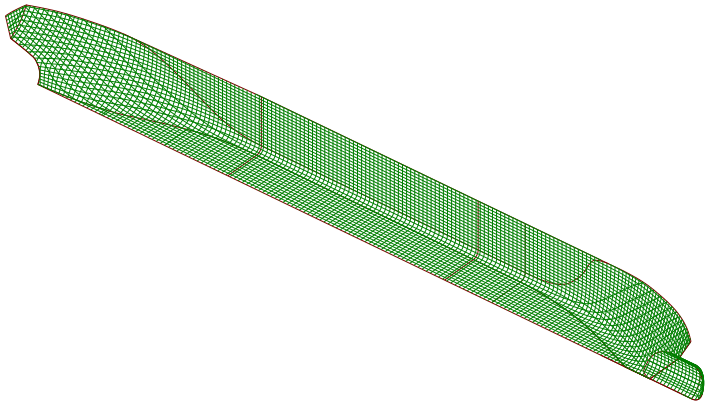
MARINE SOFTWARE INTEGRATION

Date: 7/16/2020

Project "XXXXXXX" Bulbous bow shape optimization.



Symbols:

Lpp	Length between perpendiculars
Loa	Length over all
B	Maximum breadth
D	Total vessel height
Ti	Draft for the i-th load condition
mi	Displacement for the i-th load condition
LCGi	Longitudinal centre of gravity for the i-th load condition
Vj	Speed in knots of the j-th speed condition
Frj	Froude number for the j-th speed
Ft	Total resistance
Fp	Pressure resistance
Fv	Viscous resistance
Ct	Total resistance coefficient
Cp	Pressure resistance coefficient
Cv	Viscous resistance coefficient
S	Wetted surface during sailing
z	Dynamic sinkage relative to hydrostatic condition. Positive denotes upward displacement
ϕ	Dynamic trim angle, positive denotes bow down trim
ϕs	Static trim angle, positive denotes bow down trim

Purposes for bulbows bow optimization:

The main goal of the optimization:

1. Try to minimize bulbous bow resistance,
2. Keep same displacement and longitudinal position of center of buoyancy same as ship with original bow.
3. Satisfy requirements to keep position of collision bulkhead same as before hull modernization.

As basis used resistance calculation of original lightened vessel for speed 12 knots and two loading conditions: 3m and 6.65m drafts.

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Ship with original bulbous bow

Ship particulars

Lpp	112 m
Loa	119 m
B	14 m
D	9.33 m

Load condition 1

T_1	3.0 m
m_1	3757.623205 t
LCG_1	61.9418170333 m
V_1	12 kt
Fr_1	0.186

Load condition 2

T_1	6.65 m
m_1	8912.912702 t
LCG_1	55.7045746263 m
V_1	12 kt
Fr_1	0.186

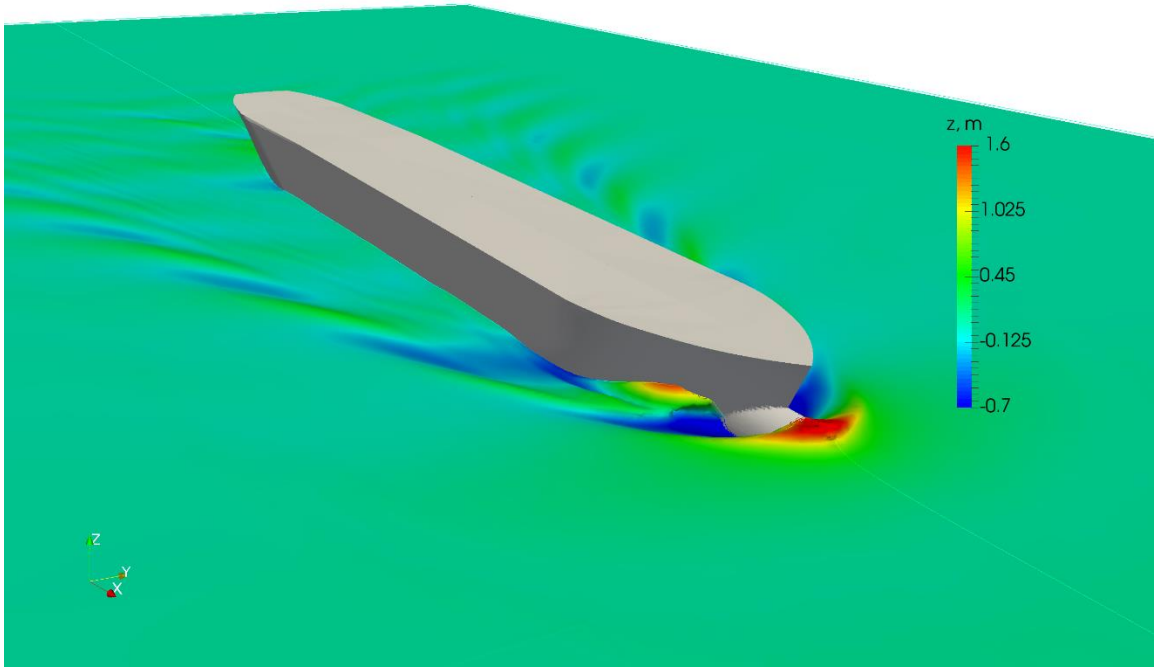
Resistance data load condition 1

Velocity, kt	12
Ft, N	178652.993
Fp, N	116467.086
Fv, N	62185.906
$Ct \times 10^3$,–	4.956
$Cp \times 10^3$,–	3.231
$Cv \times 10^3$,–	1.725
S, m^2	1845.816
z, m	-0.153
ϕ, o	0.025
ϕ_S, o	0.958

