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VII CONGRESO INTERNACIONAL DE DISEÑO E INGENIERIA NAVAL

ANALYSIS OF THE ANGLE OF INCIDENCE OF A RIGID SAIL ON A CATAMARAN-TYPE BOAT

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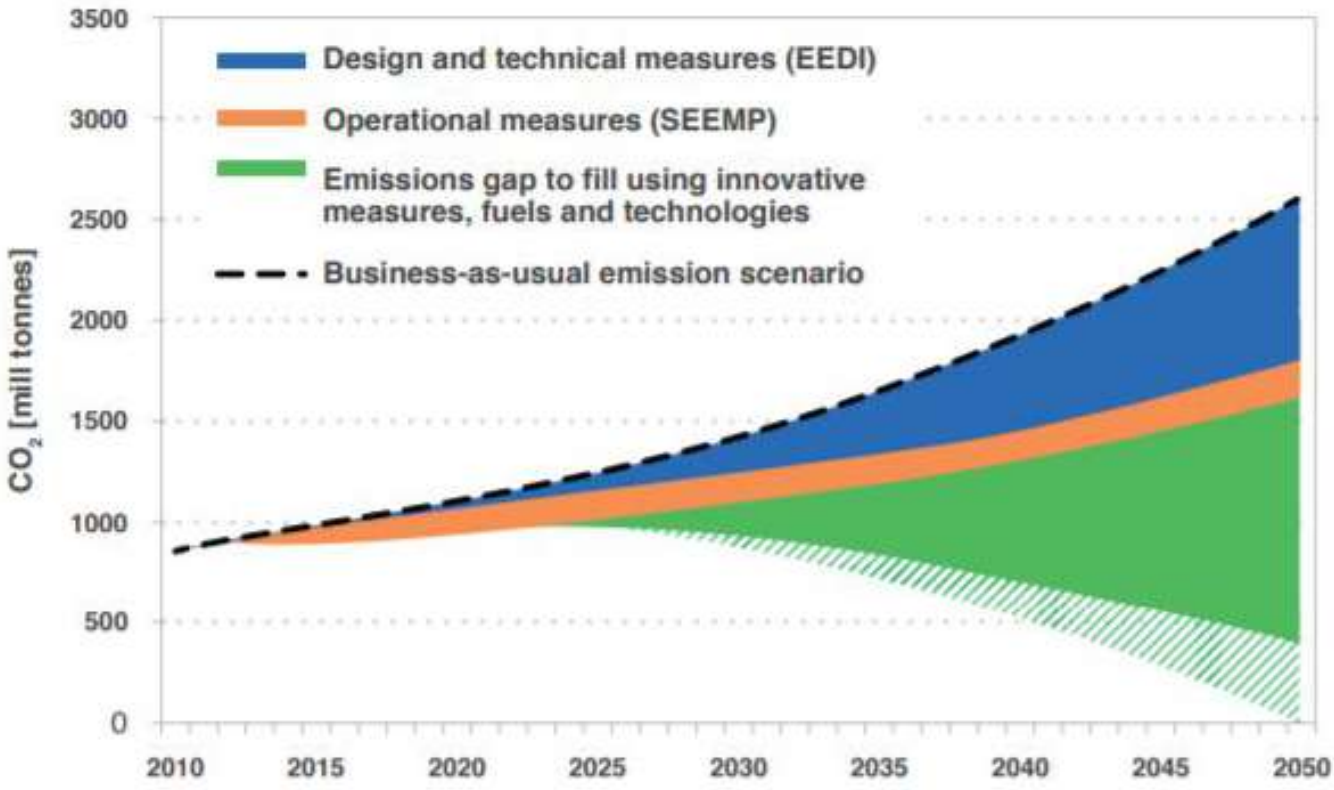
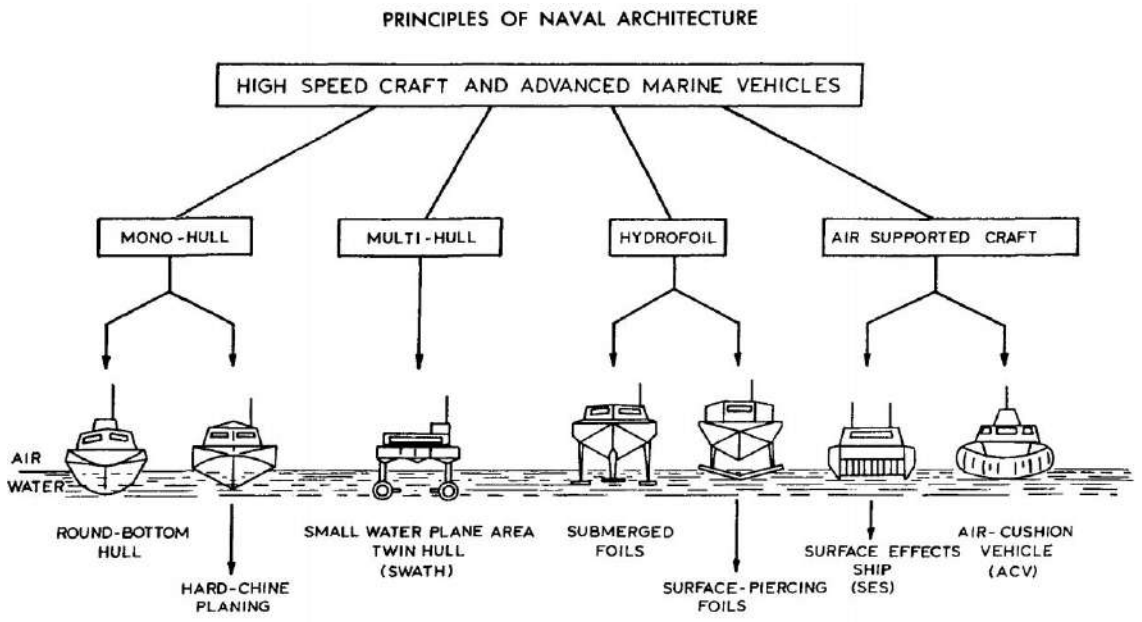
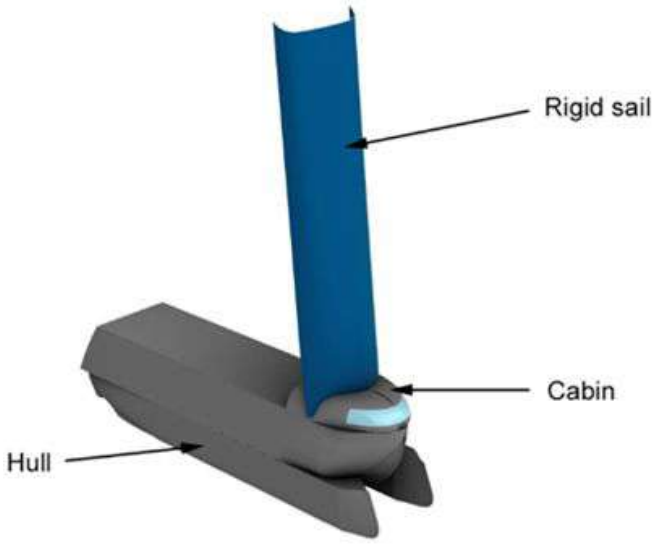
Goals of GHG reduction



