

## DAFTAR PUSTAKA

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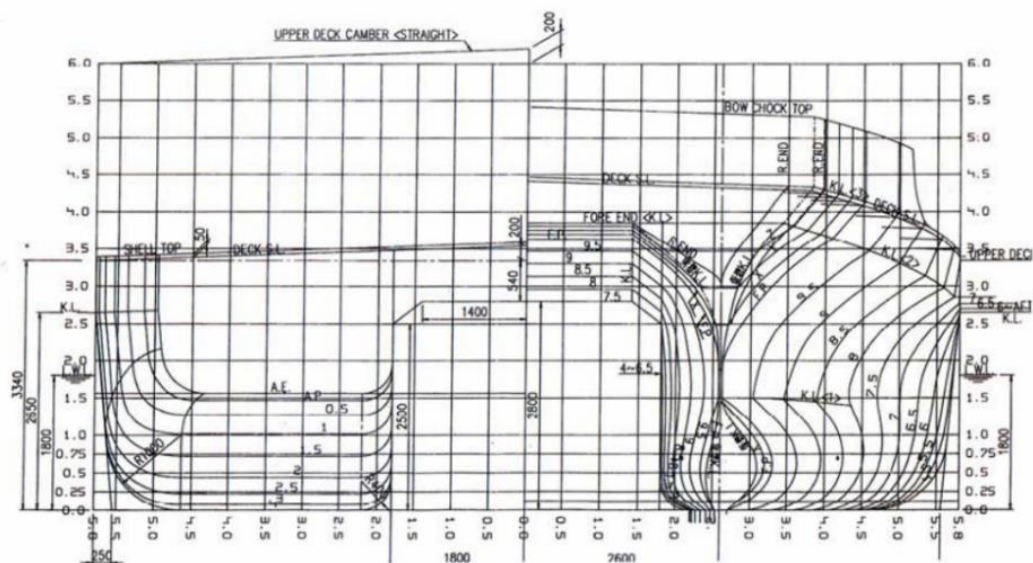
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# **LAMPIRAN**

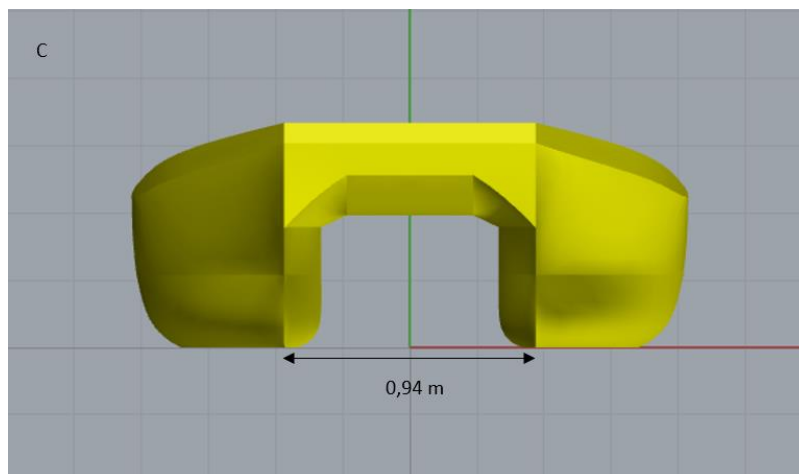
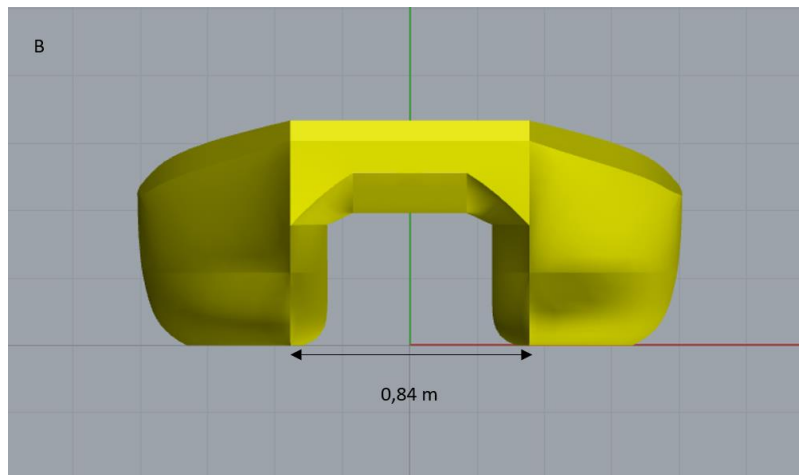
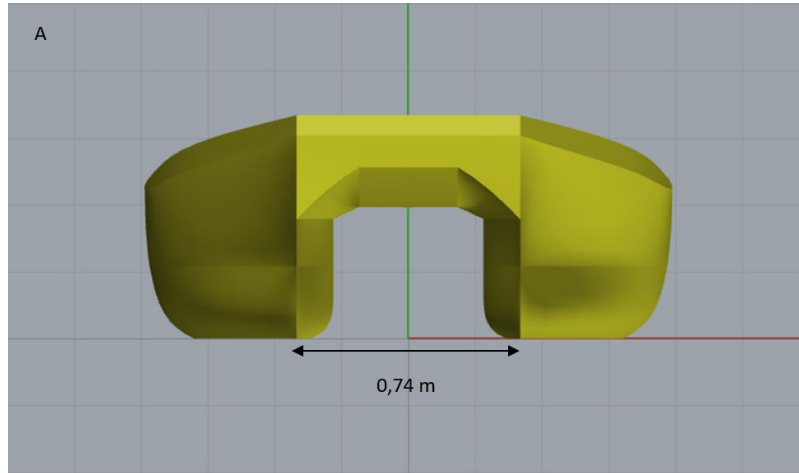
## Lampiran 1 Ukuran Utama dan Body Plan

Parameter	Dimensi
LBP (m)	28 m
LWL (m)	28,8 m
B (m)	4 m
H (m)	3,34 m
D (m)	1,7 m
W (m)	11,6 m
V (knot)	14,5 <i>knot</i>

Body Plan kapal katamaran



## Lampiran 2 Model katamaran berdasarkan jarak antar lambung



### Lampiran 3 Data hidrostatik model dari Maxsurf

#### Model A

Hydrostatics at DWL

	Measurement	Value	Units
1	Displacement	171,9	t
2	Volume (displaced)	167,685	m <sup>3</sup>
3	Draft Amidships	1,700	m
4	Immersed depth	1,700	m
5	WL Length	28,111	m
6	Beam max extents on WL	7,986	m
7	Wetted Area	269,653	m <sup>2</sup>
8	Max sect. area	8,672	m <sup>2</sup>
9	Waterpl. Area	114,954	m <sup>2</sup>
10	Prismatic coeff. (Cp)	0,688	
11	Block coeff. (Cb)	0,439	
12	Max Sect. area coeff. (Cm)	0,639	
13	Waterpl. area coeff. (Cwp)	0,512	
14	LCB length	0,008	from zero pt. (+ve fwd)
15	LCF length	-1,001	from zero pt. (+ve fwd)
16	LCB %	0,028	from zero pt. (+ve fwd)
17	LCF %	-3,560	from zero pt. (+ve fwd)
18	KB	0,919	m
19	KG fluid	0,000	m
20	BMt	4,470	m
21	BML	29,610	m
22	GMt corrected	5,389	m
23	GML	30,529	m
24	KMt	5,389	m
25	KML	30,529	m
26	Immersion (TPc)	1,178	tonne/cm
27	MTc	0,000	tonne.m
28	RM at 1deg = GMt.Disp.si	16,166	tonne.m
29	Length:Beam ratio	3,520	
30	Beam:Draft ratio	4,697	
31	Length:Vol <sup>0.333</sup> ratio	5,098	
32	Precision	Highest	212 stations

## Model B

### Hydrostatics at DWL

	Measurement	Value	Units
1	Displacement	171,8	t
2	Volume (displaced)	167,627	m <sup>3</sup>
3	Draft Amidships	-1,700	m
4	Immersed depth	1,700	m
5	WL Length	28,111	m
6	Beam max extents on WL	7,785	m
7	Wetted Area	269,653	m <sup>2</sup>
8	Max sect. area	8,671	m <sup>2</sup>
9	Waterpl. Area	114,950	m <sup>2</sup>
10	Prismatic coeff. (Cp)	0,688	
11	Block coeff. (Cb)	0,632	
12	Max Sect. area coeff. (Cm)	0,920	
13	Waterpl. area coeff. (Cwp)	0,737	
14	LCB length	0,010	from zero pt. (+ve fwd)
15	LCF length	-1,000	from zero pt. (+ve fwd)
16	LCB %	0,035	from zero pt. (+ve fwd)
17	LCF %	-3,557	from zero pt. (+ve fwd)
18	KB	-2,481	m
19	KG fluid	-1,700	m
20	BMt	4,143	m
21	BML	29,622	m
22	GMt corrected	3,362	m
23	GML	28,842	m
24	KMt	1,662	m
25	KML	27,142	m
26	Immersion (TPc)	1,178	tonne/cm
27	MTc	0,000	tonne.m
28	RM at 1deg = GMt.Disp.si	10,082	tonne.m
29	Length:Beam ratio	5,066	
30	Beam:Draft ratio	3,264	
31	Length:Vol <sup>0.333</sup> ratio	5,098	
32	Precision	High	112 stations

## Model C

### Hydrostatics at DWL

	Measurement	Value	Units
1	Displacement	171,9	t
2	Volume (displaced)	167,685	m <sup>3</sup>
3	Draft Amidships	1,700	m
4	Immersed depth	1,700	m
5	WL Length	28,111	m
6	Beam max extents on WL	8,188	m
7	Wetted Area	269,653	m <sup>2</sup>
8	Max sect. area	8,672	m <sup>2</sup>
9	Waterpl. Area	114,954	m <sup>2</sup>
10	Prismatic coeff. (Cp)	0,688	
11	Block coeff. (Cb)	0,429	
12	Max Sect. area coeff. (Cm)	0,623	
13	Waterpl. area coeff. (Cwp)	0,499	
14	LCB length	0,008	from zero pt. (+ve fwd)
15	LCF length	-1,001	from zero pt. (+ve fwd)
16	LCB %	0,028	from zero pt. (+ve fwd)
17	LCF %	-3,560	from zero pt. (+ve fwd)
18	KB	0,919	m
19	KG fluid	0,000	m
20	BMt	4,817	m
21	BML	29,610	m
22	GMt corrected	5,737	m
23	GML	30,529	m
24	KMt	5,737	m
25	KML	30,529	m
26	Immersion (TPc)	1,178	tonne/cm
27	MTc	0,000	tonne.m
28	RM at 1deg = GMt.Disp.si	17,208	tonne.m
29	Length:Beam ratio	3,433	
30	Beam:Draft ratio	4,817	
31	Length:Vol <sup>0.333</sup> ratio	5,098	
32	Precision	Highest	212 stations