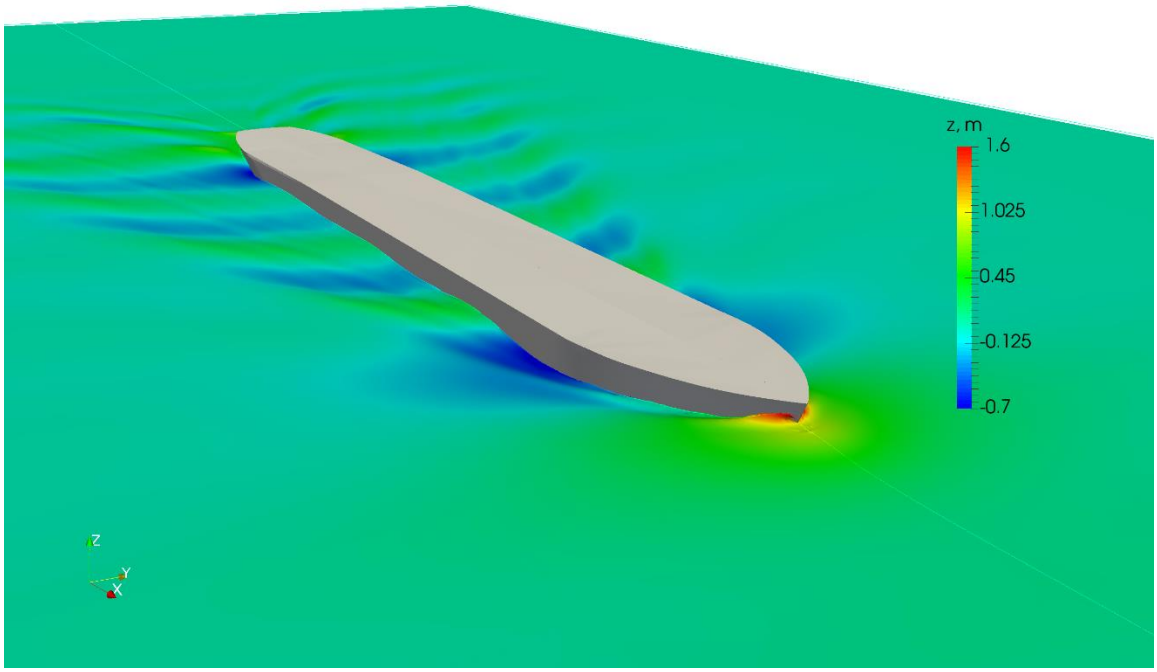
Resistance data load condition 2

Velocity, kt	12
Ft, N	145328.751
Fp, N	55232.273
Fv, N	90096.478
$Ct \times 10^3$,–	2.704
$Cp \times 10^3$,–	1.027
$Cv \times 10^3$,–	1.676
S, m^2	2752.719
z, m	-0.131
ϕ, o	0.064
ϕ_S, o	-0.204

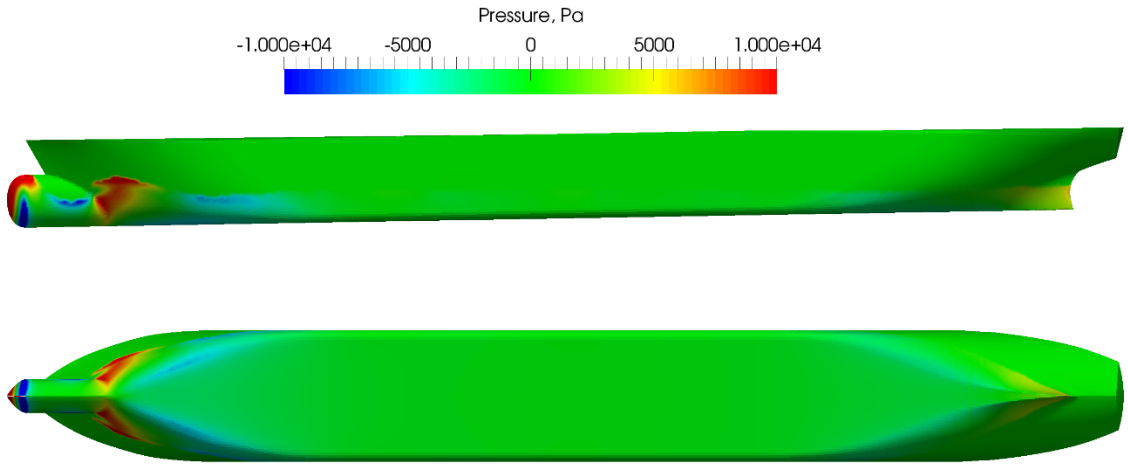
Load conditions 1 Perspective view for ship with original bulbous bow



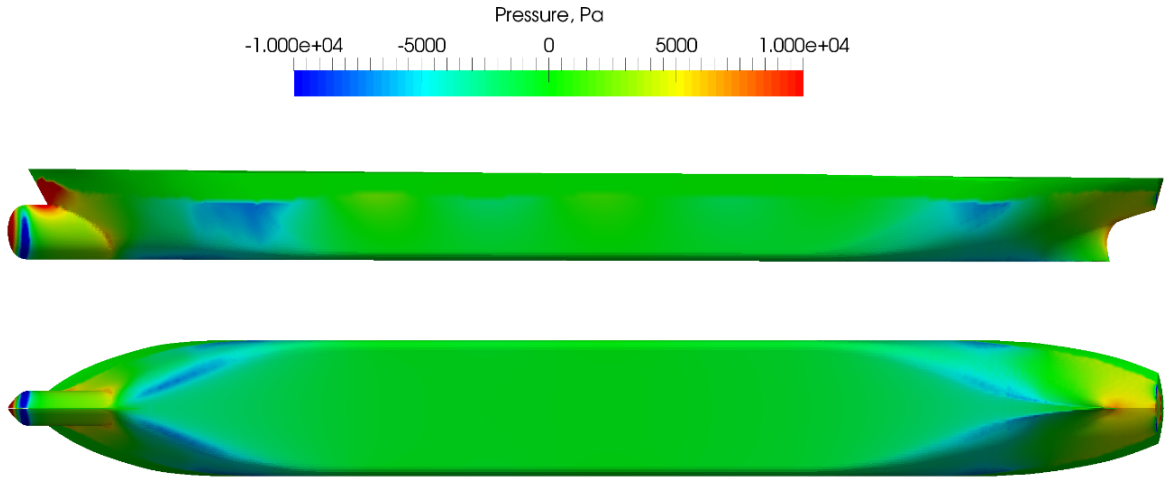
Load conditions 2 Perspective view for ship with original bulbous bow



