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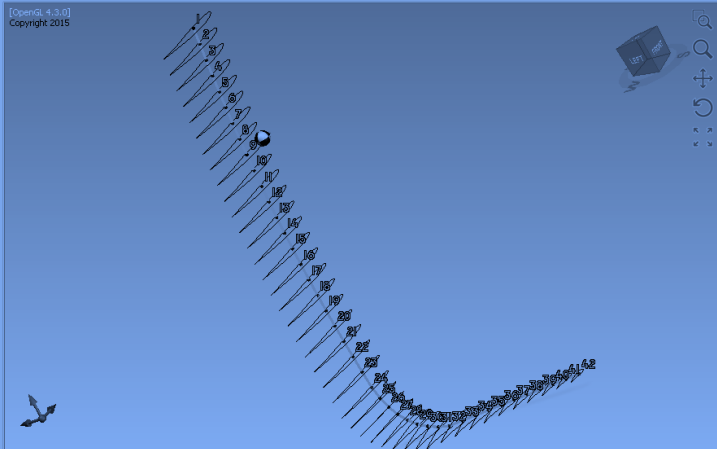
WE DO COMPOSITE STRUCTURE CALCULATION

AND WE LOVE IT !

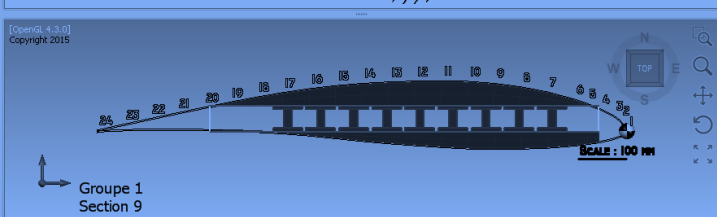


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[OpenGL 4.3.0]
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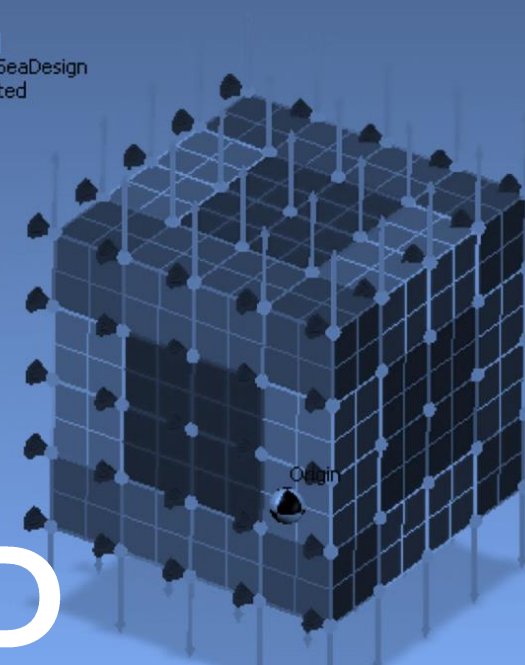


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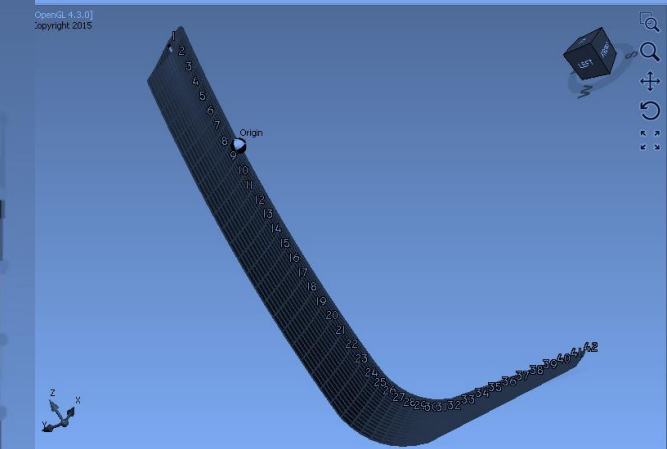


[CM2/FEM 4.0.3]
[MMF v 1.0.7.27059]
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Hardware is accelerated