#### Lampiran 4 Pengaturan setup CFD untuk *drift test*

##### *Domain Model*

No	Parameter	Keterangan
1	<i>Angle</i>	<i>0, 5, 10, 15, 20 (degrees)</i>
2	<i>Domain type</i>	<i>Immersed solid</i>
3	<i>Domain motion</i>	<i>Stationary</i>

##### *Domain Fluida*

No	Parameter	Keterangan
1	<i>Domain type</i>	<i>Fluid domain</i>
2	<i>Material</i>	<i>Water</i>
3	<i>Morphology</i>	<i>Continous fluid</i>
4	<i>Buoyancy model</i>	<i>Non bouyant</i>
5	<i>Domain motion</i>	<i>Stationary</i>
6	<i>Mesh deformation</i>	<i>None</i>
7	<i>Heat transfer</i>	<i>None</i>
8	<i>Turbulunce</i>	<i>Shear stress transport</i>
9	<i>Wall function</i>	<i>Automatic</i>
10	<i>Combustion</i>	<i>None</i>
11	<i>Thermal radiation</i>	<i>None</i>
12	<i>Velocity type</i>	<i>Cartesian</i>
13	<i>Cartesian Velocity Componen</i>	<i>Automatic With Value <math>U=0 \text{ m/s}^l</math>, <math>V=0 \text{ m/s}^l</math>, <math>W=0 \text{ m/s}^l</math></i>
14	<i>Static pressure</i>	<i>1 atm</i>

##### **Inlet**

1	<i>Flow Regime</i>	<i>Subsonic</i>
2	<i>Mass and Momentum</i>	<i>Normal speed (7,4588 m/s)</i>
3	<i>Turbulence</i>	<i>Medium (Intensity 5%)</i>

##### **Outlet**

1	<i>Flow Regime</i>	<i>Subsonic</i>
2	<i>Mass and Momentum</i>	<i>Static pressure</i>

3	<i>Relative Pressure</i>	<i>1 atm</i>
<b>Wall</b>		
1	<i>Boundary type</i>	<i>opening</i>
2	<i>Flow Regime</i>	<i>Subsonic</i>
3	<i>Mass and Momentum</i>	<i>Opening pres and dirn</i>
4	<i>Flow direction</i>	<i>Normal to boundary condition</i>
5	<i>Turbulence</i>	<i>Medium (Intensity 5%)</i>

## Lampiran 5 Pengaturan setup CFD untuk *turning circle*

### *Domain Model*

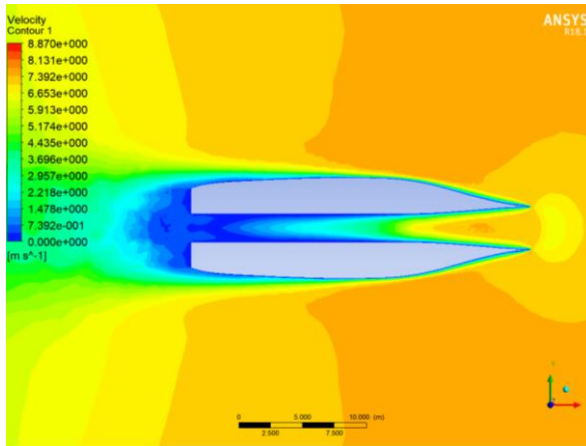
<b>R 1 = 37,29 m</b>		
1	<i>Domain type</i>	<i>Immersed solid</i>
2	<i>Domain motion</i>	<i>Rotating</i>
3	<i>Angular Velocity</i>	<i>0,06368 rev/s</i>
4	<i>Axis Definition</i>	<i>Two points</i>
5	<i>Rotation Axis From</i>	<i>0; 18.65; 0</i>
6	<i>Rotation Axis to</i>	<i>0; 18.65; 1</i>
<b>R 2 = 49,73 m</b>		
1	<i>Domain type</i>	<i>Immersed solid</i>
2	<i>Domain motion</i>	<i>Rotating</i>
3	<i>Angular Velocity</i>	<i>0,0477rev/s</i>
4	<i>Axis Definition</i>	<i>Two points</i>
5	<i>Rotation Axis From</i>	<i>0; 24.86; 0</i>
6	<i>Rotation Axis to</i>	<i>0; 24.86; 1</i>
<b>R 3 = 74,59 m</b>		
1	<i>Domain type</i>	<i>Immersed solid</i>
2	<i>Domain motion</i>	<i>Rotating</i>
3	<i>Angular Velocity</i>	<i>0,0318 rev/s</i>
4	<i>Axis Definition</i>	<i>Two points</i>
5	<i>Rotation Axis From</i>	<i>0; 37.29; 0</i>
6	<i>Rotation Axis to</i>	<i>0; 37.29; 1</i>
<b>R 4 = 149,18 m</b>		
1	<i>Domain type</i>	<i>Immersed solid</i>
2	<i>Domain motion</i>	<i>Rotating</i>
3	<i>Angular Velocity</i>	<i>0,0159 rev/s</i>
4	<i>Axis Definition</i>	<i>Two points</i>
5	<i>Rotation Axis From</i>	<i>0; 74.59; 0</i>
6	<i>Rotation Axis to</i>	<i>0; 74.59; 1</i>

### *Domain Fluida*

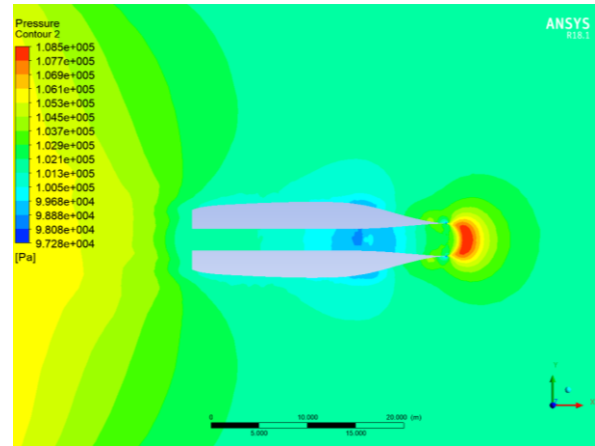
<b>No</b>	<b>Parameter</b>	<b>Keterangan</b>
1	<i>Domain type</i>	<i>Fluid domain</i>
2	<i>Material</i>	<i>Water</i>
3	<i>Morphology</i>	<i>Continous fluid</i>
4	<i>Reference Pressure</i>	<i>1 atm</i>
5	<i>Buoyancy model</i>	<i>Non bouyant</i>
6	<i>Domain motion</i>	<i>Stationary</i>
7	<i>Mesh deformation</i>	<i>None</i>
8	<i>Heat transfer</i>	<i>None</i>
10	<i>Turbulunce</i>	<i>Shear stress transport</i>
11	<i>Wall function</i>	<i>Automatic</i>
12	<i>Combustion</i>	<i>None</i>
13	<i>Thermal radiation</i>	<i>None</i>
14	<i>Velocity type</i>	<i>Cartesian</i>
15	<i>Cartesian Velocity Componen</i>	<i>Automatic With Value <math>U=0</math> m/s<sup>l</sup>, <math>V=0</math> m/s<sup>l</sup>, <math>W=0</math> m/s<sup>l</sup></i>
16	<i>Static pressure</i>	<i>1 atm</i>
17	<i>Turbulenece</i>	<i>Medium (Intensitty 5%)</i>
<b>Side</b>		
1	<i>Boundary type</i>	<i>wall</i>
2	<i>Mass and momentum</i>	<i>No slip wall</i>
3	<i>Wall roughness</i>	<i>Smooth wall</i>
<b>Wall</b>		
1	<i>Boundary type</i>	<i>opening</i>
2	<i>Flow Regime</i>	<i>Subsonic</i>
3	<i>Mass and Momentum</i>	<i>Opening pres and dirn</i>
4	<i>Relative pressure</i>	<i>1 atm</i>
5	<i>Flow direction</i>	<i>Normal to boundary condition</i>
6	<i>Turbulence</i>	<i>Medium (Intensity 5%)</i>