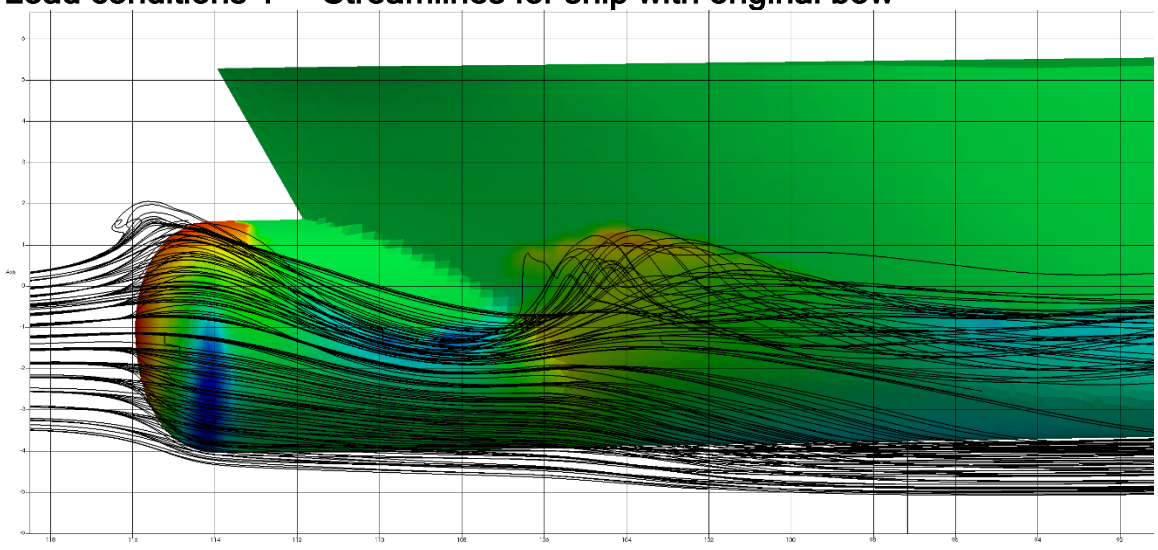
Load conditions 1 Pressure distribution for ship with original bow



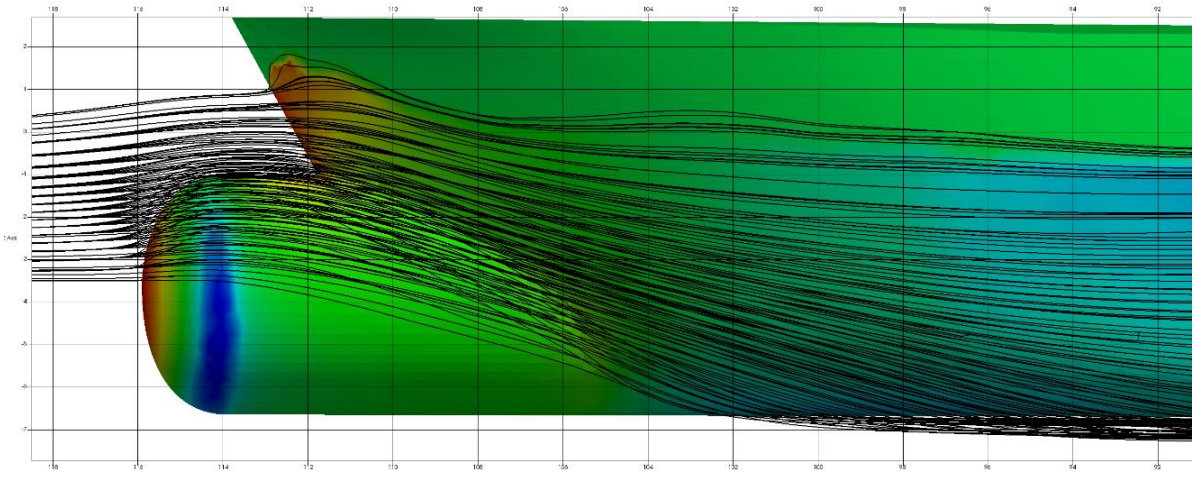
Load conditions 2 Pressure distribution for ship with original bow



Load conditions 1 Streamlines for ship with original bow



Load conditions 2 Streamlines for ship original bow



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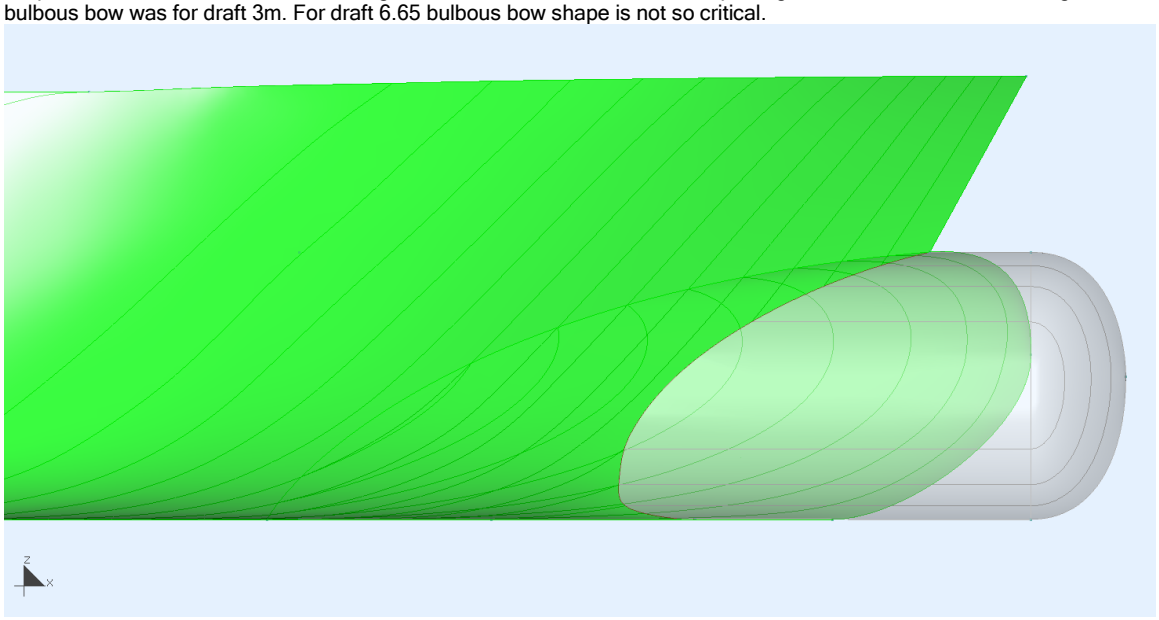
New bulbous bow proposal V1.

Proposed bulb 2 meters shorter than original and have more convenient shape. Highest resistance values for original bulbous bow was for draft 3m. For draft 6.65 bulbous bow shape is not so critical.