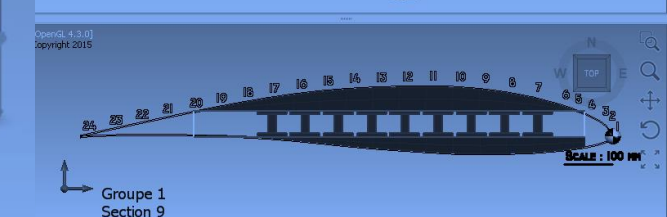
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+0.066
+0.062
+0.058
+0.053
+0.049
+0.045
+0.041
+0.036
+0.032
+0.028
+0.024
+0.019
+0.015
+0.011
+0.007
+0.002
-0.002
-0.006
-0.01
-0.019
-0.027
-0.036



[OpenGL 4.3.0]
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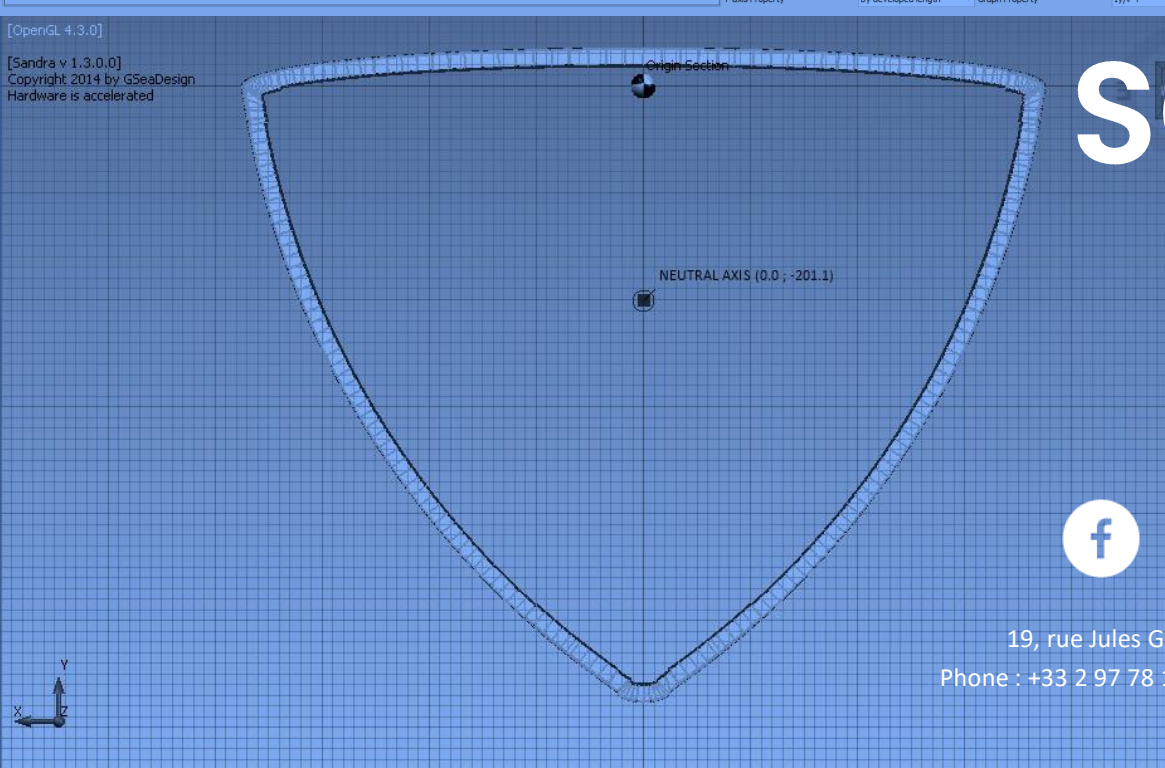


[OpenGL 4.3.0]
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[OpenGL 4.3.0]

