkan perhitungan dari persamaan diatas, maka penentuan ukuran lebar model kapal (Bm) maksimal yang memenuhi kriteria yaitu 1,1 m, sehingga skala yang digunakan untuk ukuran model kapal yaitu 1:50. Adapun data ukuran model kapal dari hasil skala model dapat dilihat pada tabel berikut.

Ukuran model kapal skala 1:50

No.	Ukuran Utama	Nilai (m)
1	Length Over All (LOA)	1,978
2	Length Between Perpendicular ((LBP)	1,840
3	Length Water Line (LWL)	1,890
4	Breadth (B)	0.470
5	Height (H)	0.200
6	Draft (T)	0.130

Lampiran 3 Penentuan Kecepatan Model Kapal

Kesamaan kinematis antara model dan kapal lebih menitik beratkan pada hubungan antara kecepatan model dengan kecepatan kapal sebenarnya. Dengan adanya skala yang menunjukkan hubungan antara kecepatan model dan kecepatan kapal yang sebenarnya maka dapat dikatakan bahwa kesamaan kinematis bisa terpenuhi.

$$Fn = \frac{V}{\sqrt{g.L}}$$

Atau :

$$\frac{Vm}{\sqrt{g.Lm}} = \frac{Vs}{\sqrt{g.Ls}}$$

Maka

$$Fn_s = \frac{Vs}{\sqrt{g.Ls}}$$

$$= \frac{5{,}658}{\sqrt{9{,}81 \times 92}}$$

$$= 0{,}188$$

$Fn_s = Fn_m = 0{,}188$

Maka,

$$Fn_m = \frac{Vm}{\sqrt{g.Lm}}$$

$$0{,}188 = \frac{Vm}{\sqrt{9{,}81 \times 1{,}84}}$$

$Vm = 0{,}8$ m/s

Lampiran 4 Data *Hydrostatics* dari setiap variasi trim

- Kondisi Trim Haluan

	Draft Amidships m	6.498
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	7.218
4	Draft at AP m	5.777
5	Draft at LCF m	6.511
6	Trim (+ve by stern) m	-1.441
7	WL Length m	94.038
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2902.81
10	Waterpl. Area m^2	1971.95
11	Prismatic coeff. (Cp)	0.781
12	Block coeff. (Cb)	0.738
13	Max Sect. area coeff. (Cm)	0.990
14	Waterpl. area coeff. (Cwp)	0.892
15	LCB from zero pt. (+ve fwd) m	50.597
16	LCF from zero pt. (+ve fwd) m	46.869
17	KB m	3.394
18	KG m	6.500
19	BMt m	7.007
20	BML m	101.940
21	GMt m	3.829
22	GML m	98.761
23	KMt m	10.400
24	KML m	105.321
25	Immersion (TPc) tonne/cm	20.213
26	MTc tonne.m	129.334
27	RM at 1deg = GMt.Disp.sin(1) to	805.090
28	Max deck inclination deg	0.8974
29	Trim angle (+ve by stern) deg	-0.8974

Trim Haluan -1,441 m

	Draft Amidships m	6.501
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	7.001
4	Draft at AP m	6.001
5	Draft at LCF m	6.506
6	Trim (+ve by stern) m	-1.000
7	WL Length m	94.619
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2915.64
10	Waterpl. Area m^2	1986.65
11	Prismatic coeff. (Cp)	0.789
12	Block coeff. (Cb)	0.756
13	Max Sect. area coeff. (Cm)	0.990
14	Waterpl. area coeff. (Cwp)	0.893
15	LCB from zero pt. (+ve fwd) m	50.102
16	LCF from zero pt. (+ve fwd) m	46.448
17	KB m	3.387
18	KG m	6.900
19	BMt m	7.041
20	BML m	104.449
21	GMt m	3.497
22	GML m	100.904
23	KMt m	10.428
24	KML m	107.830
25	Immersion (TPc) tonne/cm	20.363
26	MTc tonne.m	132.141
27	RM at 1deg = GMt.Disp.sin(1) to	735.236
28	Max deck inclination deg	0.6228
29	Trim angle (+ve by stern) deg	-0.6228