Grey color show original bulb shape and green one new proposal. New shape has been tested on draft 3m and speed 12 knots with following results:

Load condition1

T1	3.0 m
m1	3757.93284 t
LCG1	61.8396133601 m
V1	12 kt
Fr1	0.186

Resistance data load condition 1

Velocity, kt	12
Ft, N	114627.58
Fp, N	55344.226
Fv, N	59283.354
Ct × 103,	− 3.23
Cp × 103,	− 1.559
Cv × 103,	− 1.67
S, m2	1817.578
z, m	-0.16
ϕ, o	0.045
ϕ S, o	0.958

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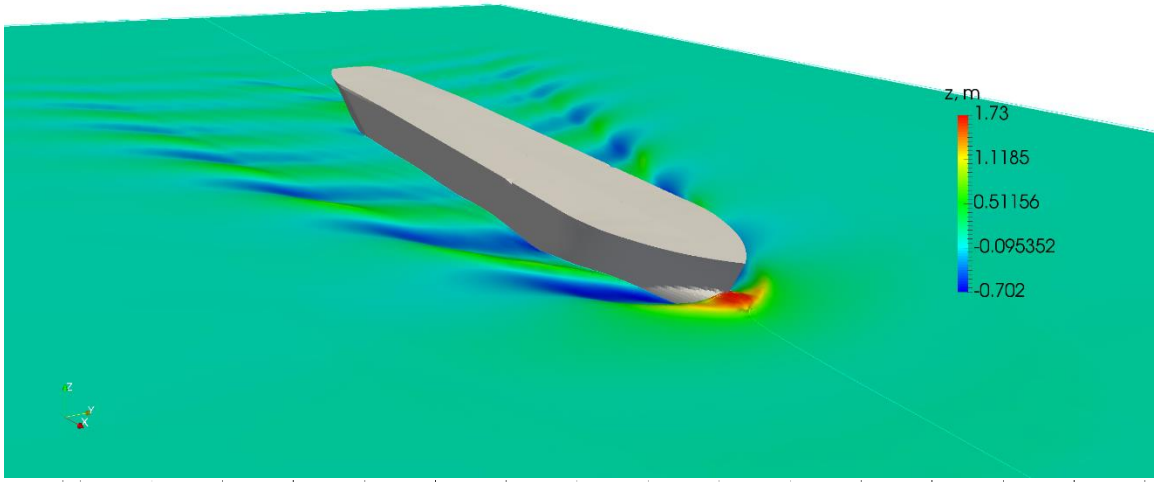
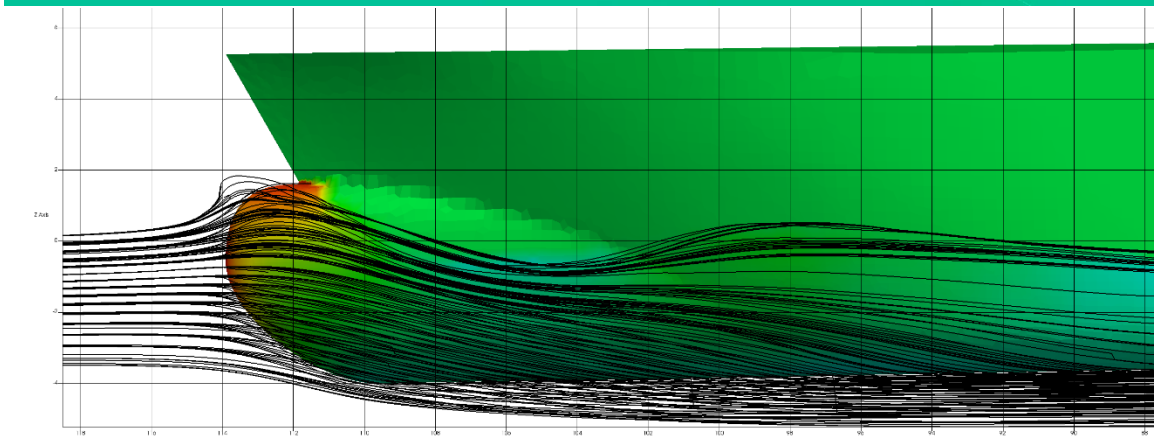
Flow pictures:





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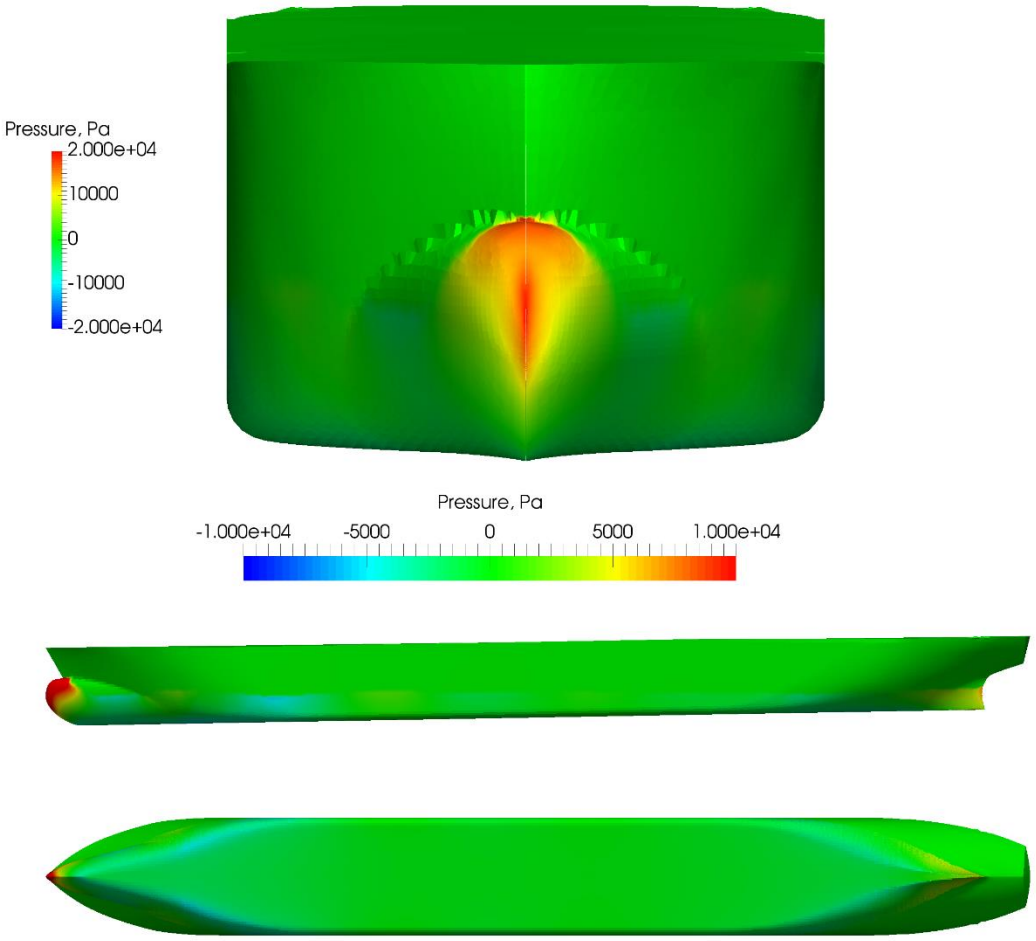