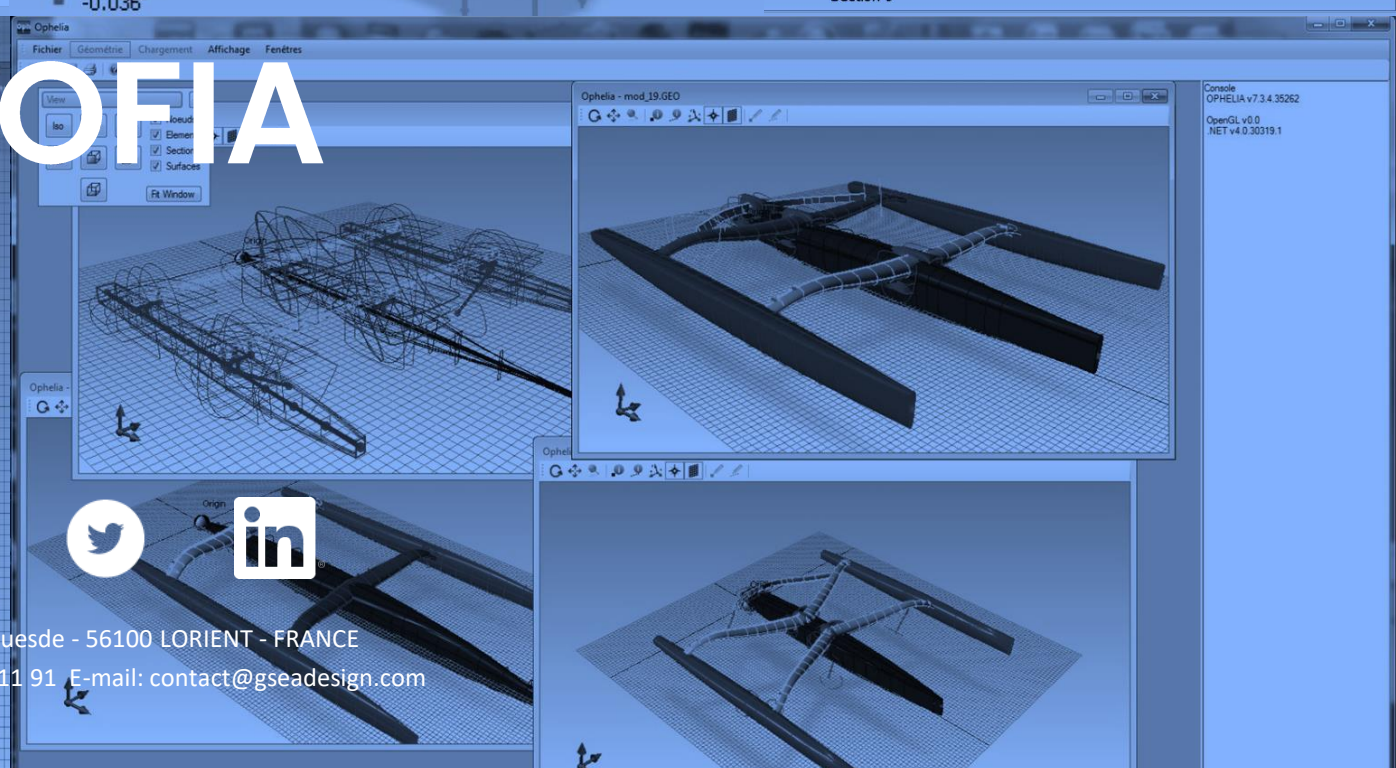
[Sandra v 1.3.0.0]
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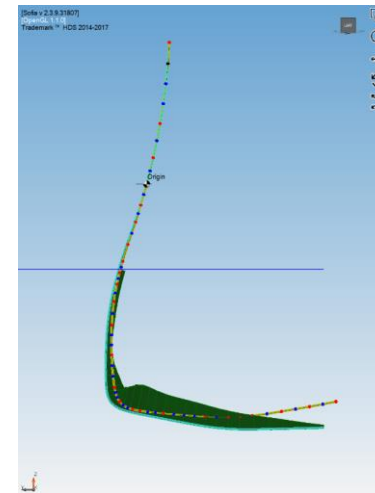
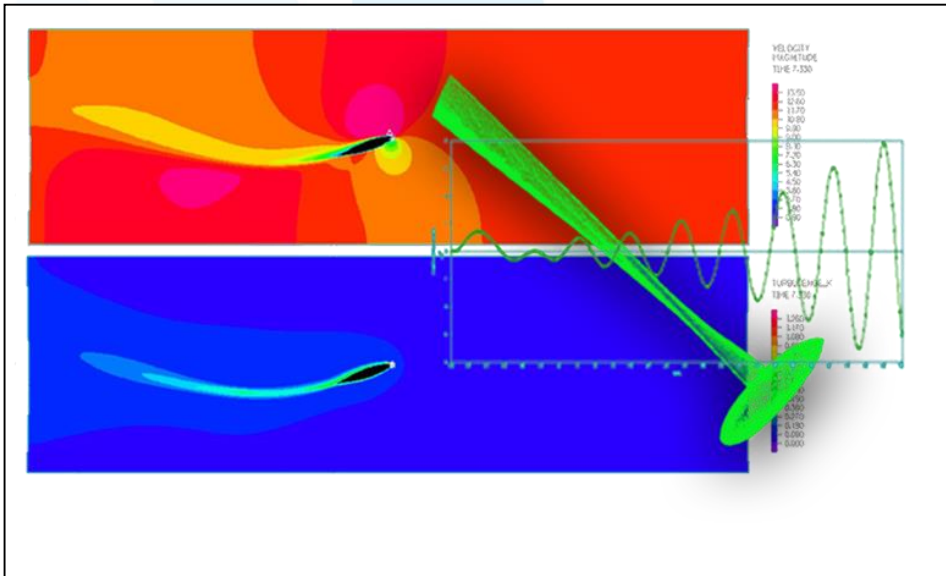
R&D SOFIA