Trim Haluan -1 m

	Draft Amidships m	6.502
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	6.752
4	Draft at AP m	6.252
5	Draft at LCF m	6.503
6	Trim (+ve by stern) m	-0.500
7	WL Length m	94.513
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2925.63
10	Waterpl. Area m^2	1998.68
11	Prismatic coeff. (Cp)	0.805
12	Block coeff. (Cb)	0.784
13	Max Sect. area coeff. (Cm)	0.994
14	Waterpl. area coeff. (Cwp)	0.900
15	LCB from zero pt. (+ve fwd) m	49.529
16	LCF from zero pt. (+ve fwd) m	46.103
17	KB m	3.382
18	KG m	6.900
19	BMt m	7.080
20	BML m	106.389
21	GMt m	3.549
22	GML m	102.859
23	KMt m	10.462
24	KML m	109.770
25	Immersion (TPc) tonne/cm	20.486
26	MTc tonne.m	134.700
27	RM at 1deg = GMt.Disp.sin(1) to	746.299
28	Max deck inclination deg	0.3114
29	Trim angle (+ve by stern) deg	-0.3114

Trim Haluan -0,5 m

- Kondisi Even Keel

	Draft Amidships m	6.502
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	6.502
4	Draft at AP m	6.502
5	Draft at LCF m	6.502
6	Trim (+ve by stern) m	0.000
7	WL Length m	94.500
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2933.73
10	Waterpl. Area m^2	2008.88
11	Prismatic coeff. (Cp)	0.818
12	Block coeff. (Cb)	0.814
13	Max Sect. area coeff. (Cm)	0.995
14	Waterpl. area coeff. (Cwp)	0.905
15	LCB from zero pt. (+ve fwd) m	48.946
16	LCF from zero pt. (+ve fwd) m	45.815
17	KB m	3.381
18	KG m	6.900
19	BMt m	7.119
20	BML m	107.989
21	GMt m	3.599
22	GML m	104.469
23	KMt m	10.499
24	KML m	111.369
25	Immersion (TPc) tonne/cm	20.591
26	MTc tonne.m	136.809
27	RM at 1deg = GMt.Disp.sin(1) to	756.803
28	Max deck inclination deg	0.0000
29	Trim angle (+ve by stern) deg	0.0000

Even Keel

- Kondisi Trim Buritan

	Draft Amidships m	6.500
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	6.250
4	Draft at AP m	6.750
5	Draft at LCF m	6.503
6	Trim (+ve by stern) m	0.500
7	WL Length m	94.501
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2940.50
10	Waterpl. Area m^2	2018.31
11	Prismatic coeff. (Cp)	0.812
12	Block coeff. (Cb)	0.786
13	Max Sect. area coeff. (Cm)	0.993
14	Waterpl. area coeff. (Cwp)	0.909
15	LCB from zero pt. (+ve fwd) m	48.355
16	LCF from zero pt. (+ve fwd) m	45.576
17	KB m	3.382
18	KG m	6.900
19	BMt m	7.158
20	BML m	109.434
21	GMt m	3.647
22	GML m	105.923
23	KMt m	10.541
24	KML m	112.815
25	Immersion (TPc) tonne/cm	20.688
26	MTc tonne.m	138.712
27	RM at 1deg = GMt.Disp.sin(1) to	766.828
28	Max deck inclination deg	0.3114
29	Trim angle (+ve by stern) deg	0.3114

Trim Buritan 0,5 m

	Draft Amidships m	6.497
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	5.997
4	Draft at AP m	6.997
5	Draft at LCF m	6.504
6	Trim (+ve by stern) m	1.000
7	WL Length m	94.585
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2946.02
10	Waterpl. Area m^2	2027.06
11	Prismatic coeff. (Cp)	0.803
12	Block coeff. (Cb)	0.759
13	Max Sect. area coeff. (Cm)	0.991
14	Waterpl. area coeff. (Cwp)	0.912
15	LCB from zero pt. (+ve fwd) m	47.757
16	LCF from zero pt. (+ve fwd) m	45.372
17	KB m	3.387
18	KG m	6.900
19	BMt m	7.198
20	BML m	110.765
21	GMt m	3.691
22	GML m	107.258
23	KMt m	10.584
24	KML m	114.145
25	Immersion (TPc) tonne/cm	20.777
26	MTc tonne.m	140.461
27	RM at 1deg = GMt.Disp.sin(1) to	776.112
28	Max deck inclination deg	0.6228
29	Trim angle (+ve by stern) deg	0.6228