## Lampiran 6 Visualisasi Aliran

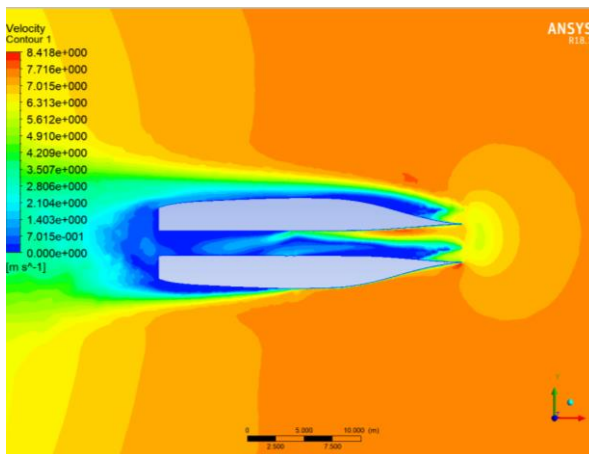
### Drift test model A



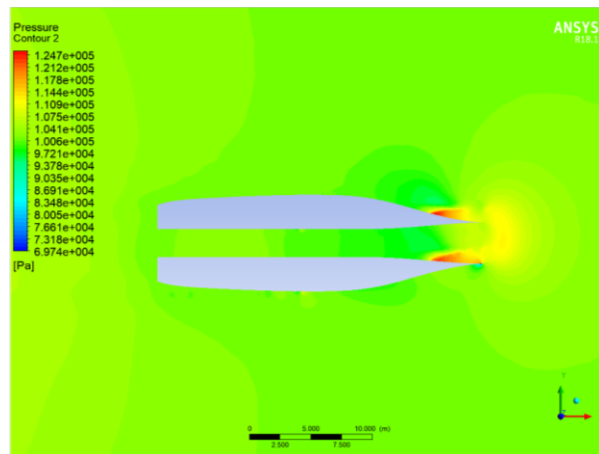
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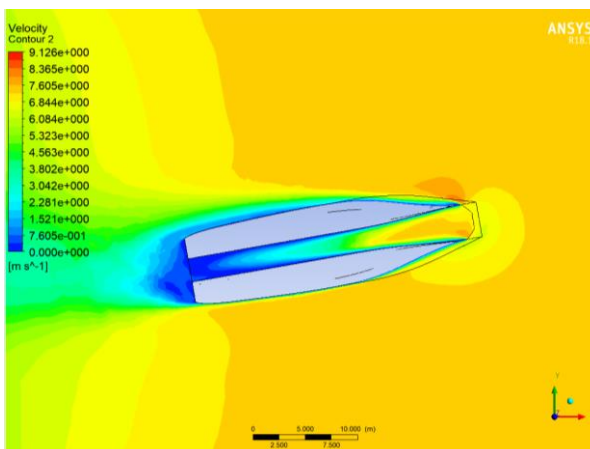
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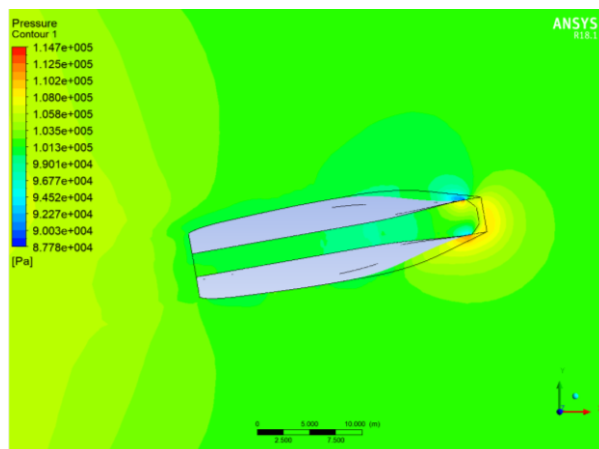
Velocity Bottom view drift 5 derajat



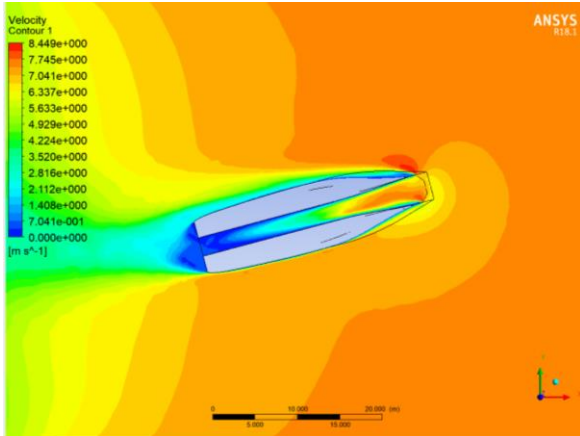
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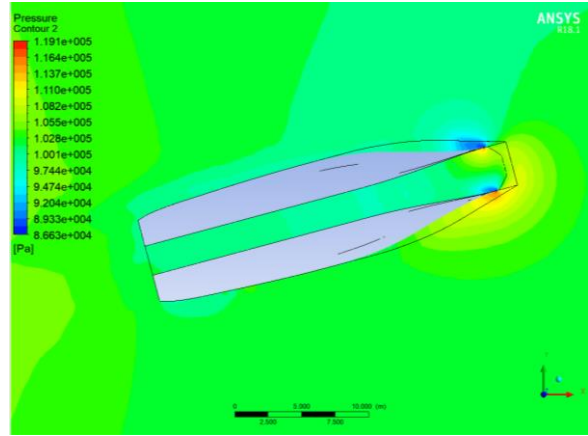
Velocity Bottom view drift 10 derajat



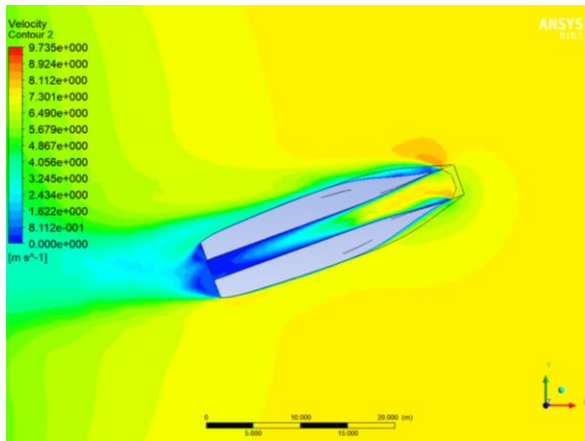
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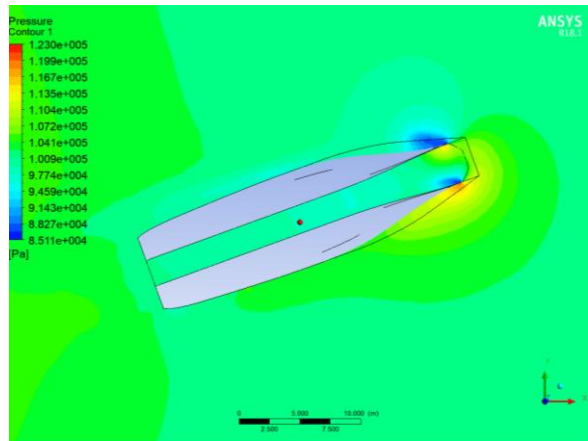
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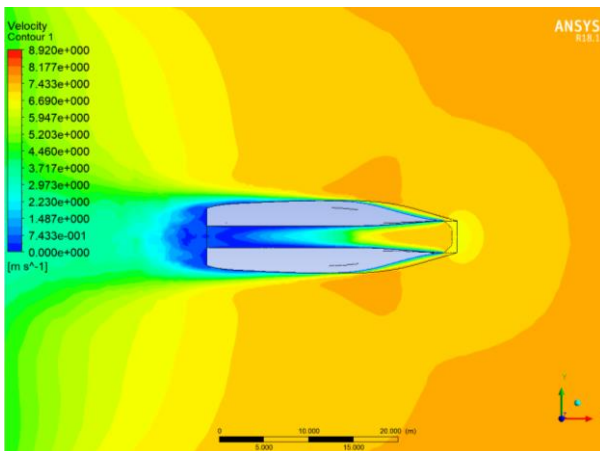


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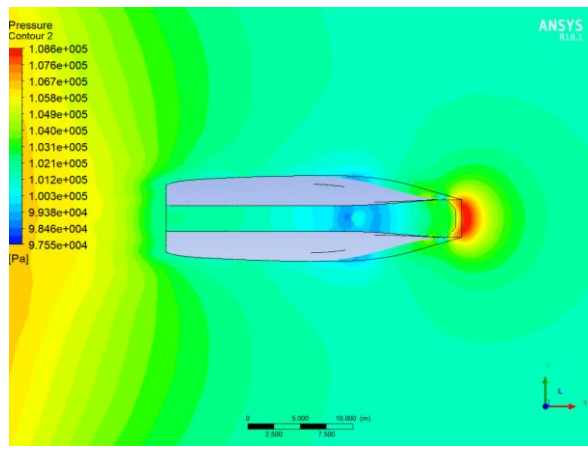


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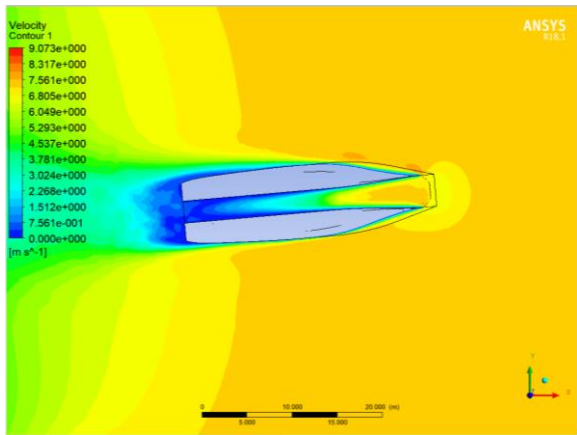
Drift test model B