Main types of hight-speed

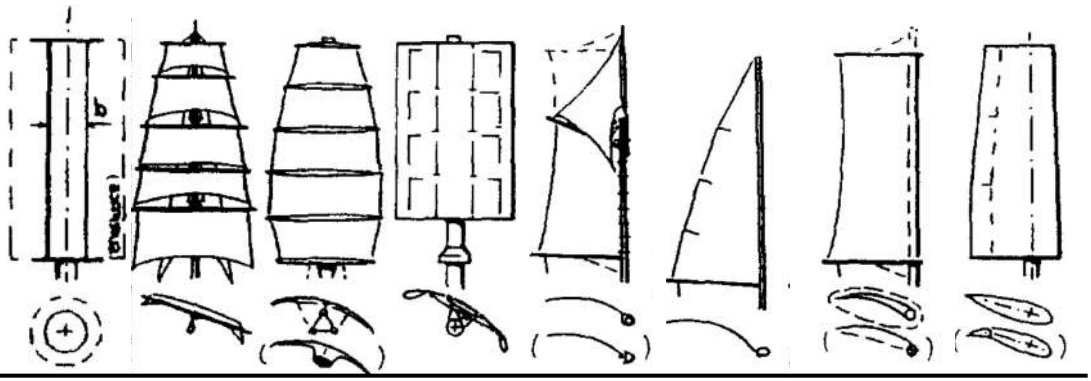


Case study



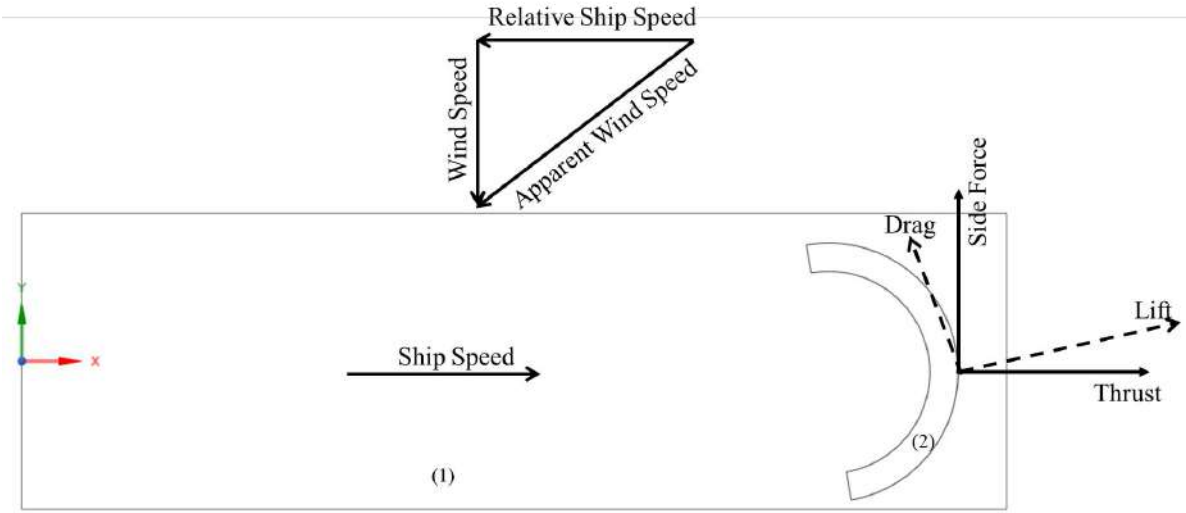
Main characteristics		Units
Lenght overall	85	m
Waterline Length	81	m
Beam	22	m
Depth	20.5	m
Desplacement	2650.56	ton
Operation speed	13	
Hull type	Catamaran	