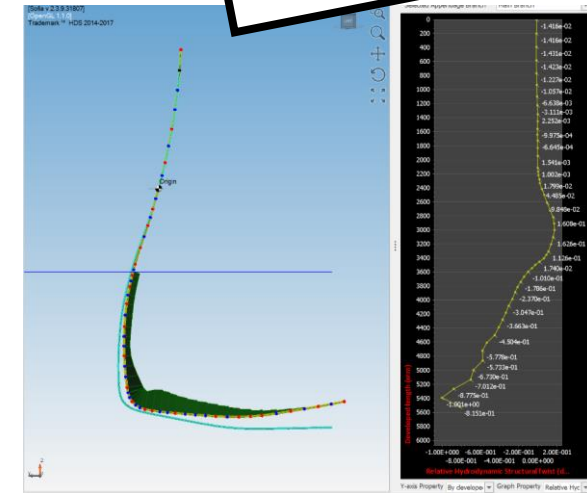
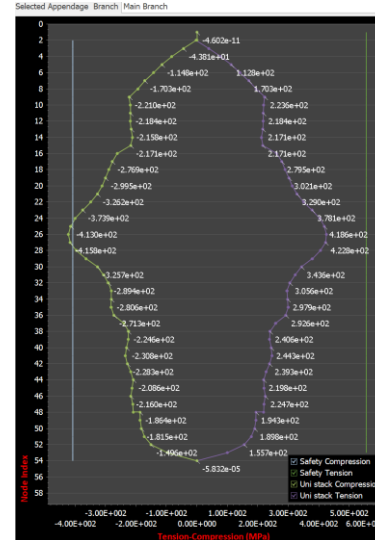
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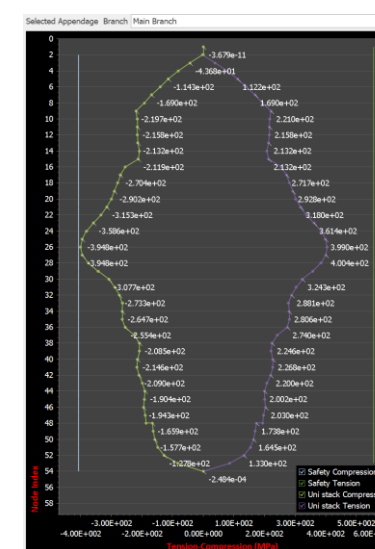
- FSI dedicated software
- 3D pannel code
- Betterment = **Torsion validated**
- Structural mechanic validated (our betterment)
- Hydrodynamic loads calculation on the **deformed shape** (structure optimization)
- Automatic calculation loops, **convergence**
- Hydrodynamic loads validation by specialist → **AVL integration**