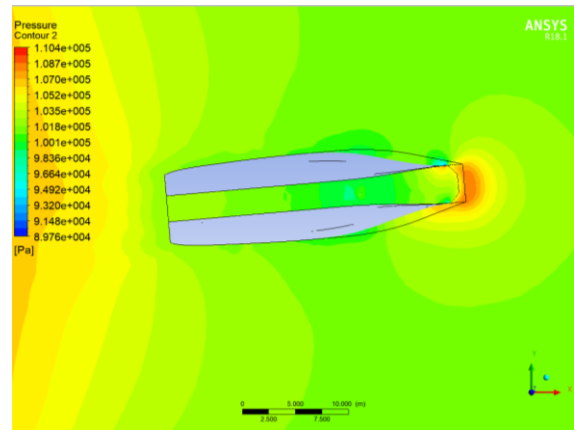
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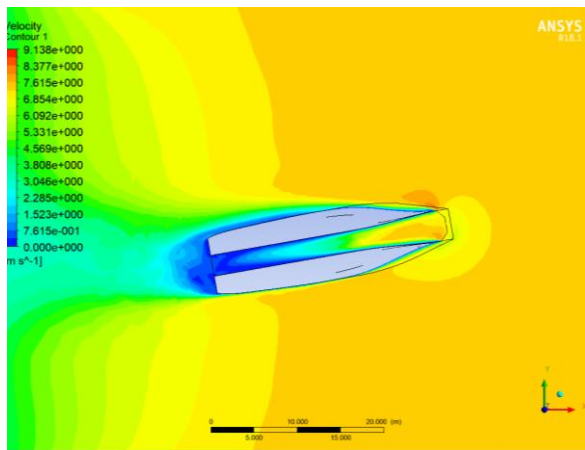
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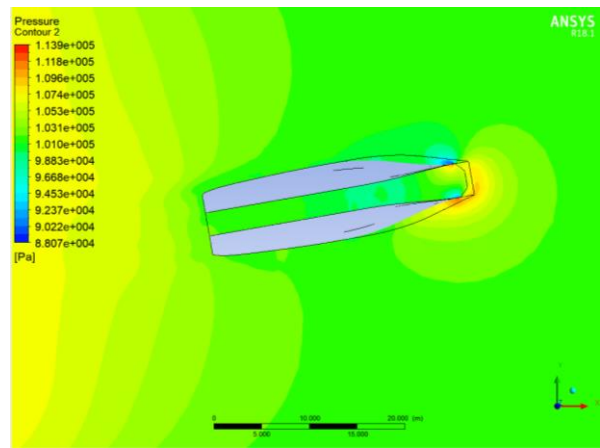
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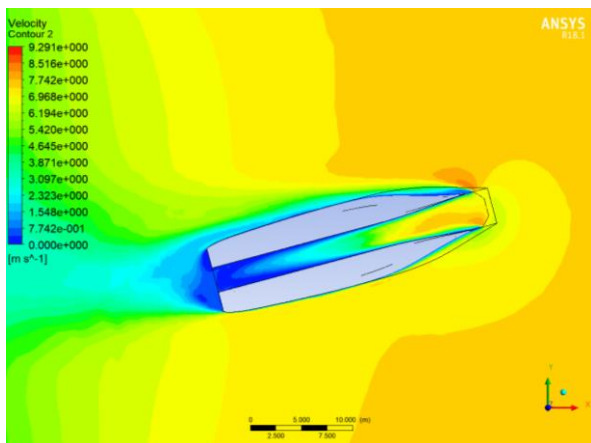
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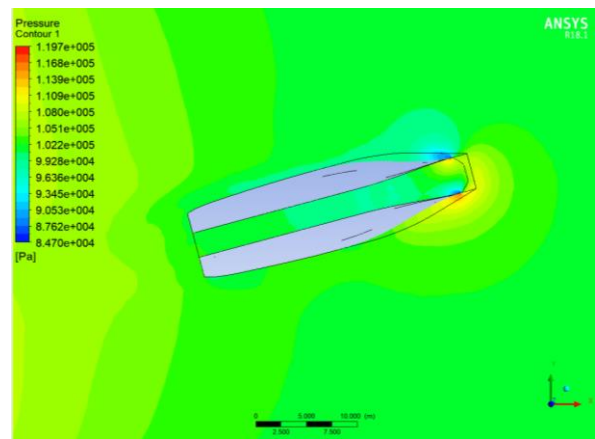
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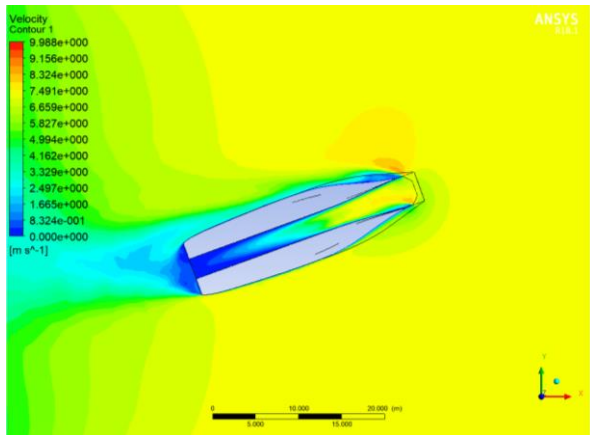
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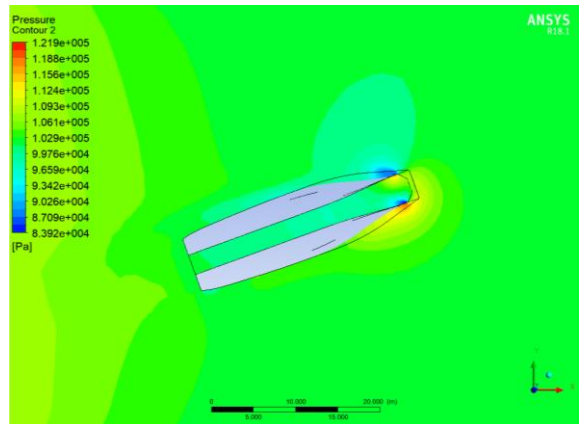
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pressure Bottom view drift 15 derajat

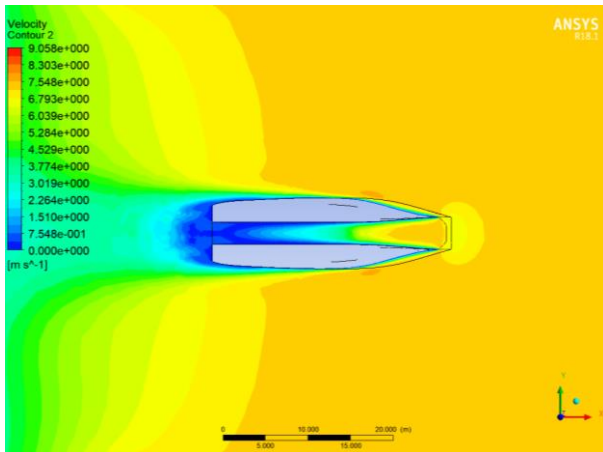


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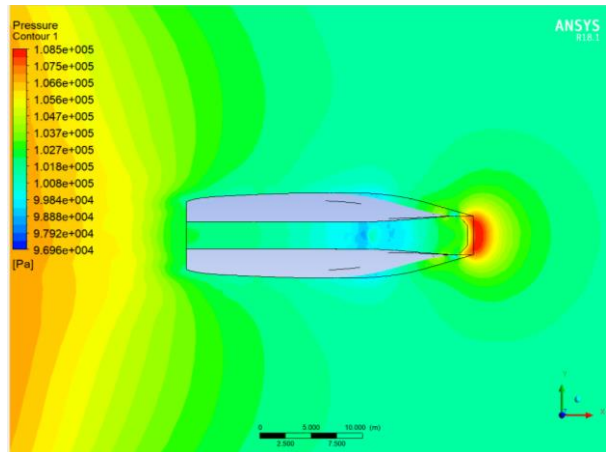


pressure Bottom view drift 20 derajat

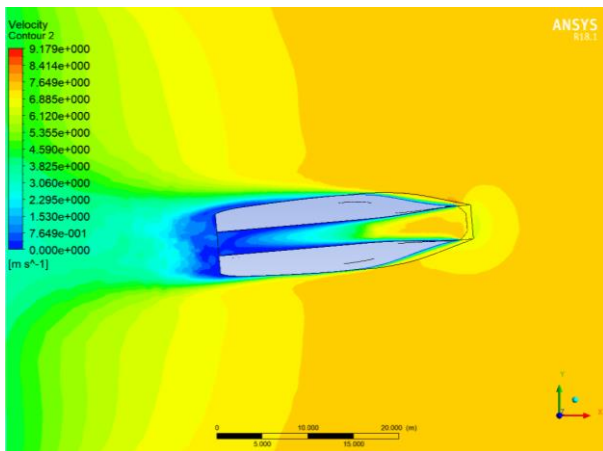
Drift test model C



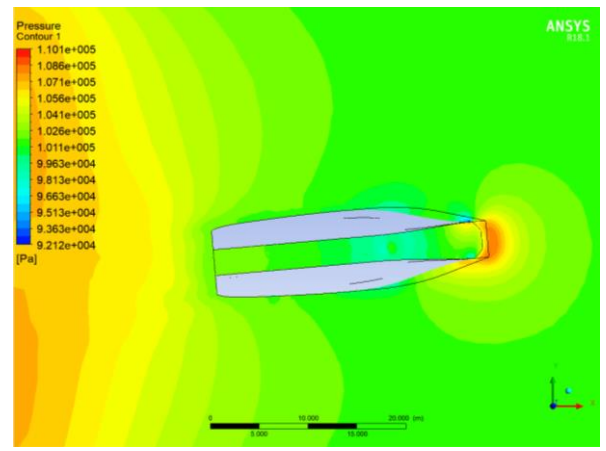
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pressure Bottom view drift 0 derajat