Types of sails



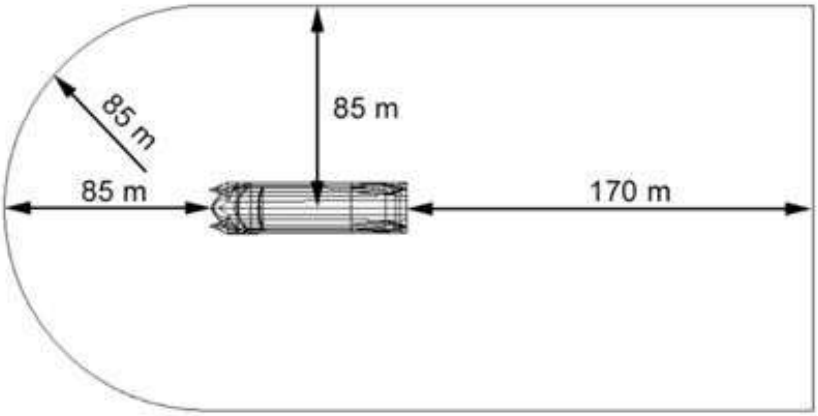
Coefficient	TS TRADIT. SQUARE RIG	MS (DS) MODERN SQUARE (DYNA)	RS RIGID SQUARE RIG	TG (MS) TRAID. GAF (MOD.G.)	BM BERMUDA MAINSL	SW (MR) SAILWING (MASTRO L)	WS (WF) WINGSAIL (TE. FLAP)	FR FLETTNER ROTOR (SURFACE)
Cdo	0.13	0.1 (0.07)	0.1	0.1 (0.7)	0.08	0.05 (0.06)	0.02	0.6 (0.2)
CD1	0.65	0.46 (0.43)	0.58	0.35 (0.37-0.27)	0.28-0.23	0.36-0.26	0.27-0.17 (0.65-0.45)	4-5.6 (1.3-1.8)
CCM	0.9	1.5	1.5	1.1 (1.2-1.5)	1-1.3	1.7 (1.6)	1.1-1.4 (1.8-2)	7-10 (2.2-3.2)
FRE	0.5	2	1.5	1.6 (2-3)	2-3	2-3	2-3	6-9 (2-3)