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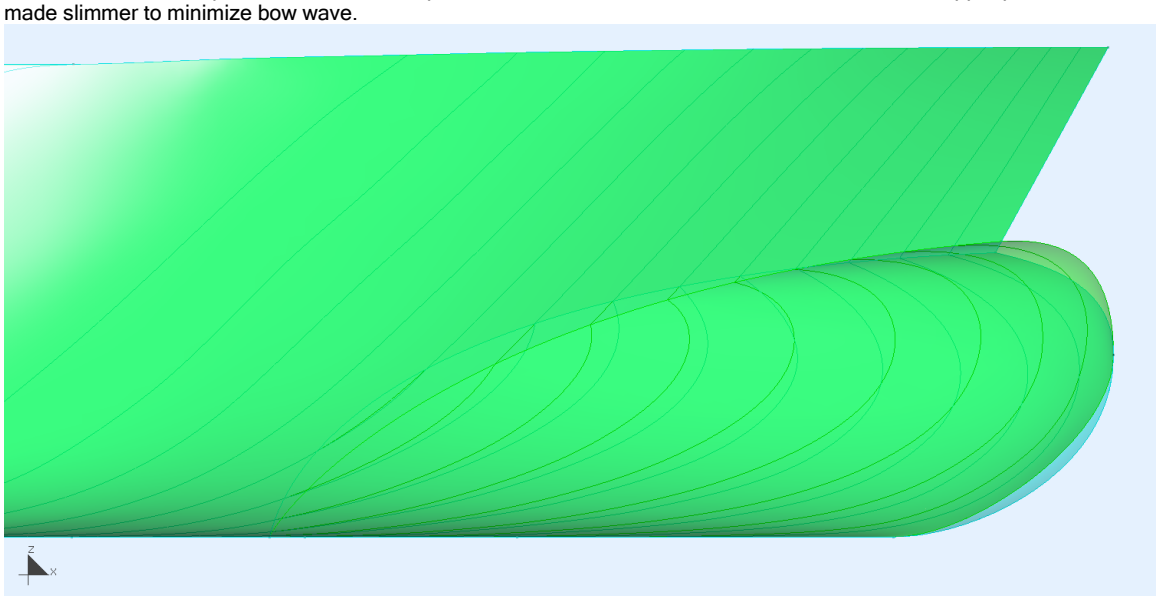
New bulbous bow proposal V2.

New bulbous bow shape based on results of previous CFD run. Bulb volume was redistributed, and upper part of bulb made slimmer to minimize bow wave.