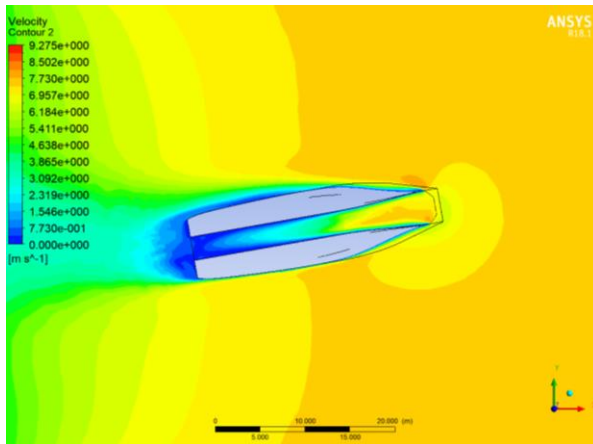


Velocity Bottom view drift 5 derajat

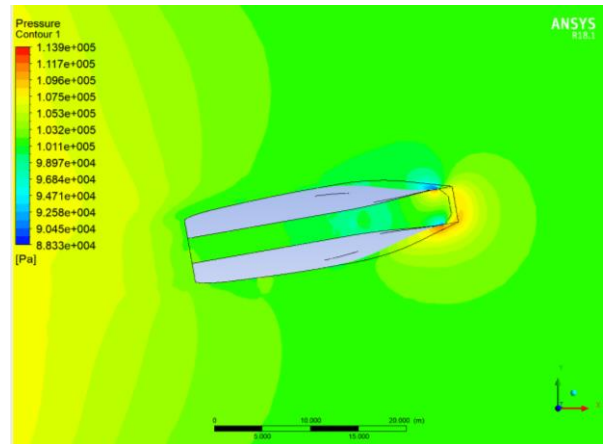


pressure Bottom view drift 5 derajat

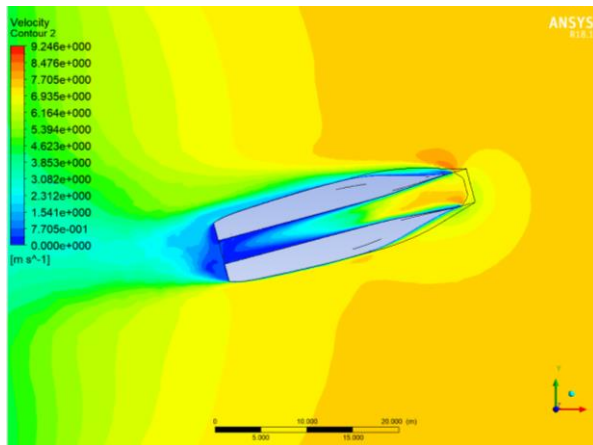




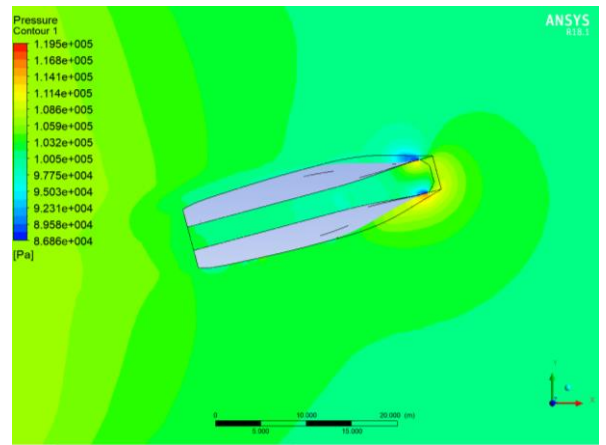
Velocity Bottom view drift 10 derajat



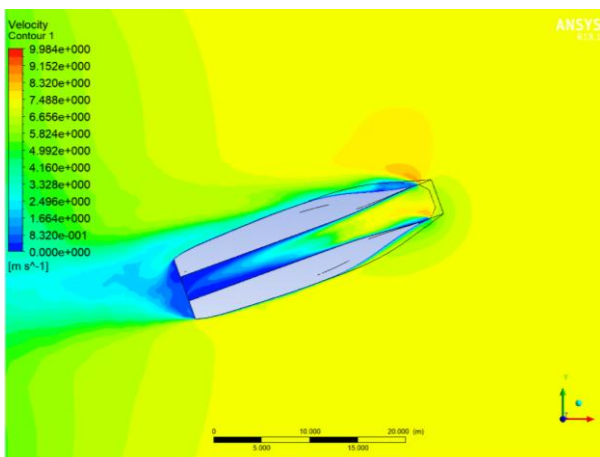
pressure Bottom view drift 10 derajat



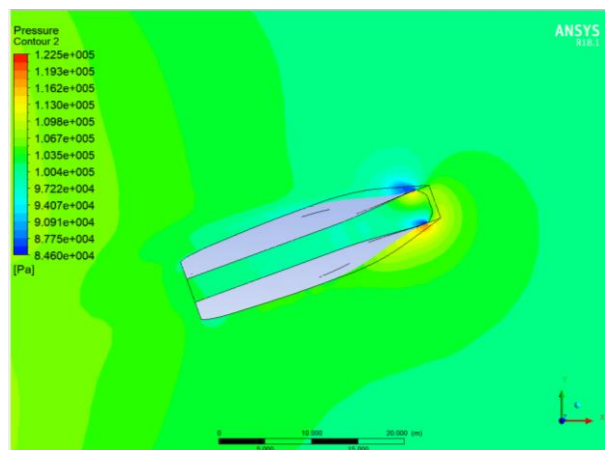
Velocity Bottom view drift 15 derajat



pressure Bottom view drift 15 derajat

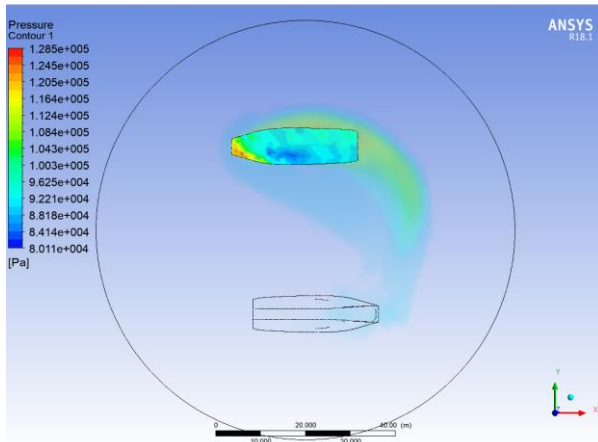


Velocity Bottom view drift 20 derajat

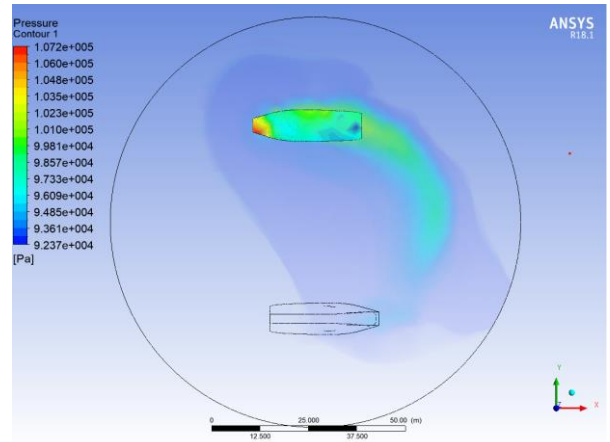


pressure Bottom view drift 20 derajat

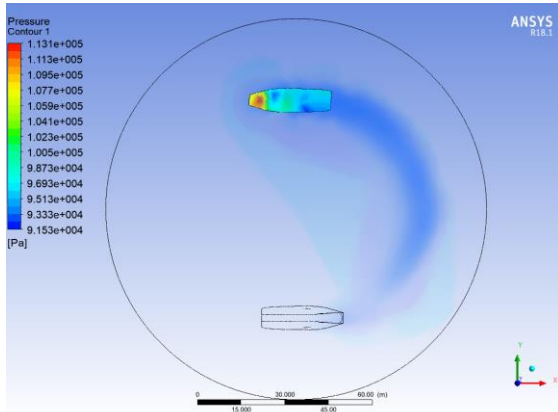
Turning circle model A



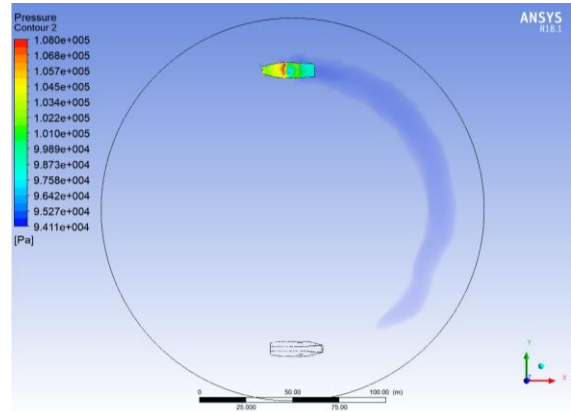
Pressure contour  $r = 0,05$



Pressure contour  $r = 0,1$

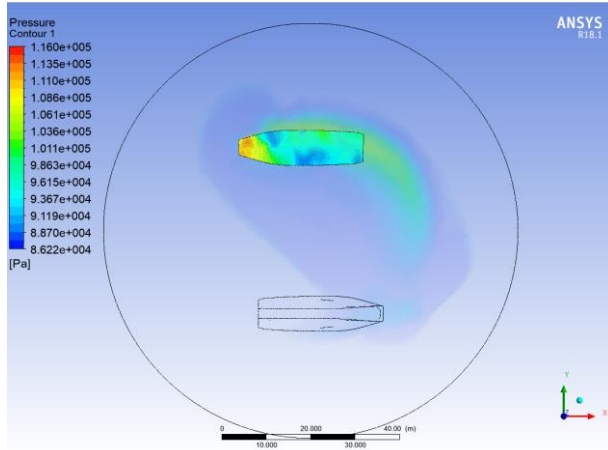


Pressure contour  $r = 0,15$

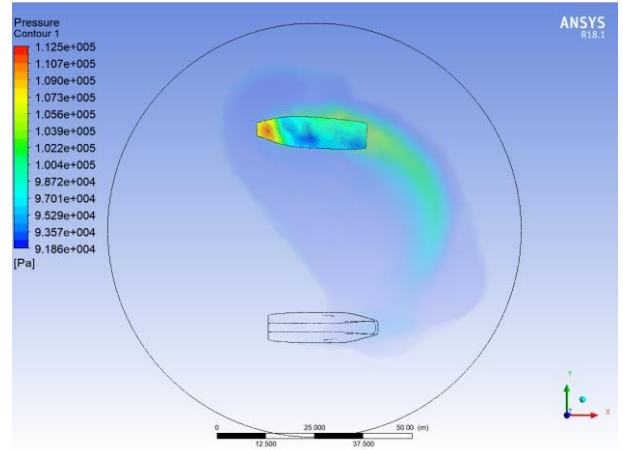


Pressure contour  $r = 0,2$

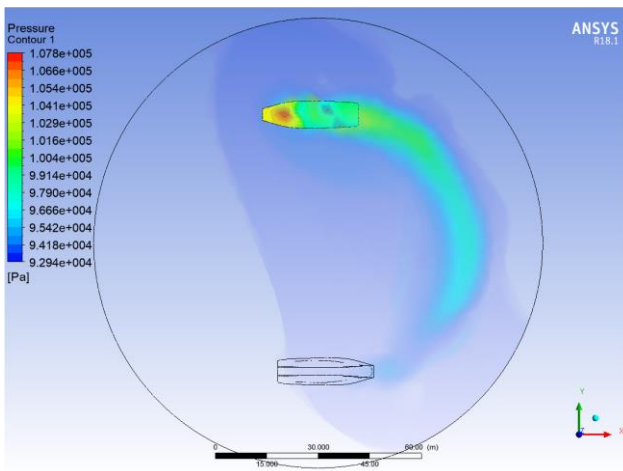
Turning circle model B



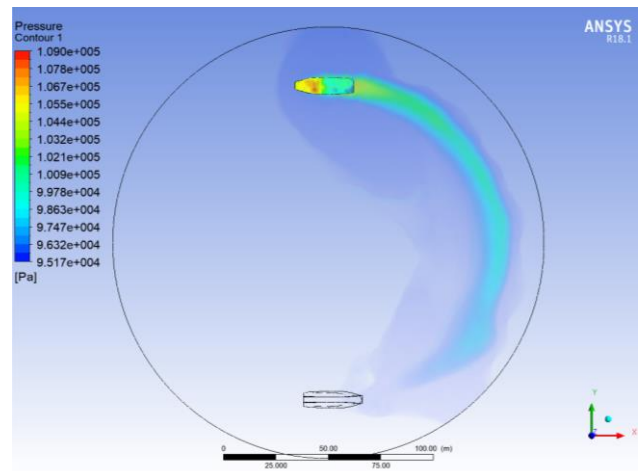
Pressure contour  $r = 0,05$



Pressure contour  $r = 0,1$

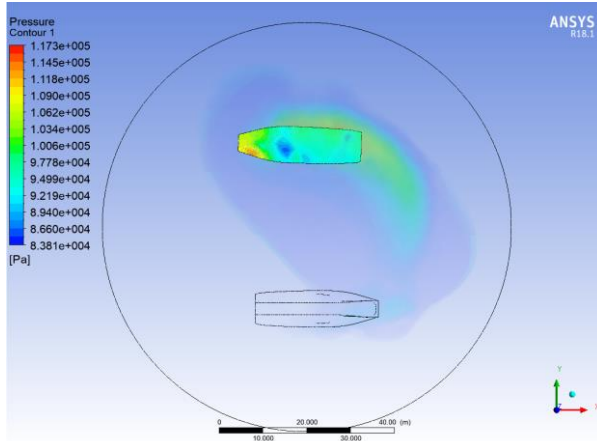


Pressure contour  $r = 0,15$

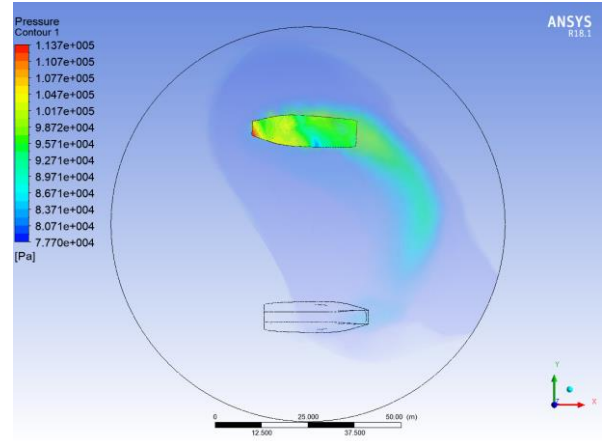


Pressure contour  $r = 0,2$

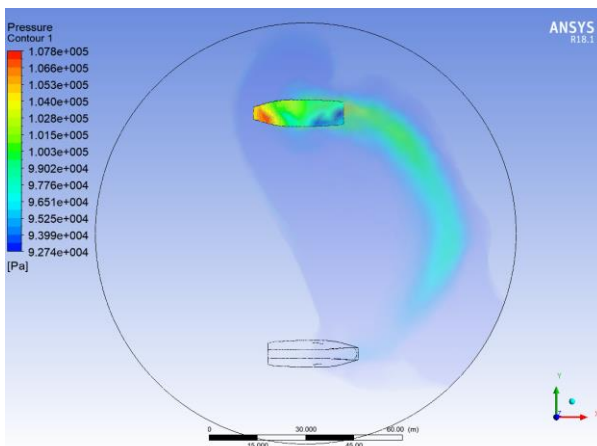
Turning circle model C



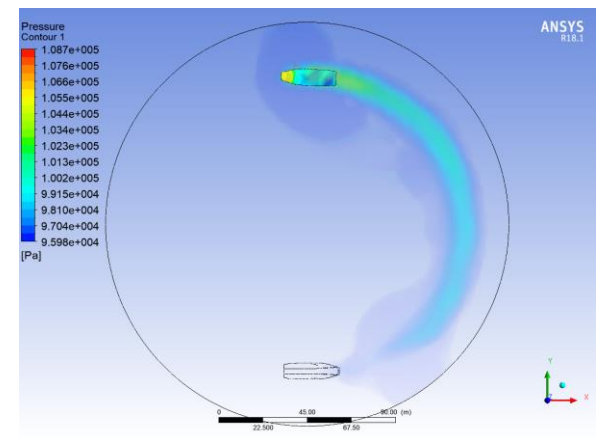
Pressure contour  $r = 0,05$



Pressure contour  $r = 0,1$



Pressure contour  $r = 0,15$



pressure contour  $r = 0,2$

## Lampiran 7 Perhitungan gaya dan momen untuk drift test dan turning circle

a) Data kapal untuk nondimensional

$$LBP = 28 \text{ m}$$

$$T = 1,7 \text{ m}$$

$$V = 7,458 \text{ m/s}$$

$$\rho = 1025 \text{ kg/m}^3$$

$$V^2 = 55,63 \text{ m/s}$$

$$Lbp^2 = 784 \text{ m}$$

b) Nilai X, Y, dan N

$$X', Y' = 0,5 \rho lbp d U^2$$

$$N' = 0,5 \rho lbp^2 d U^2$$

$$X' = 1357184,5$$

$$Y' = 1357184,5$$

$$N' = 38001153,4$$

c) Tabel gaya surge dan sway pada variasi drift

Model	Sudut (derajat)									
	0		5		10		15		20	
	Drag	Lift	Drag	Lift	Drag	Lift	Drag	Lift	Drag	Lift
A	50999	0	51683,9	56813,8	36535,2	129132,2	15393	182560,7	-16178,9	248983,6
B	48934	0	51050,0	49564,1	34104,9	146523,4	15832	199641,4	-41371,2	286594,3
C	50895	0	53287,3	59852,1	42667,1	149788,4	16549	200961,4	-42756,4	314794,4

$$X = F_D \cos \beta + F_D \sin \beta$$

$$Y = -F_D \sin \beta + F_L \cos \beta$$

Bheta (Rad)	Cos Bheta	Sin Bheta
0	1	0
0,08726646	0,99619470	0,08715574
0,17453293	0,98480775	0,17364818
0,26179939	0,96592583	0,25881905
0,34906585	0,93969262	0,34202014

Dimana, X = drag (N), Y = lift (N)

Tabel gaya drag dan lift dari simulasi *drift test*

Model	Sudut (derajat)									
	0		5		10		15		20	
	Drag (N)	Lift (N)	Drag (N)	Lift (N)	Drag (N)	Lift (N)	Drag (N)	Lift (N)	Drag (N)	Lift (N)
A	50999	0	56439	52093	58404	120826	62118	172356	69954	239502
B	48934	0	55176	44926	59030	138375	66964	188741	59145	283460
C	50895	0	58301	54980	68029	140104	67997	189831	67488	310434