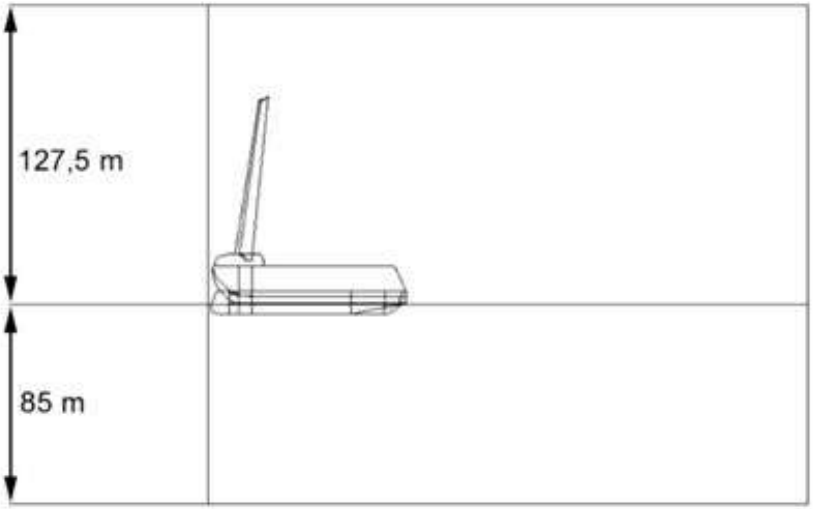
Forces on sail



Main characteristics		Units
Height	66.87	m
Width	19	m
Area	2970	m2

Computational domain



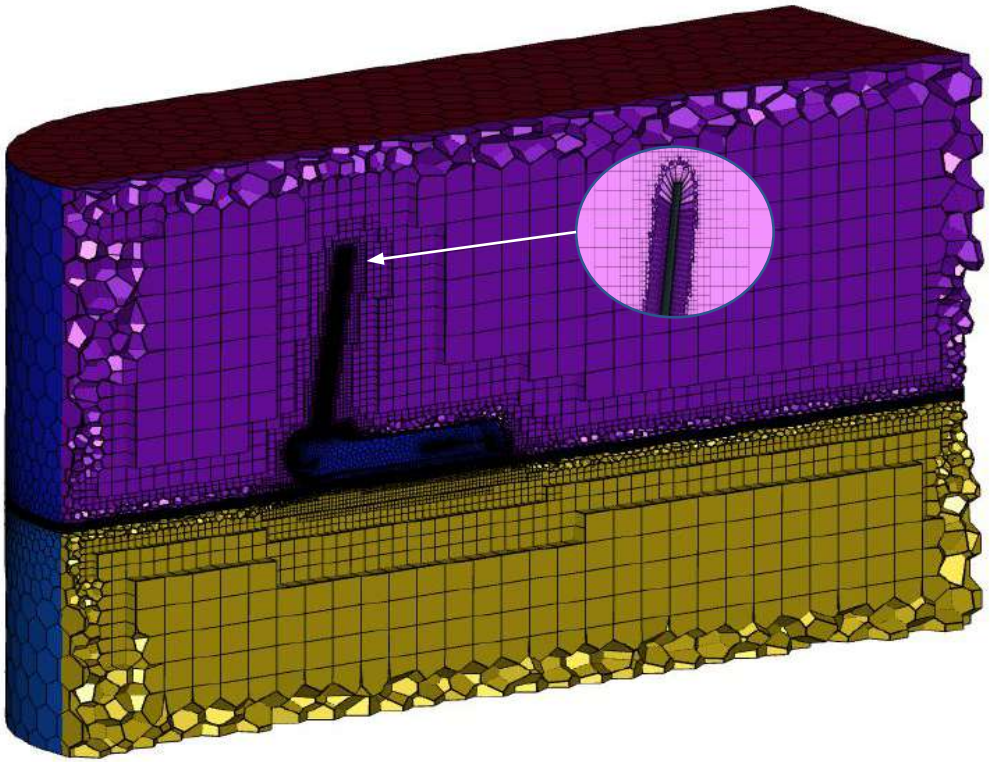


- Curve inlet
- LOA = 85 m
- No symmetry condition
- Air domain
- Water domain

Boundary condition

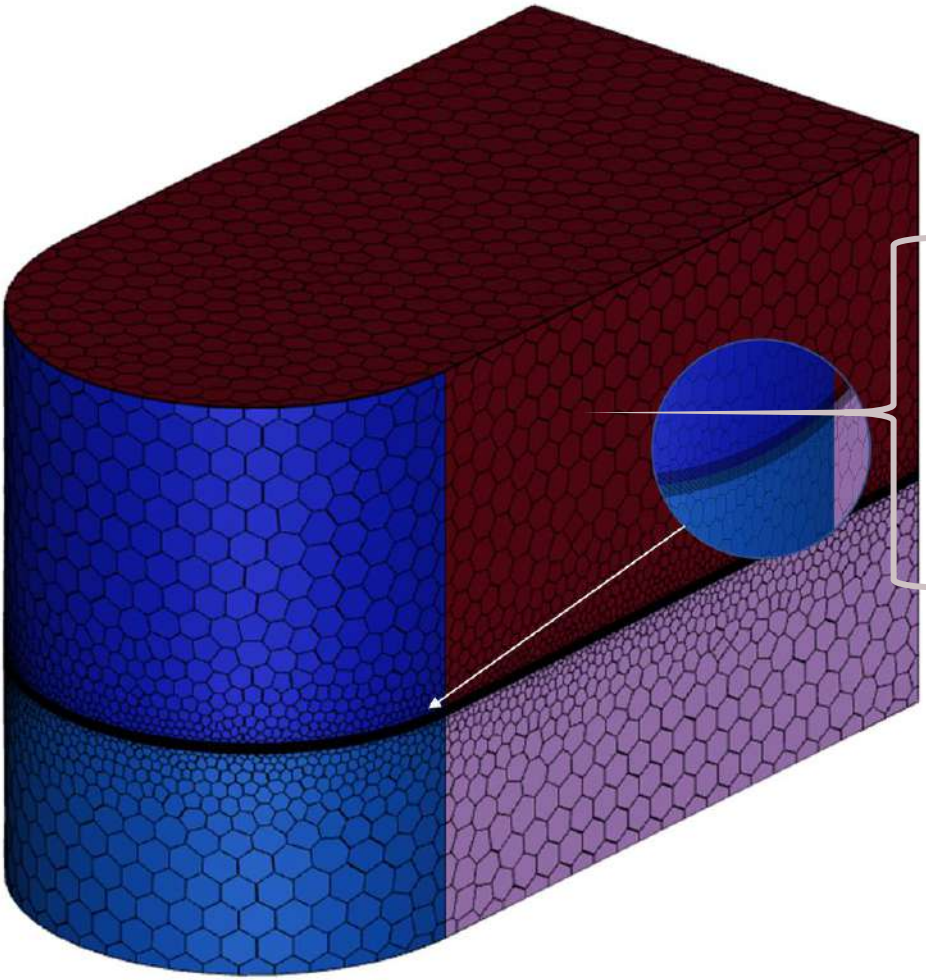
	Tipo de frontera	Especificación
Inlet_air	Velocity inlet	Vel_X: -6.68778 m/s;
		Vel_Y: -15.4333 m/s;
Inlet_water	Pressure Inlet	Vel_X: -6.68778 m/s;
		Open Channel:
		Nivel de superficie libre: 0 m
		Profundidad: 85 m
Modelo de turbulencia K-ε Realizable		
Outlet_air	Pressure Outlet	
		Gauge Pressure (pascal): 0
Outlet_water	Pressure Outlet	Open Channel:
		Nivel de superficie libre: 0 m
		Profundidad: 85 m
Top, bottom, side	Wall	Esfuerzo cortante: 0
Hull	Wall	