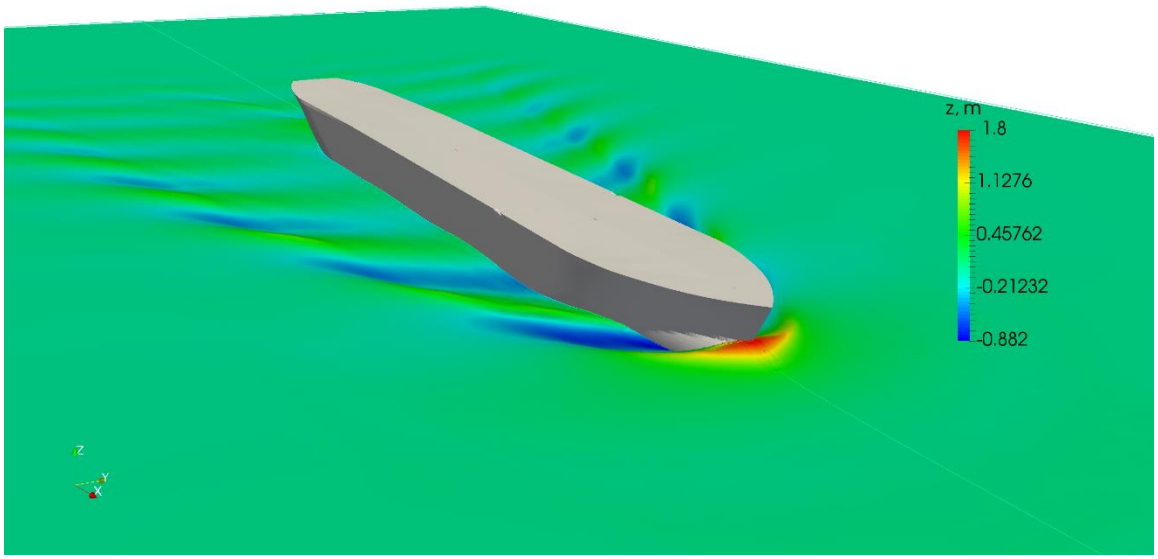


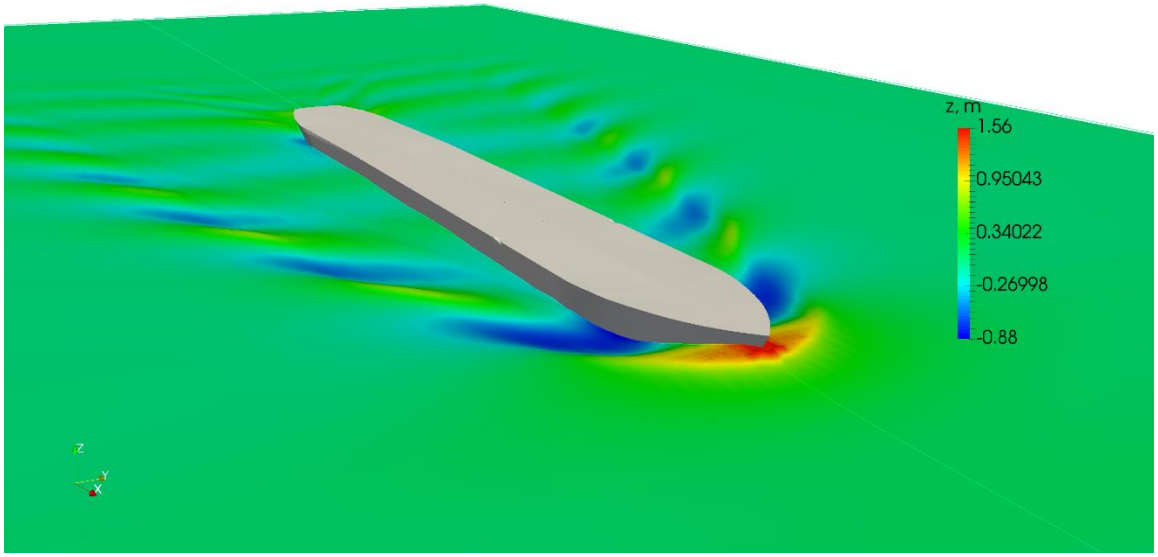
Blue shape is new proposal. After second CFD run for 3m draft, 6.65 m CFD run was performed for finally prove resistance. Changes in resistance in comparison with previous results was relatively small.

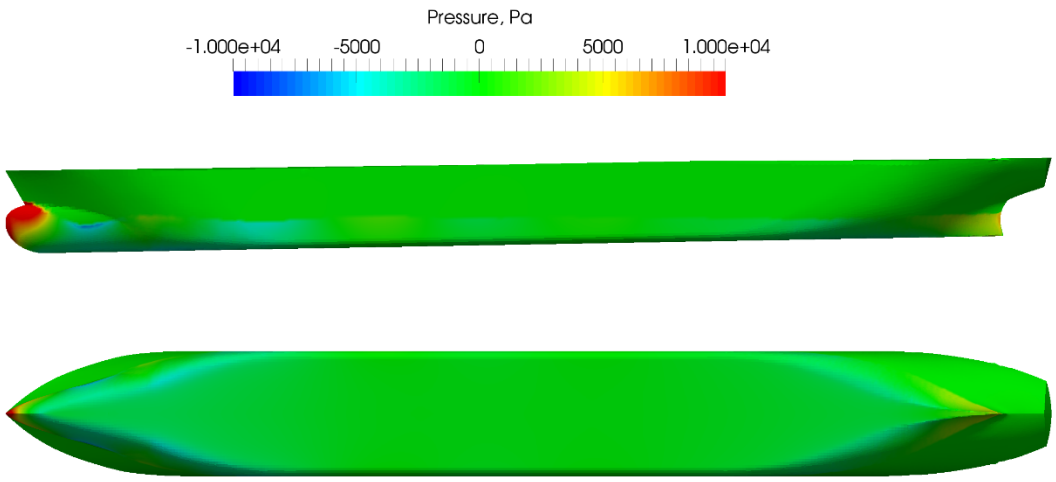
Load condition1		Load condition2	
T1	3.0 m	T2	6.65 m
m1	3766.909073 t	m2	8916.811096 t
LCG1	61.9451264717 m	LCG2	55.6896117925 m
V1	12 kt	V1	12 kt
Fr1	0.186	Fr1	0.186

Resistance data load condition 1		Resistance data load condition 2	
Velocity, kt	12	Velocity, kt	12
Ft, N	113121.411	Ft, N	103631.671
Fp, N	53254.774	Fp, N	13540.871
Fv, N	59866.637	Fv, N	90090.8
Ct × 103,	− 3.18	Ct × 103,	− 1.951
Cp × 103,	− 1.497	Cp × 103,	− 0.255
Cv × 103,	− 1.683	Cv × 103,	− 1.696
S, m2	1821.486	S, m2	2720.284
z, m	-0.167	z, m	-0.133
-, o	0.063	-, o	0.085
-S, o	0.958	-S, o	-0.204

Flow pictures:







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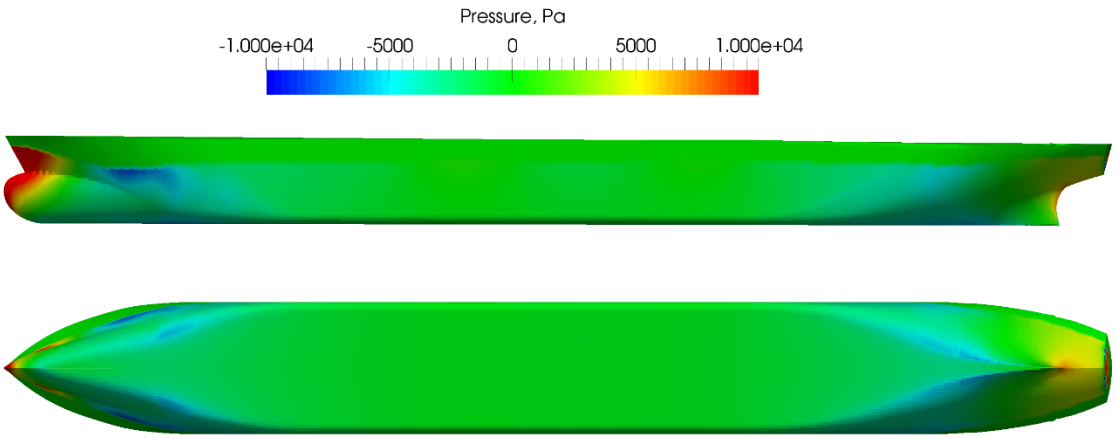