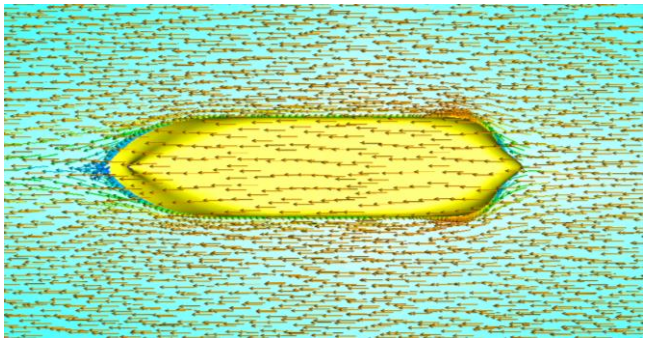
Trim Buritan 1 m

	Draft Amidships m	6.494
1	Displacement t	12048
2	Heel deg	0.0
3	Draft at FP m	5.773
4	Draft at AP m	7.214
5	Draft at LCF m	6.506
6	Trim (+ve by stern) m	1.441
7	WL Length m	94.734
8	Beam max extents on WL m	23.500
9	Wetted Area m^2	2949.54
10	Waterpl. Area m^2	2034.38
11	Prismatic coeff. (Cp)	0.795
12	Block coeff. (Cb)	0.737
13	Max Sect. area coeff. (Cm)	0.991
14	Waterpl. area coeff. (Cwp)	0.914
15	LCB from zero pt. (+ve fwd) m	47.224
16	LCF from zero pt. (+ve fwd) m	45.227
17	KB m	3.394
18	KG m	6.900
19	BMt m	7.231
20	BML m	111.879
21	GMt m	3.726
22	GML m	108.374
23	KMt m	10.624
24	KML m	115.260
25	Immersion (TPc) tonne/cm	20.852
26	MTc tonne.m	141.923
27	RM at 1deg = GMt.Disp.sin(1) to	783.409
28	Max deck inclination deg	0.8974
29	Trim angle (+ve by stern) deg	0.8974

Trim Buritan 1,441 m

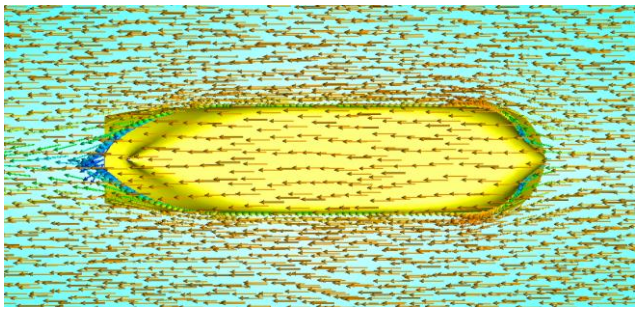
Lampiran 5 Visualisasi *velocity magnitude* tampak bawah disertai dengan vektor

- Kondisi 1



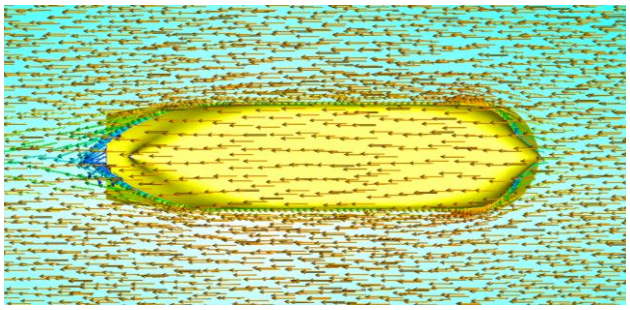
Gambar Visualisasi *velocity magnitude* kondisi trim -1,441 m