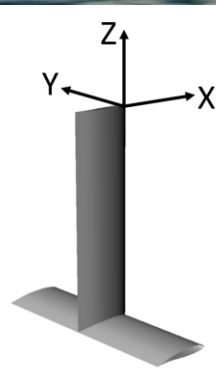
Loading on
undeformed geometry



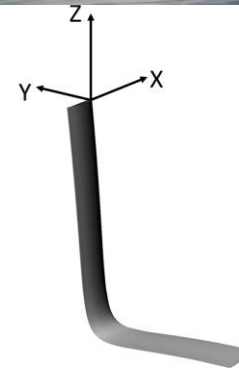
Loading on
deformed geometry



APPENDAGES



T-Shape Rudder



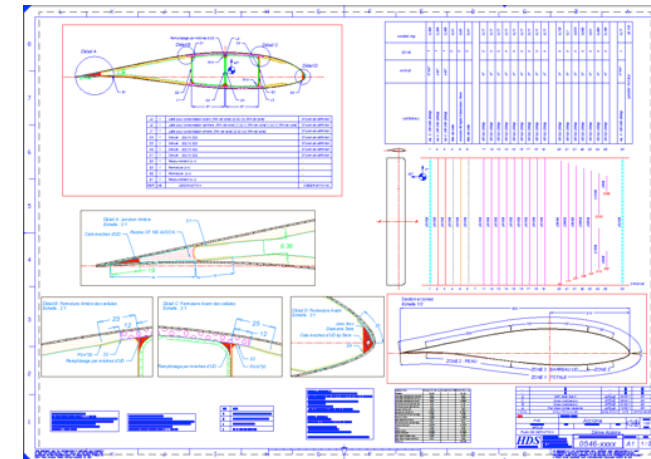
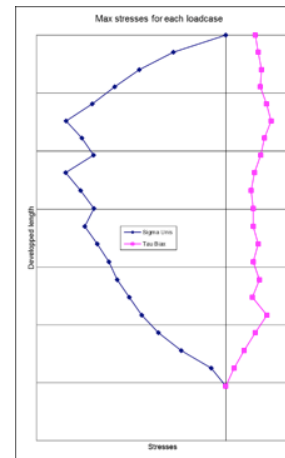
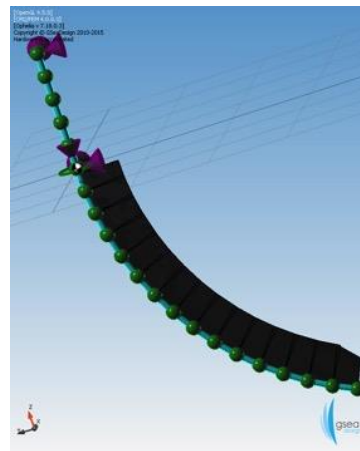
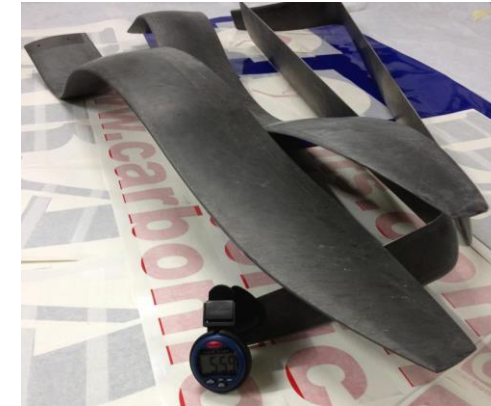
L-Shape Foil