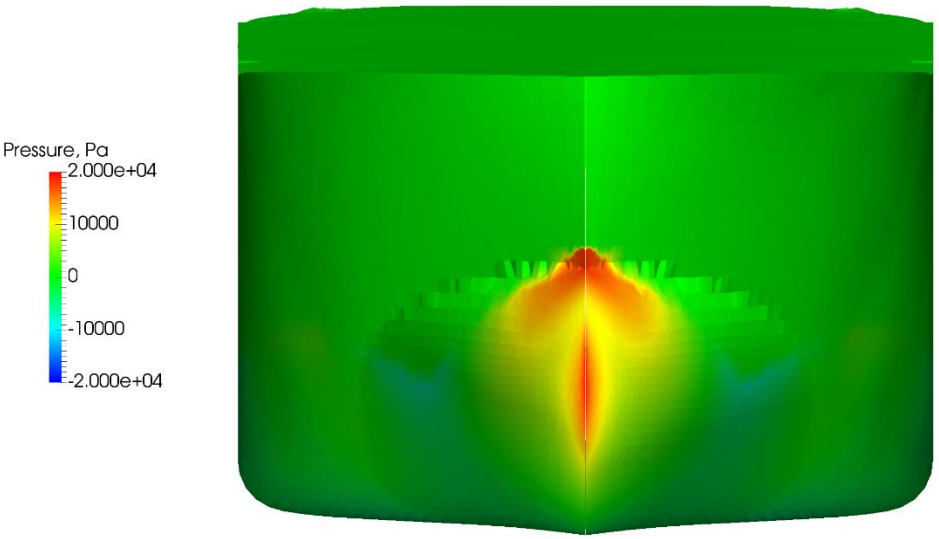

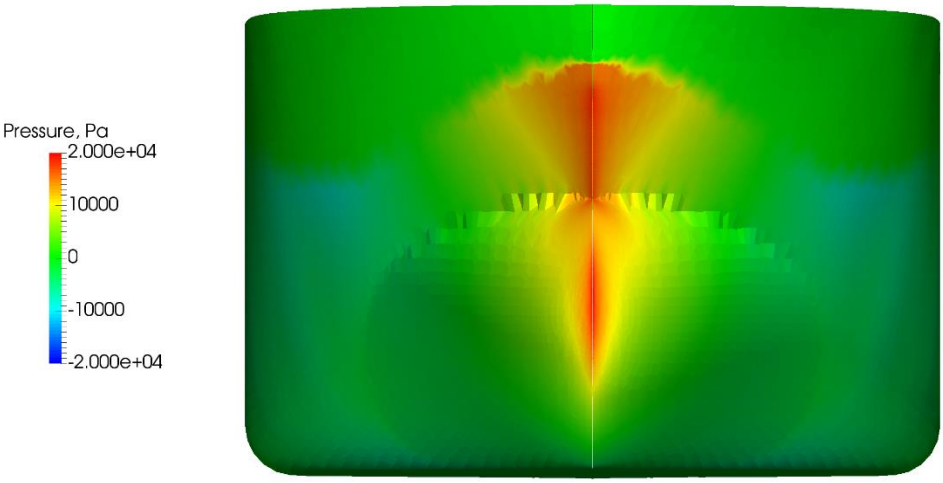

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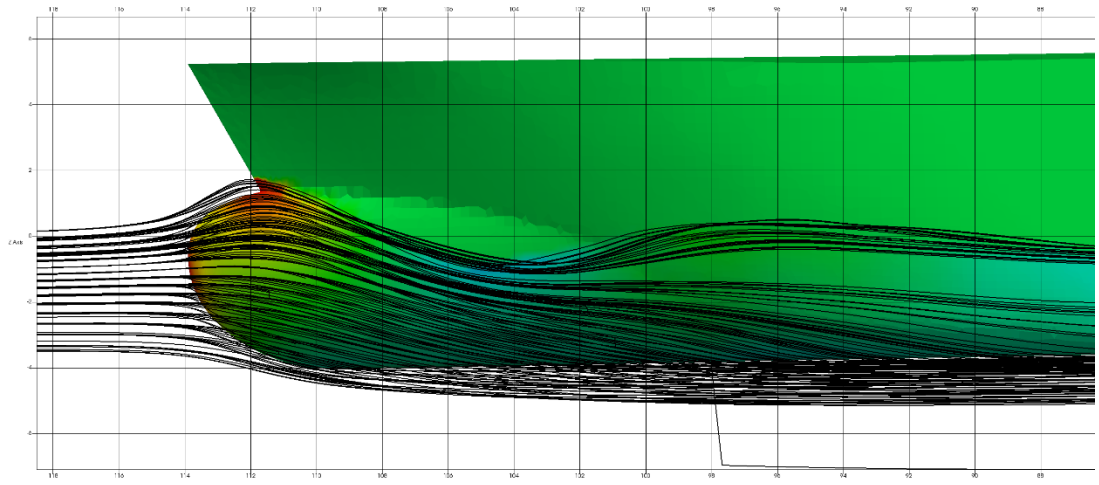
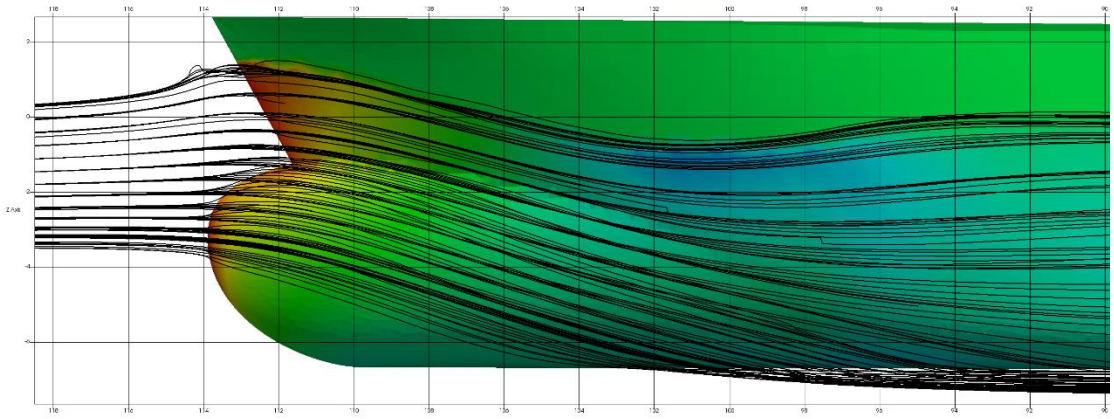