- Kondisi 2



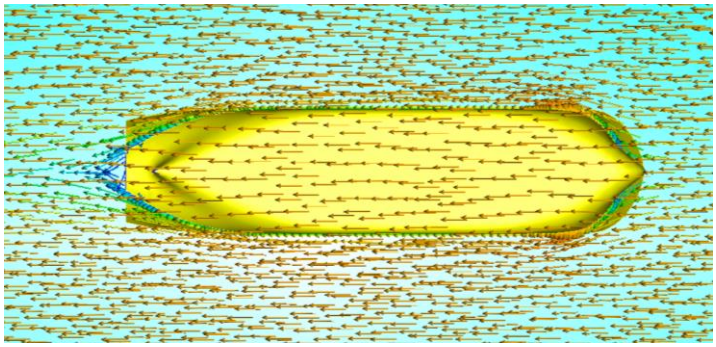
Gambar Visualisasi *velocity magnitude* kondisi trim -1 m

- Kondisi 3



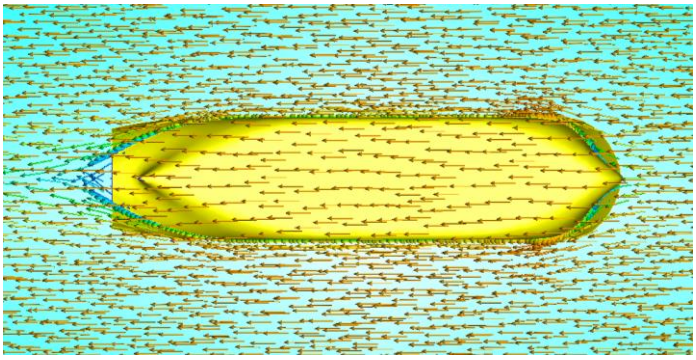
Gambar Visualisasi *velocity magnitude* kondisi trim -0,5 m

- Kondisi 4



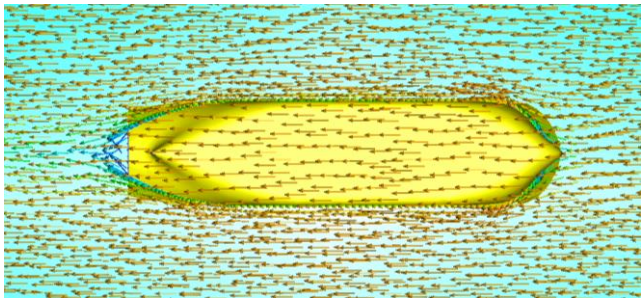
Gambar Visualisasi *velocity magnitude* kondisi even keel

- Kondisi 5



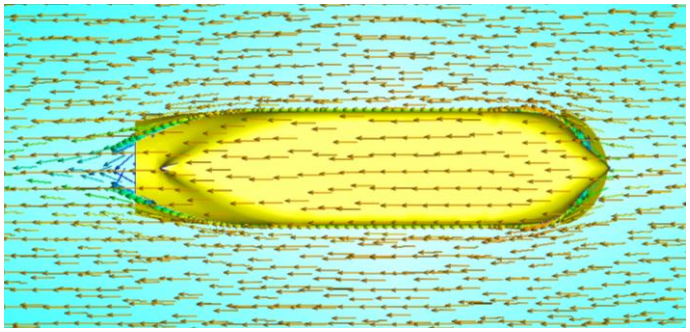
Gambar Visualisasi *velocity magnitude* kondisi trim 0,5 m