Mesh domain



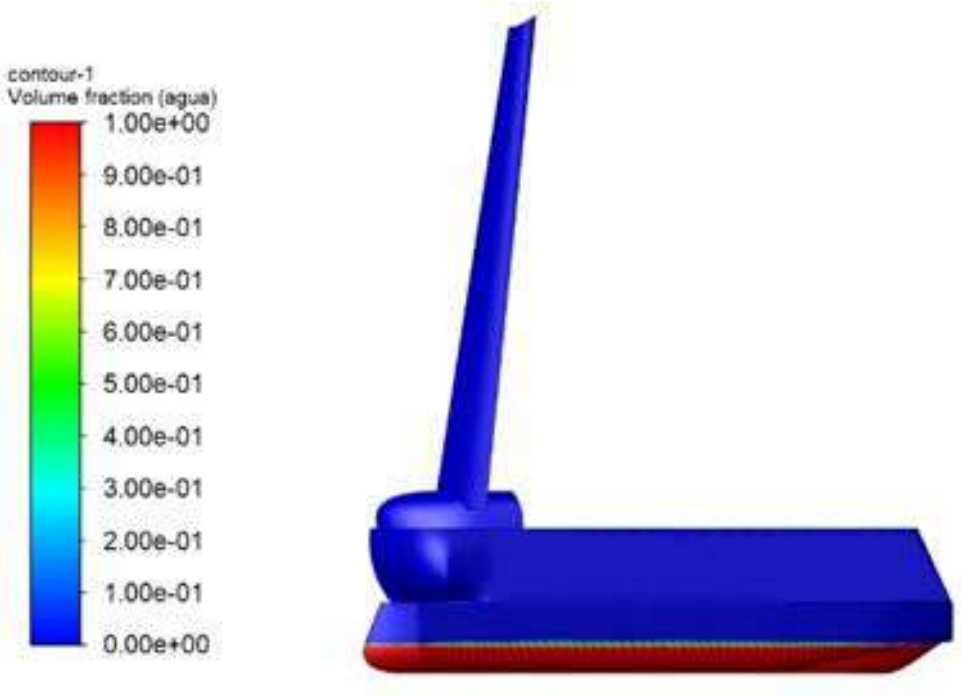
Name	Type	Min Orthogonal Quality	Max Aspect Ratio
Water domain	Mixed Cell	0.080411159	200.92801
Air domain	Mixed Cell	0.052770689	315.37531

Refinement zone



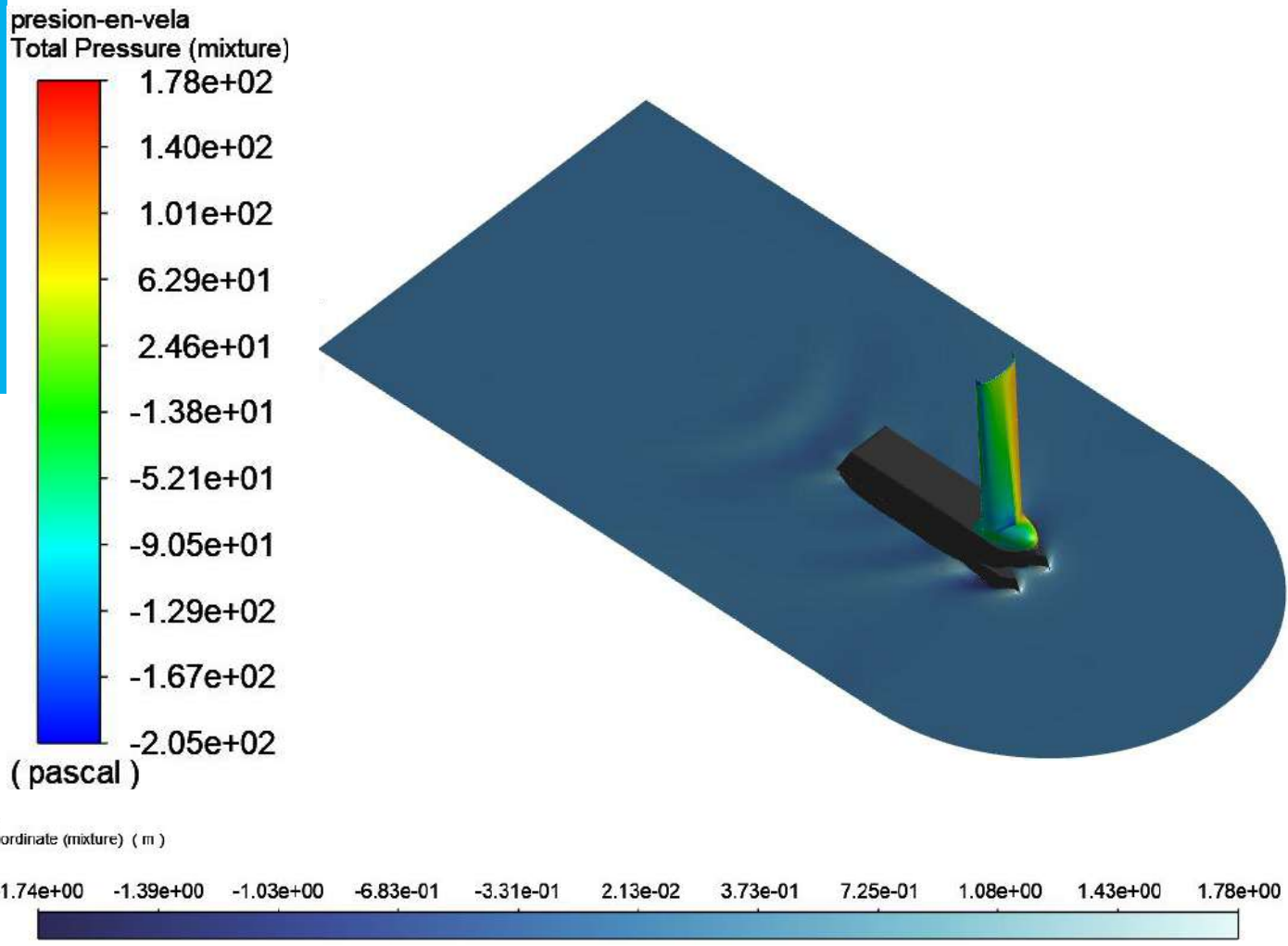
Prism layers used on free surface to represent the wave formation without increase the computational cost