OLD DESIGN METHOD



ANALYTICAL CALCULATION OF LOADCASE

- + STATIC ANALYSIS OF APPENDAGE
- + DESIGN – BUILDING – NAVIGATION



+

QUASI STEADY STATE

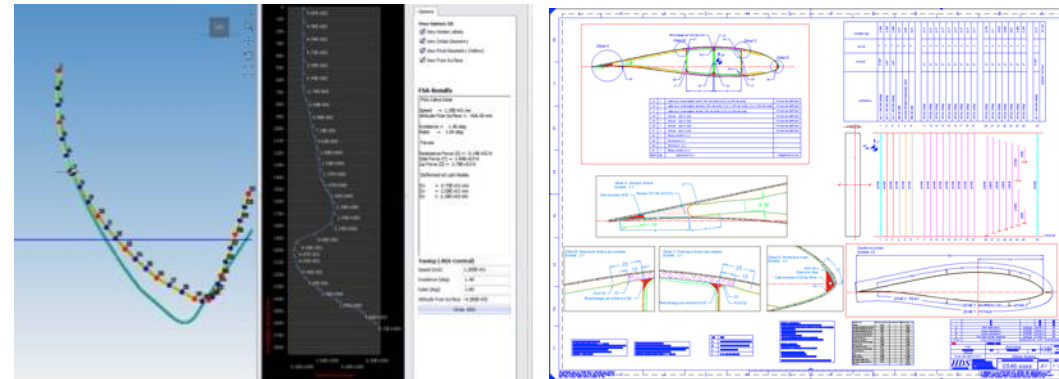
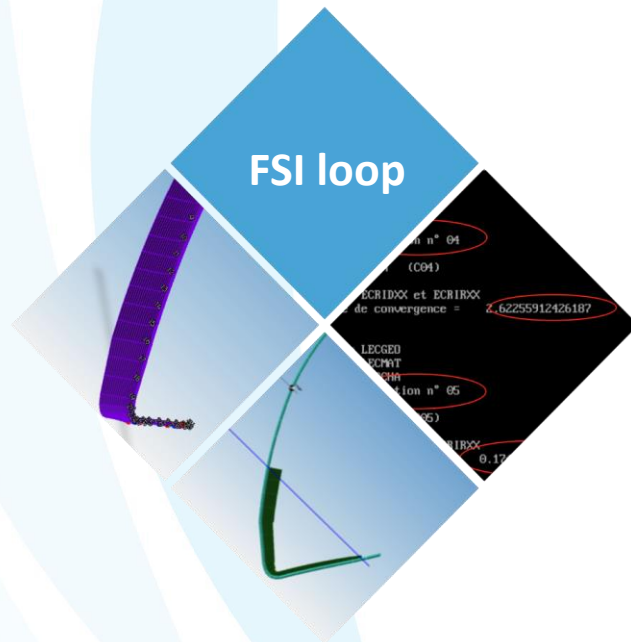
+

NUMERICAL ANALYSIS

FSI loop

gsea

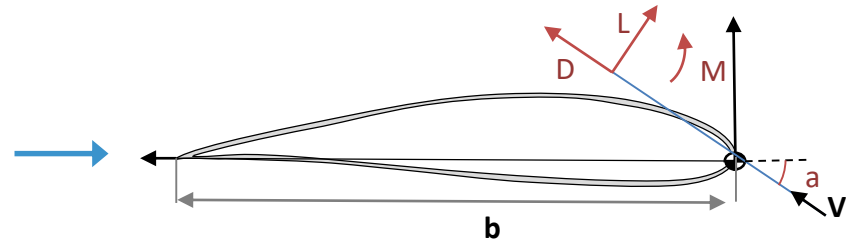
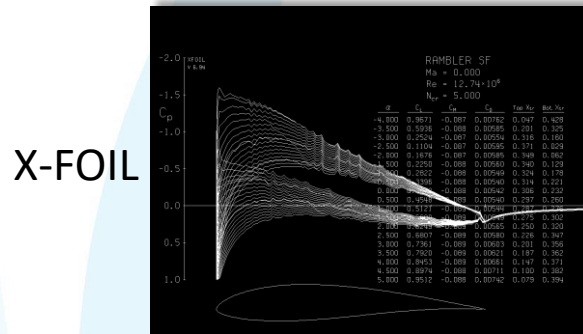
- + QUASI STEADY **NON LINEAR FLUID STRUCTURE INTERACTION (FSI)** CALCULATION
- + NUMERICAL CALCULATION OF **FLUID LOADING AT EACH STEP**