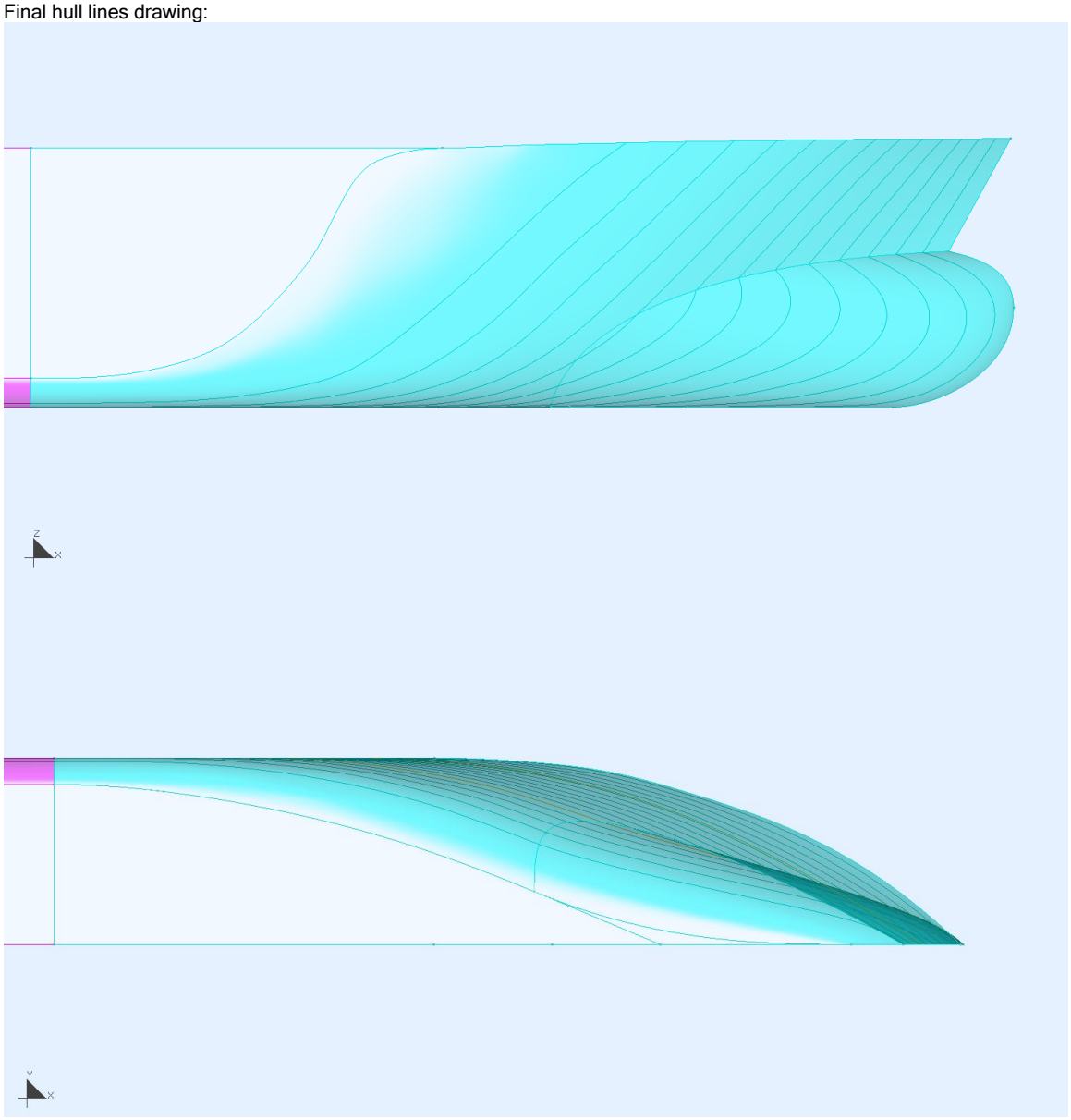
Conclusion:

Difference in resistance between first and second iteration for 3m draft:
114627.58N-113121.411N = 1506.169N It is about 1% of total resistance.
Due to little possibility for hull shape variations more optimization does not give any better result.

Final data is it followong table.

Condition	Original bulbous bow shape resistance (N)	Optimized bulbous bow shape resistance (N)	Resistance reduction in %.
1 Draft - 3m	178652.993	113121.411	-36%
2 Draft - 6.65m	145328.751	103631.671	-28%

Final hull lines drawing:



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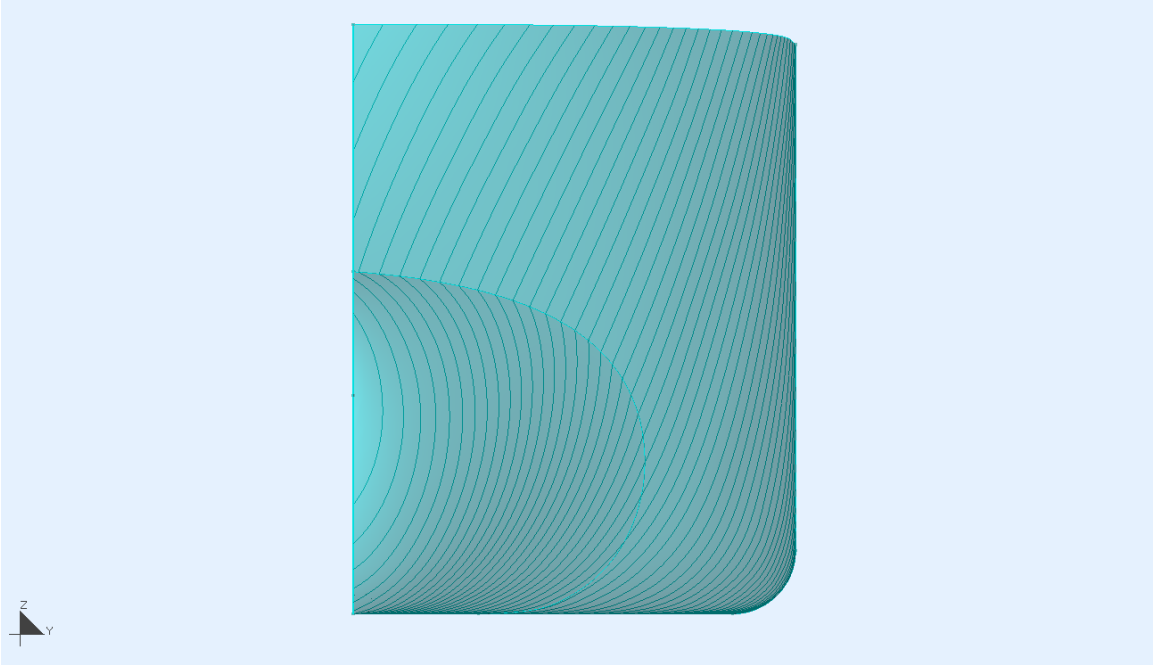

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