Free Surface modeling

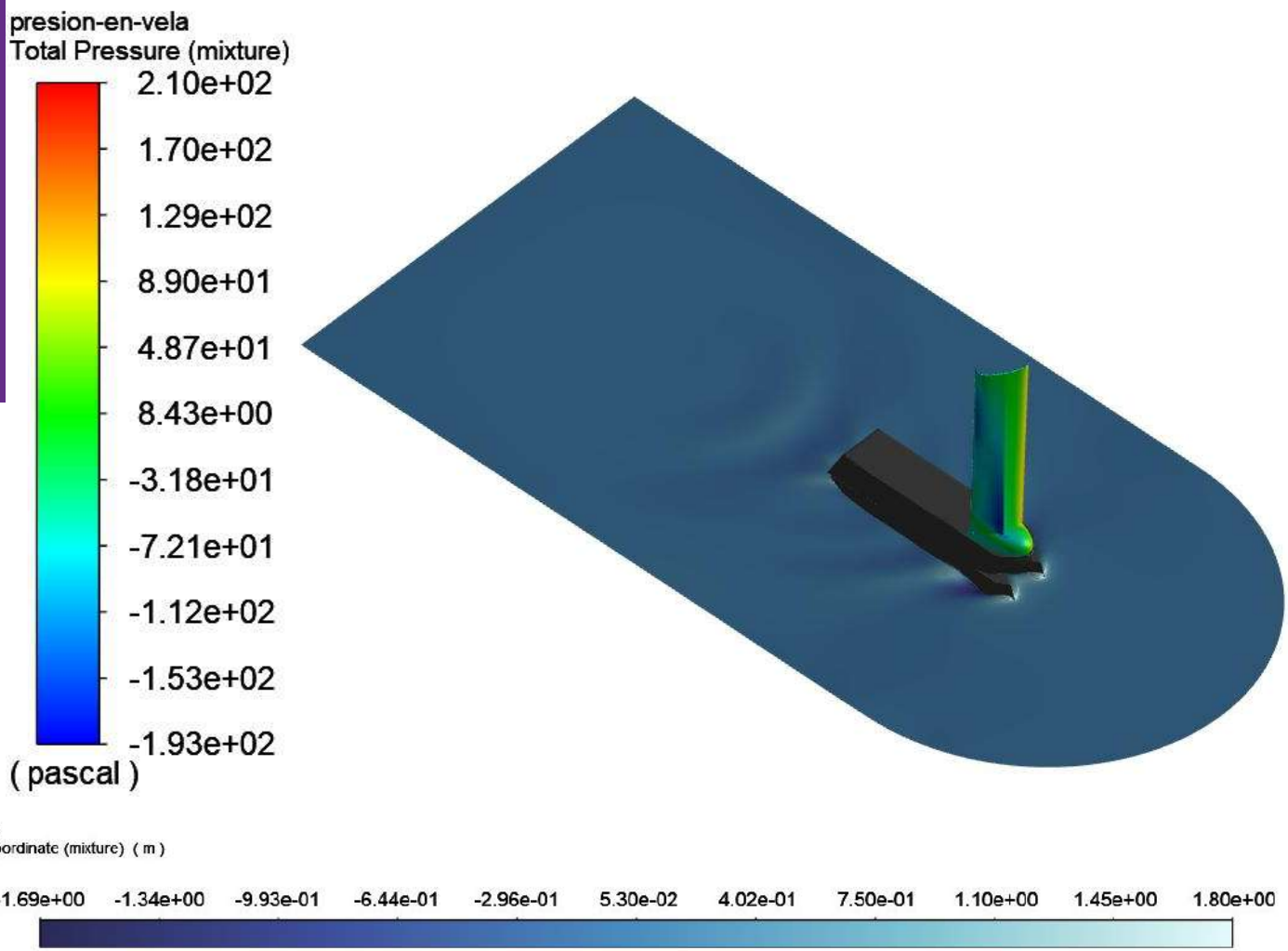


Zone	Value
Air	0
Water	1
Free surface	0.5

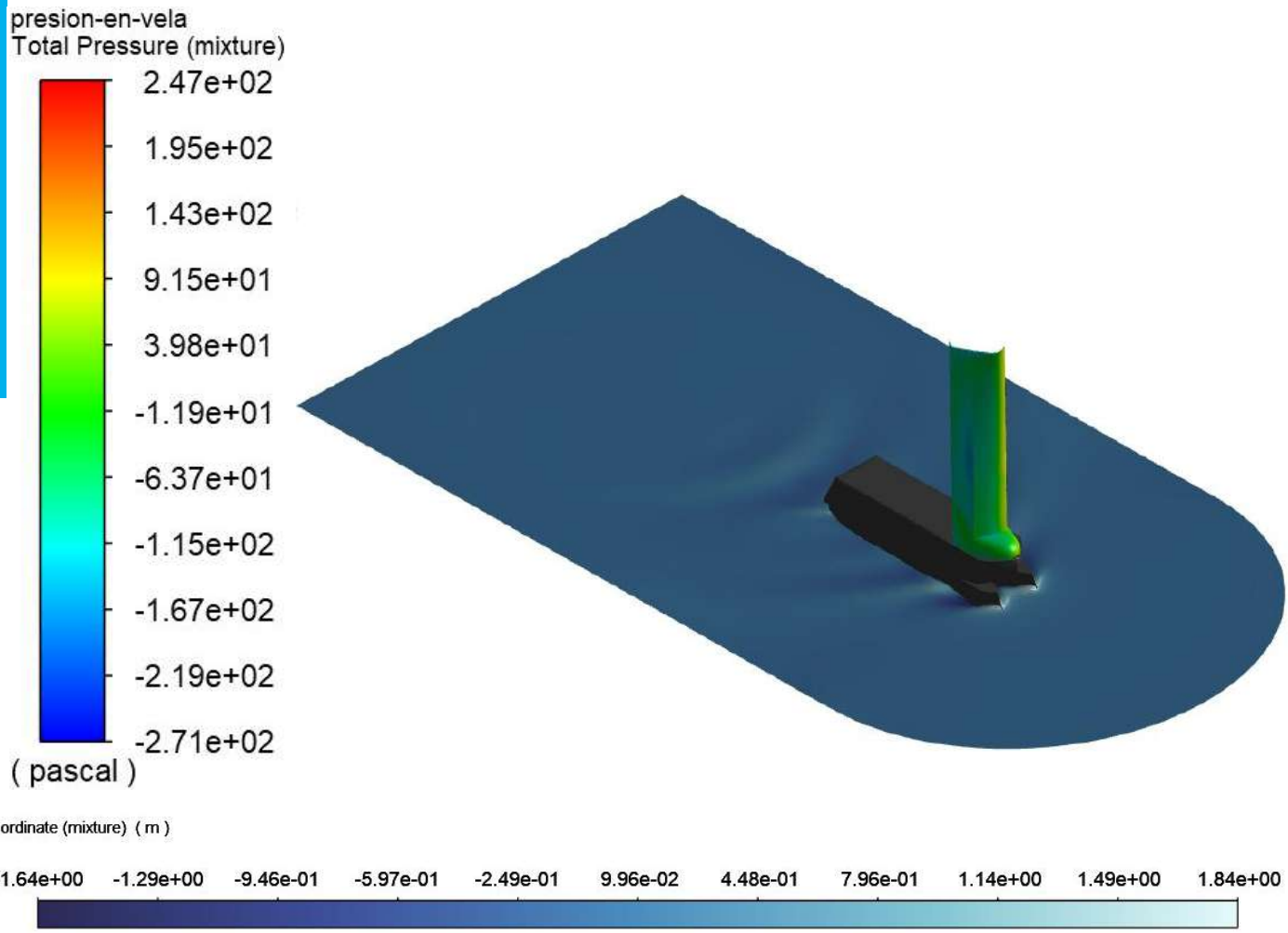
Result at 0°


presion-en-vela
Total Pressure (mixture)
1.78e+02
1.40e+02
1.01e+02
6.29e+01
2.46e+01
-1.38e+01
-5.21e+01
-9.05e+01
-1.29e+02
-1.67e+02
-2.05e+02
(pascal)
olas
Z-Coordinate (mixture) (m)
-1.74e+00
-1.39e+00
-1.03e+00
-6.83e-01
-3.31e-01
2.13e-02
3.73e-01
7.25e-01
1.08e+00
1.43e+00
1.78e+00