Non dimensional untuk X'vv

$$X_H^*, Y_H^* = \frac{X_H^*, Y_H^*}{1/2\rho LppdU^2}$$

Model	X'vv (radian)									
	0,000	0,087	0,175	0,262	0,349	0,000	-0,087	-0,175	-0,262	-0,349
A	-0,038	-0,042	-0,043	-0,046	-0,052	-0,038	-0,042	-0,043	-0,046	-0,052
B	-0,036	-0,041	-0,043	-0,049	-0,044	-0,036	-0,041	-0,043	-0,049	-0,044
C	-0,038	-0,043	-0,050	-0,050	-0,050	-0,038	-0,043	-0,050	-0,050	-0,050

Model	Y'vv (radian)									
	0,000	0,087	0,175	0,262	0,349	0,000	-0,087	-0,175	-0,262	-0,349
A	0,000	0,038	0,089	0,127	0,176	0,000	-0,038	-0,089	-0,127	-0,176
B	0,000	0,033	0,102	0,139	0,209	0,000	-0,033	-0,102	-0,139	-0,209
C	0,000	0,041	0,103	0,140	0,229	0,000	-0,041	-0,103	-0,140	-0,229



Tabel momen dari simulasi *drift test*

Model	N (momen)									
	0,000	0,087	0,175	0,262	0,349	0,000	-0,087	-0,175	-0,262	-0,349
A	0,000	704221	1053131	1512456	2471181	0	-704220,7	-1053131	-1512456,3	-2471180,5
B	0,000	726342	1244218	1622356	2660254	0	-726341,5	-1244217,8	-1622356,3	-2660253,7
C	0,000	728023	1348101	1720052	2346072	0	-728023	-1348101	-1720052	-2346072

Non dimensional untuk N'H

$$N'_H = \frac{N_H}{1/2\rho Lpp^2 dU^2}$$

Model	N'H									
	0,000	0,087	0,175	0,262	0,349	0,000	-0,087	-0,175	-0,262	-0,349
A	0,000	0,019	0,028	0,040	0,065	0,000	-0,019	-0,028	-0,040	-0,065
B	0,000	0,019	0,033	0,043	0,070	0,000	-0,019	-0,033	-0,043	-0,070
C	0,000	0,019	0,035	0,045	0,062	0,000	-0,019	-0,035	-0,045	-0,062

d) Tabel *surge force*, *sway force*, dan *yaw moment* pada *turning circle*

Tabel gaya drag dan lift dari simulasi *turning circle*

Model	R									
	0		37,29		49,73		74,59		149,18	
	0		0,05		0,1		0,15		0,2	
	Drag (N)	Lift (N)	Drag (N)	Lift (N)	Drag (N)	Lift (N)	Drag (N)	Lift (N)	Drag (N)	Lift (N)
A	0	0	2714,4	28500,9	4072	36779,7	7465	49266	9500	66638
B	0	0	950,03	26193,7	1764	38272,6	2443	51980	3257	67859
C	0	0	1221,5	24022,2	2714	34472,5	4479	45466	5972	65145

Non dimensional untuk X'rr

$$X_H^*, Y_H^* = \frac{X_H^*, Y_H^*}{1/2 \rho L_{pp} d U^2}$$

Model	X'rr									
	0,000	0,050	0,100	0,150	0,200	0,000	-0,050	-0,100	-0,150	-0,200
A	0,000	-0,002	-0,003	-0,005	-0,007	0,000	-0,002	-0,003	-0,005	-0,007
B	0,000	-0,0007	-0,001	-0,002	-0,002	0,000	-0,001	-0,001	-0,002	-0,002
C	0,000	-0,0009	-0,002	-0,003	-0,004	0,000	-0,001	-0,002	-0,003	-0,004

Model	Y'rr									
	0,000	0,050	0,100	0,150	0,200	0,000	-0,050	-0,100	-0,150	-0,200
A	0,000	0,021	0,027	0,036	0,049	0,000	-0,021	-0,027	-0,036	-0,049
B	0,000	0,019	0,028	0,038	0,050	0,000	-0,019	-0,028	-0,038	-0,050
C	0,000	0,018	0,025	0,033	0,048	0,000	-0,018	-0,025	-0,033	-0,048

Nilai momen dari simulasi *turning circle*

Model	N (momen)									
	0,000	0,050	0,100	0,150	0,200	0,000	-0,050	-0,100	-0,150	-0,200
A	0,000	193805,9	418012,7	646019,6	988030,0	0	-193805,88	-418012,7	-646019,6	-988029,9
B	0,000	228006,9	345810,5	608018,5	836025,4	0	-228006,92	-345810,5	-608018,4	-836025,3
C	0,000	121603,7	456013,8	646019,6	1064032,3	0	-121603,7	-456013,8	-646019,6	-1064032,3