- Kondisi 6



Gambar Visualisasi *velocity magnitude* kondisi trim 1 m

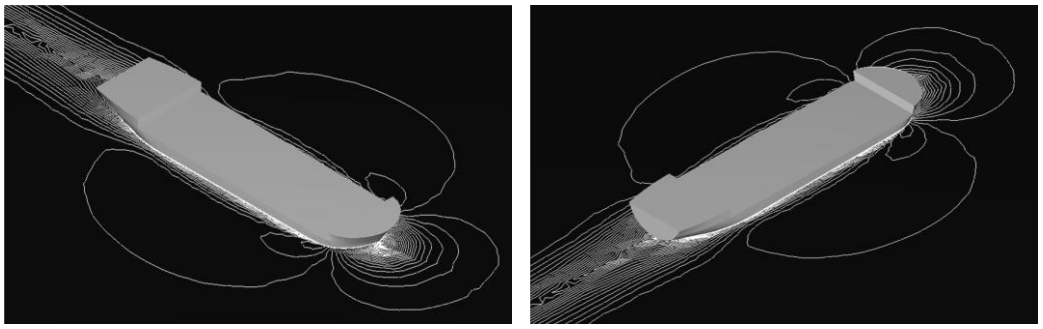
- Kondisi 7



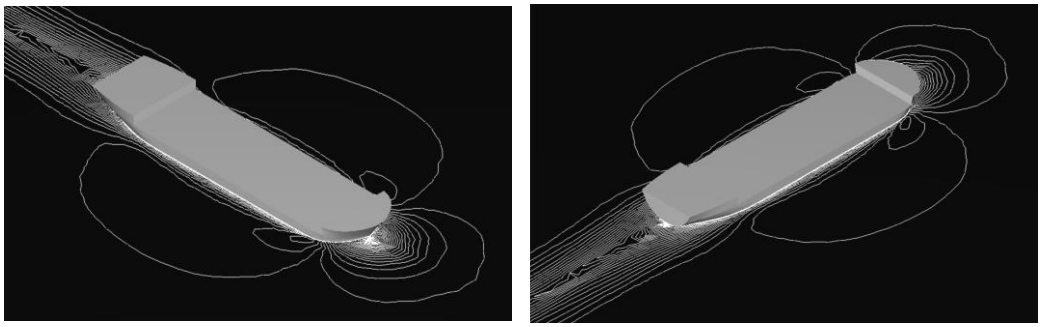
Gambar Visualisasi *velocity magnitude* kondisi trim 1,441 m