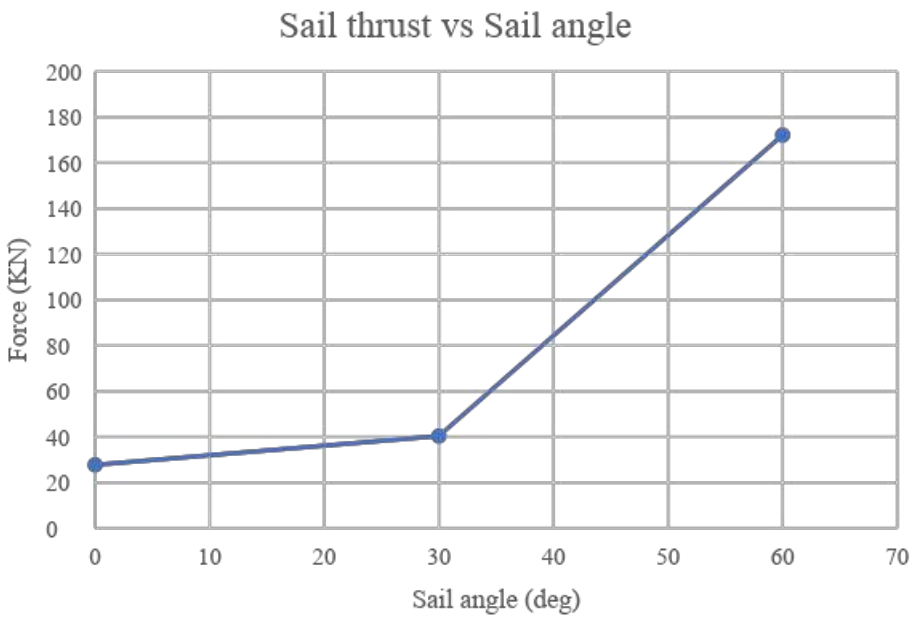
Result at 30°


presion-en-vela
Total Pressure (mixture)
2.10e+02
1.70e+02
1.29e+02
8.90e+01
4.87e+01
8.43e+00
-3.18e+01
-7.21e+01
-1.12e+02
-1.53e+02
-1.93e+02
(pascal)
olas
Z-Coordinate (mixture) (m)
-1.69e+00
-1.34e+00
-9.93e-01
-6.44e-01
-2.96e-01
5.30e-02
4.02e-01
7.50e-01
1.10e+00
1.45e+00
1.80e+00

Result at 60°

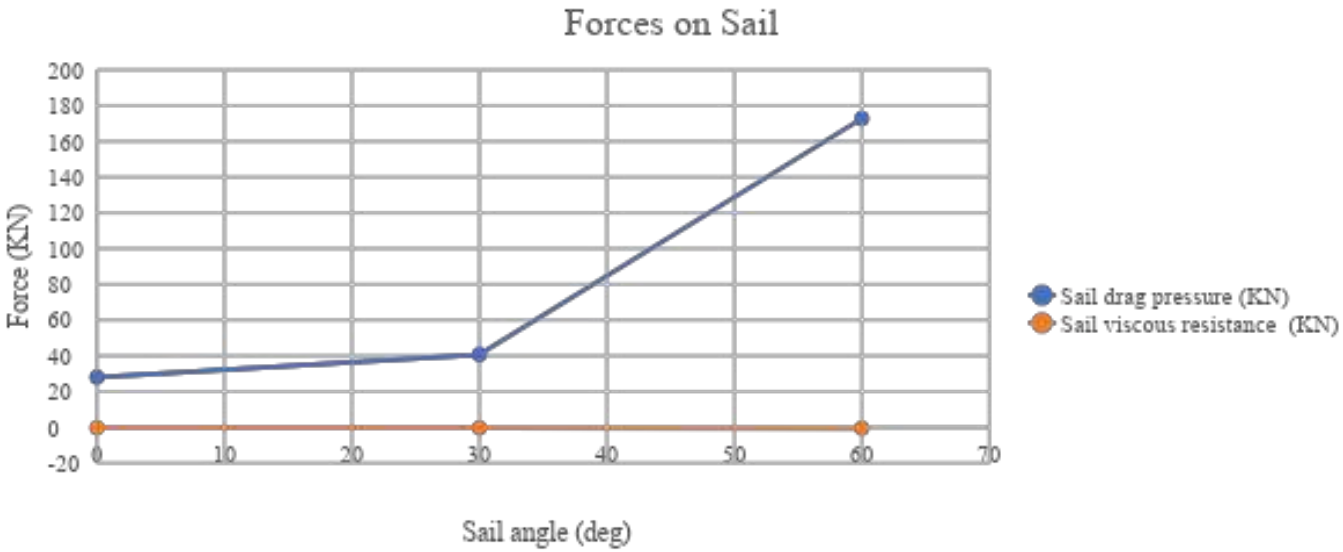

presion-en-vela
Total Pressure (mixture)
2.47e+02
1.95e+02
1.43e+02
9.15e+01
3.98e+01
-1.19e+01
-6.37e+01
-1.15e+02
-1.67e+02
-2.19e+02
-2.71e+02
(pascal)
olas
Z-Coordinate (mixture) (m)
-1.64e+00
-1.29e+00
-9.46e-01
-5.97e-01
-2.49e-01
9.96e-02
4.48e-01
7.96e-01
1.14e+00
1.49e+00
1.84e+00

Results



Sail angle	Sail thrust (N)	Hull + Sail Force (N)
0°	27755.07	-265329.92
30°	40366.98	-261841.17
60°	172243.48	-208779.83

Results



Sail angle	Sail viscous resistance (N)	Sail drag pressure (N)
0°	-267.82465	28022.896
30°	-347.33	40714.31
60°	-533.19	172776.67

THANKS