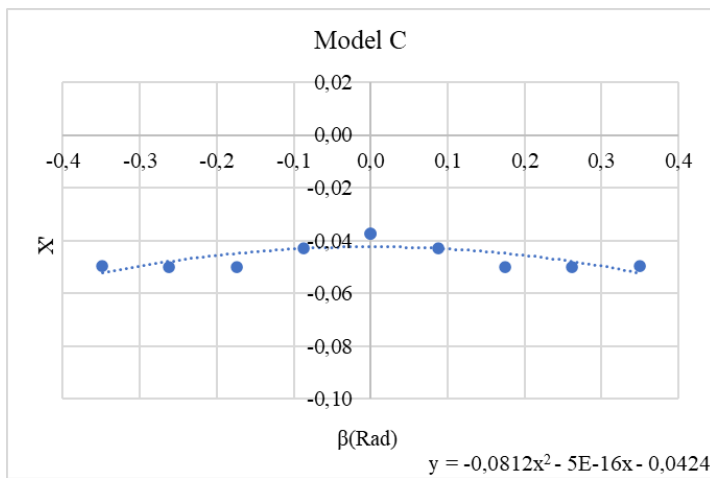
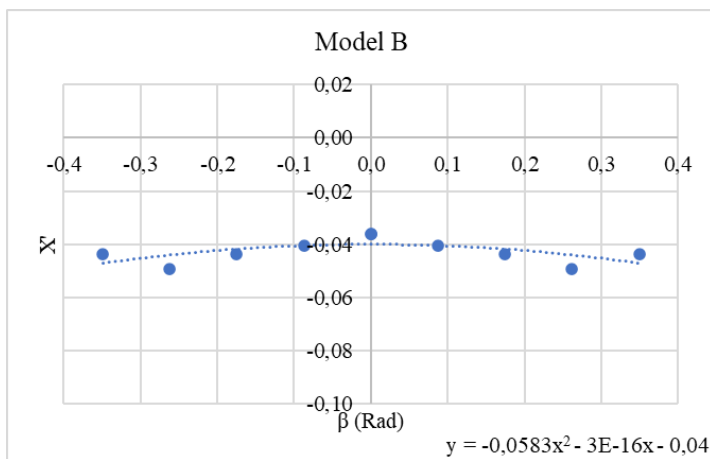
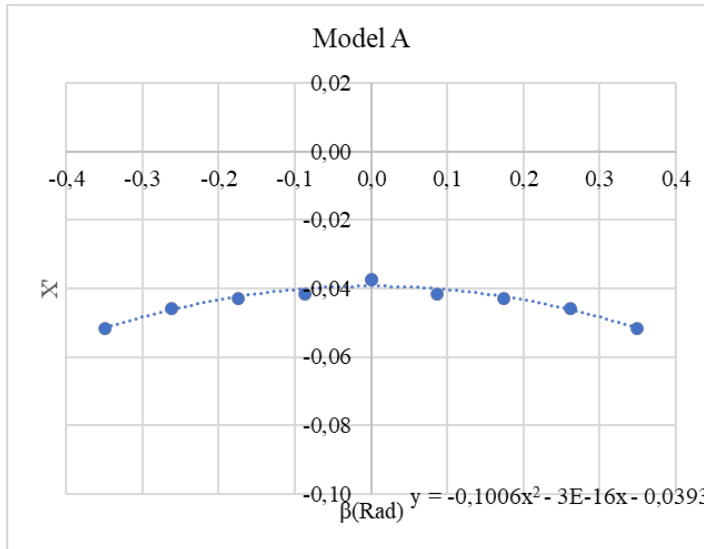
Non dimensional untuk N'rr

$$N'_H = \frac{N_H}{1/2\rho Lpp^2 dU^2}$$

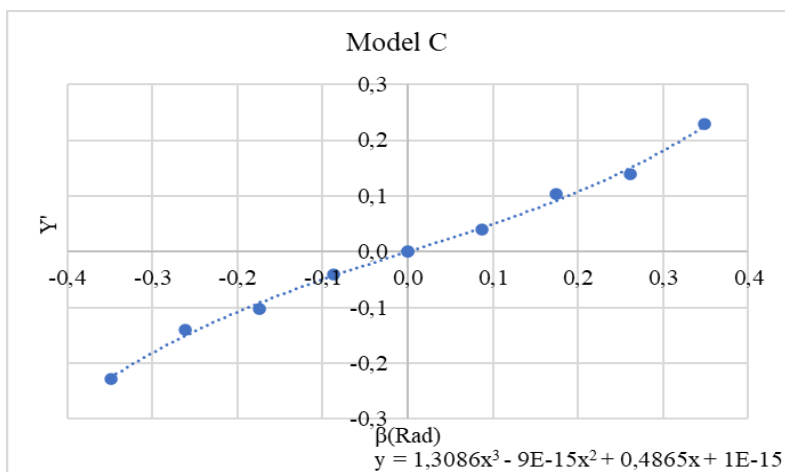
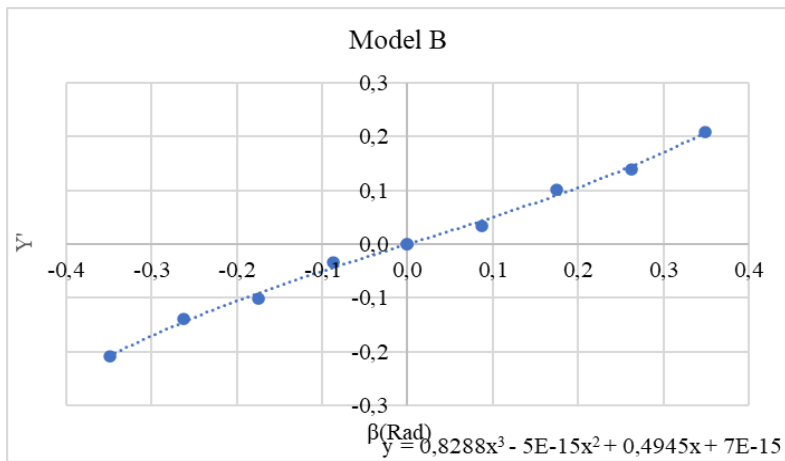
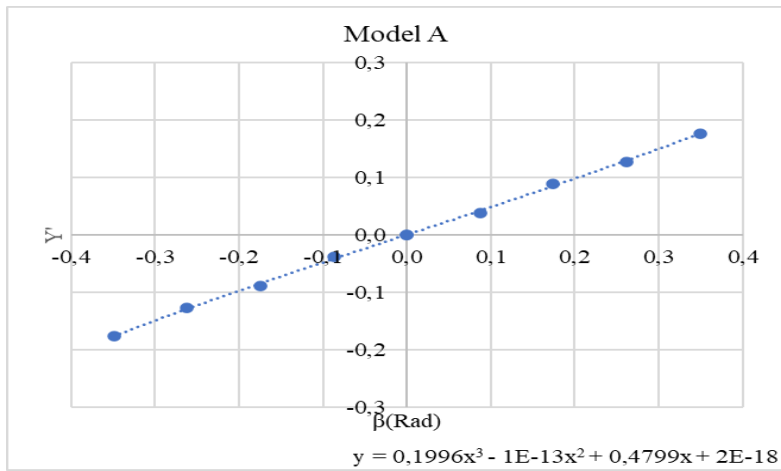
Model	N'rr									
	0,000	0,050	0,100	0,150	0,200	0,000	-0,050	-0,100	-0,150	-0,200
A	0,000	0,005	0,011	0,017	0,026	0,000	-0,005	-0,011	-0,017	-0,026
B	0,000	0,006	0,009	0,016	0,022	0,000	-0,006	-0,009	-0,016	-0,022
C	0,000	0,003	0,012	0,017	0,028	0,000	-0,003	-0,012	-0,017	-0,028

## Lampiran 8 Grafik surge force, sway force, dan yaw moment

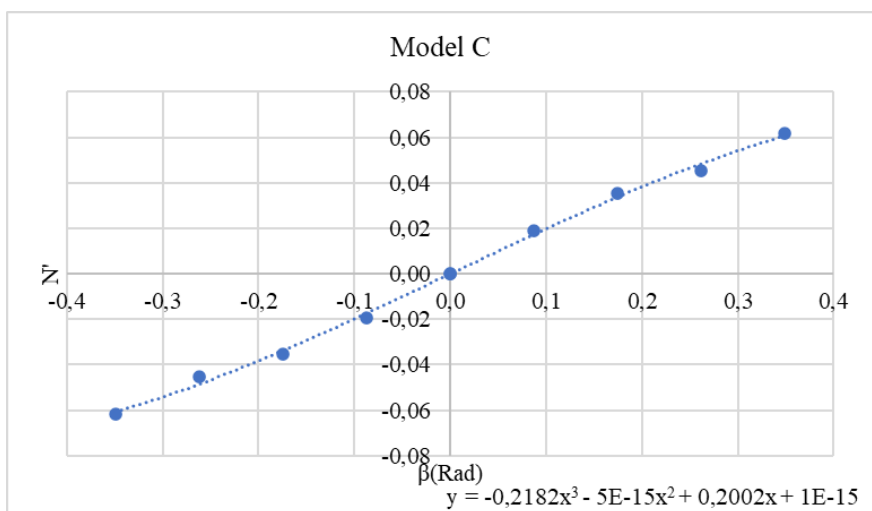
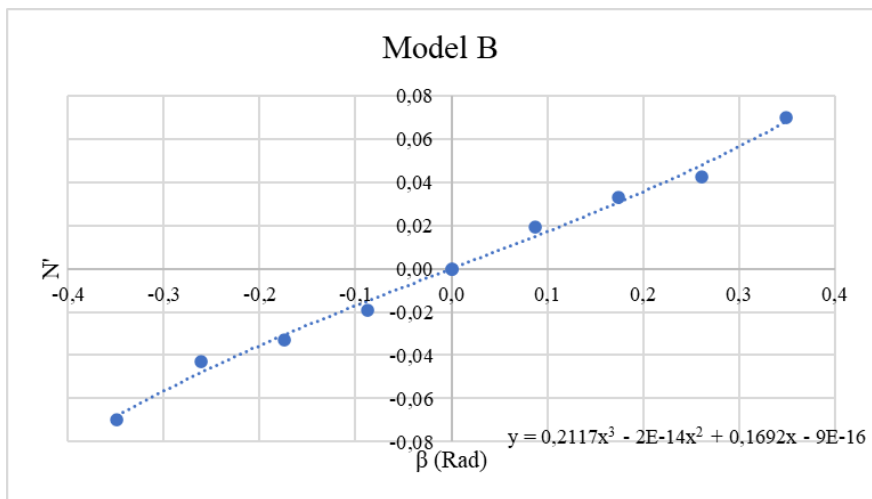
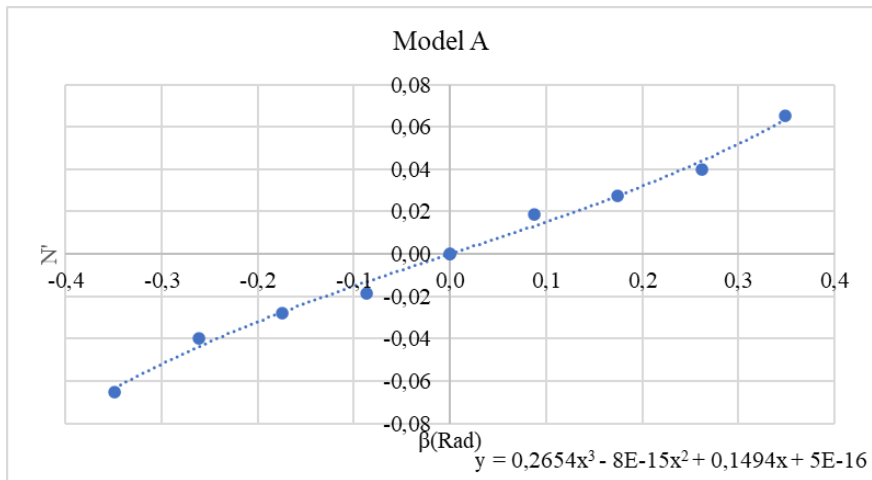
Surge force kondisi Drift test