Lampiran 6 Visualisasi Pola Gelombang

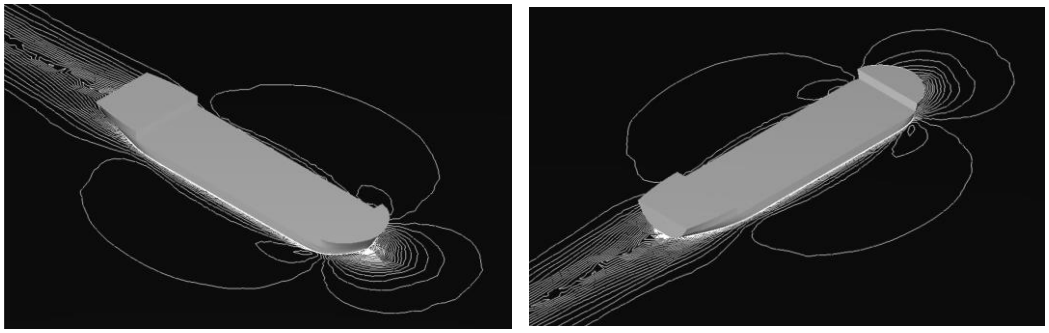
- Kondisi Trim Haluan



Trim -1,441 m



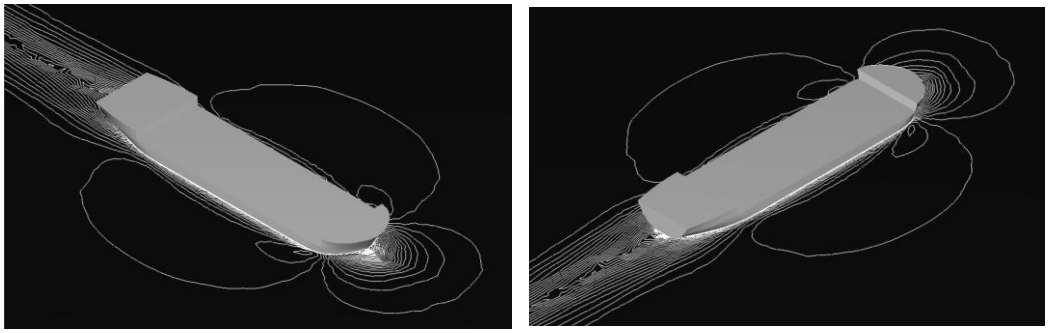
Trim -1 m



Trim -0,5 m

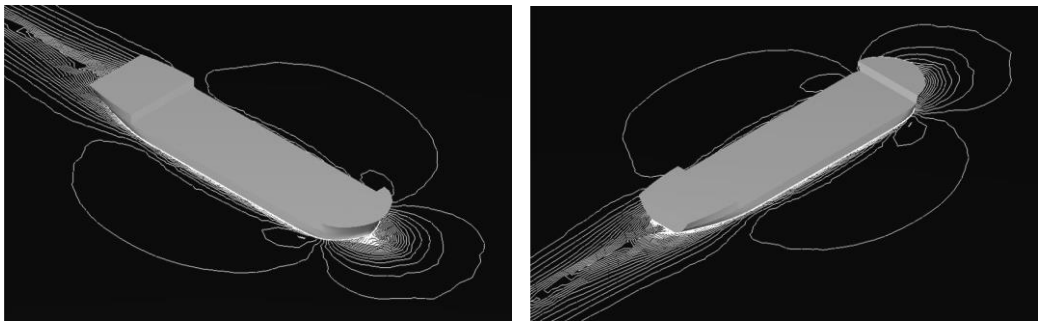
Gambar Visualisasi pola gelombang kondisi trim haluan

- Kondisi *Even Keel*

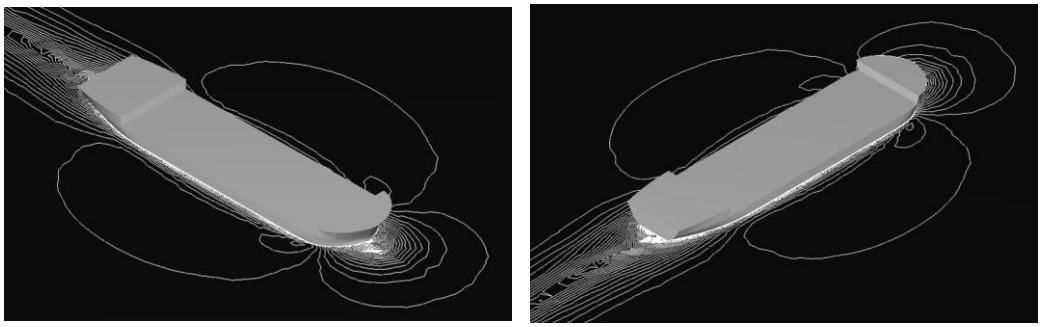


Gambar Visualisasi pola gelombang kondisi *even keel*

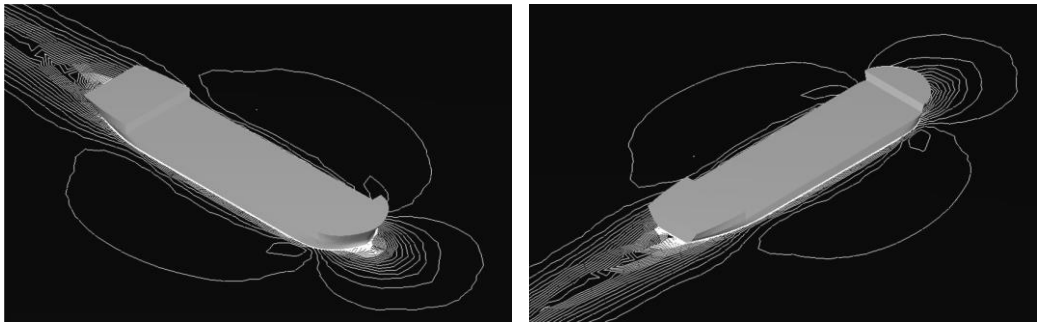
- Kondisi Trim Buritan



Trim 0,5 ,m



Trim 1 m



Trim 1,441 m

Gambar Visualiasi pola gelombang kondisi trim buritan