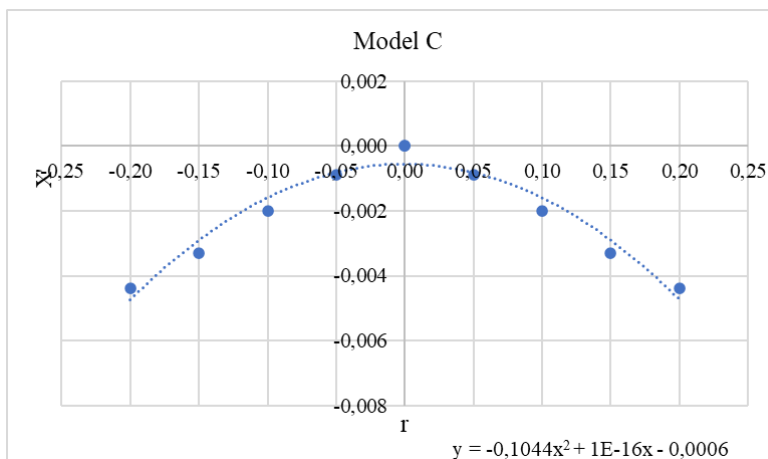
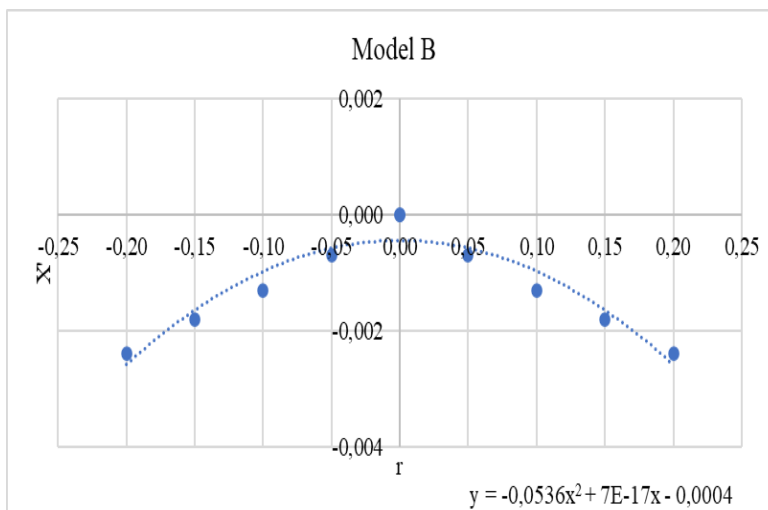
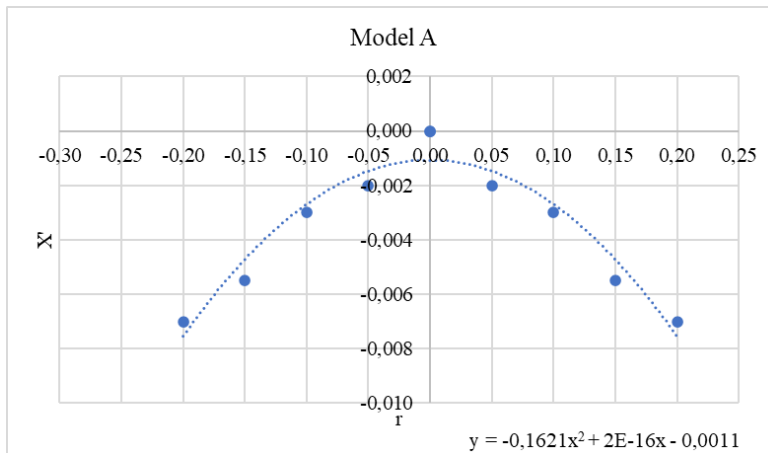
Sway force kondisi Drift test



*Yaw moment kondisi Drift test*

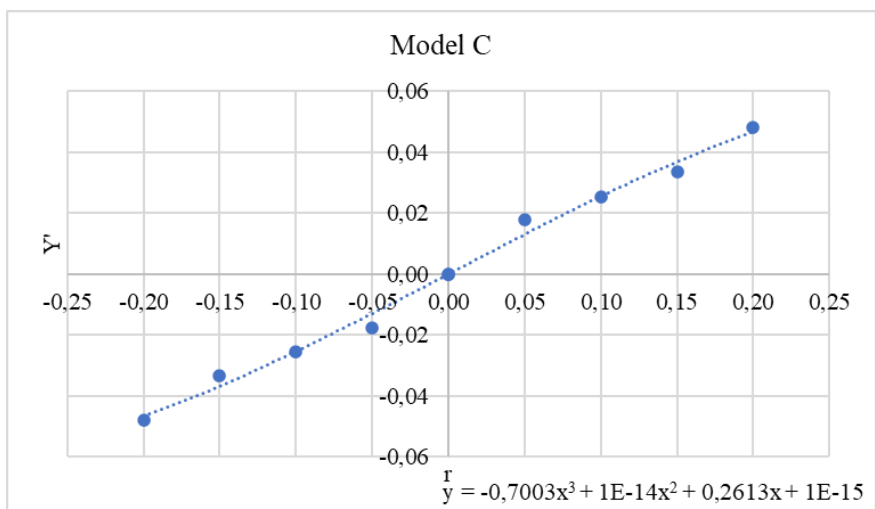
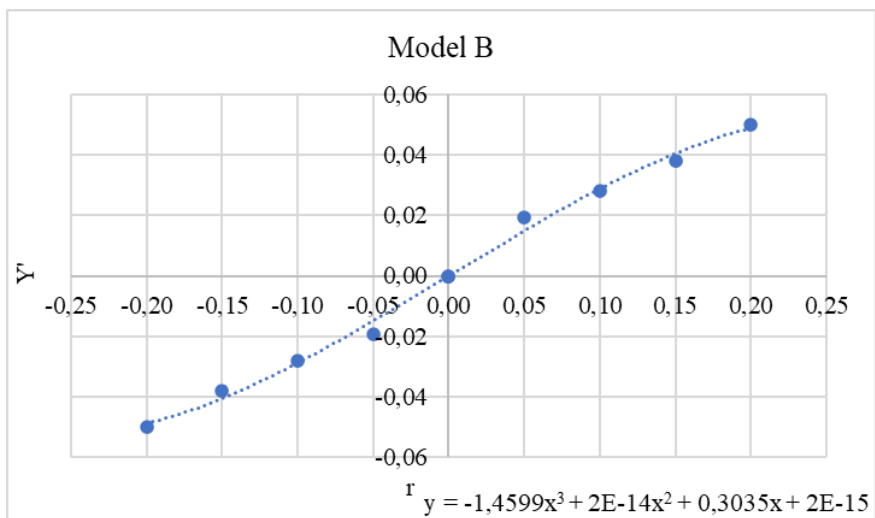
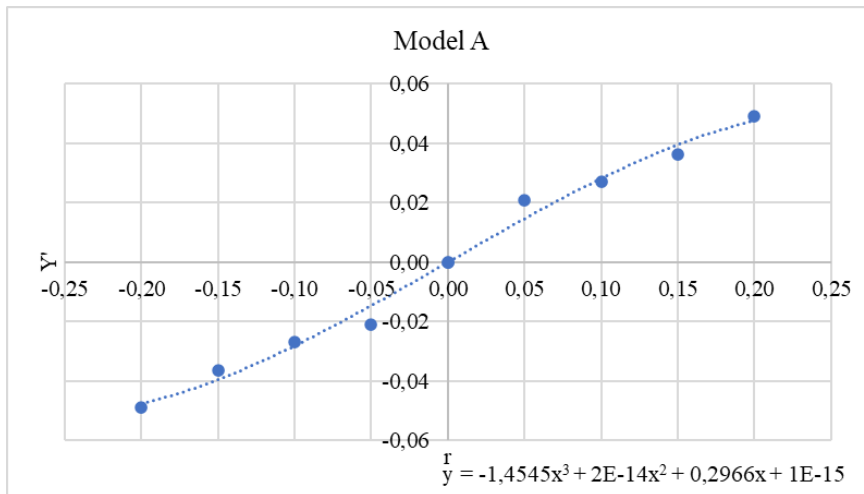


*Surge force kondisi turning circle*





Sway force kondisi turning circle



*Yaw moment kondisi turning circle*