- + Final Shape
- + Final Loads
- + Final Stresses
- + Drawing

LOADING CALCULATION

+ USE OF 2D **HYDRODYNAMIC COEFFICIENTS** CURVES FOR EACH SECTION

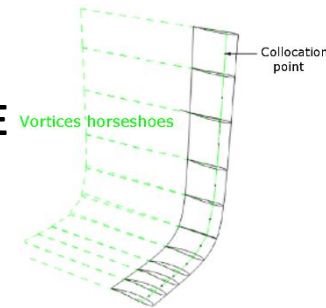


$C_L(a)$

$C_D(a)$

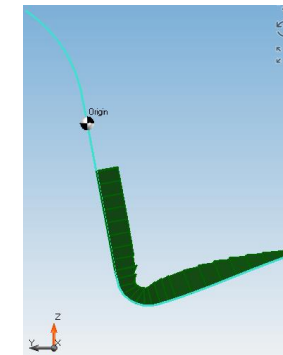
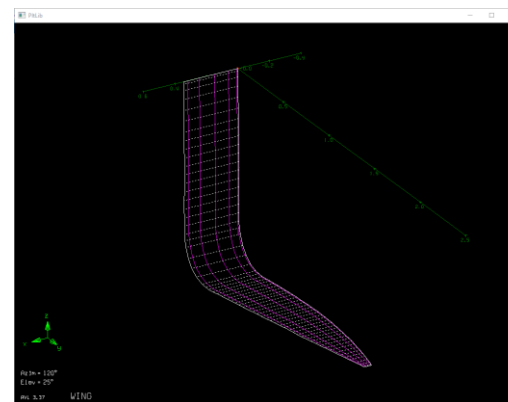
$C_M(a)$

NUMERICAL TRIDIMENSIONAL LIFTING LINE



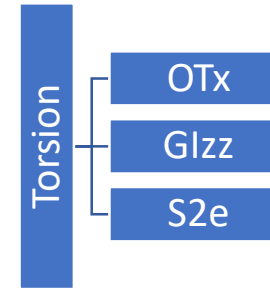
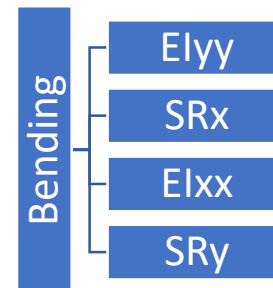
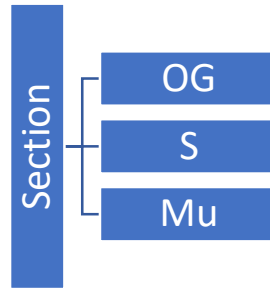
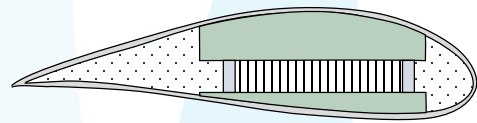
+ OR

VORTEX LATTICE (AVL)

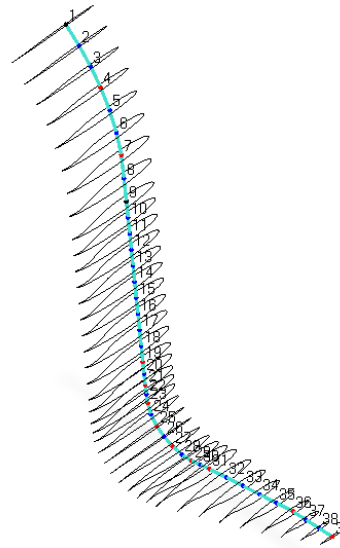
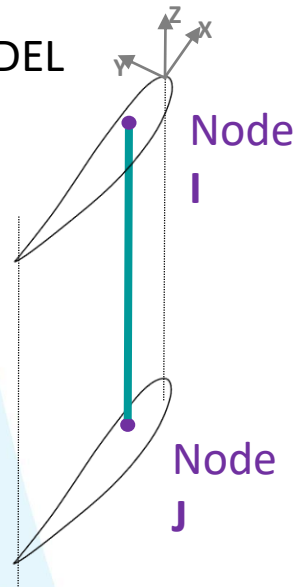


STRUCTURAL MODEL

+ SEMI ANALYTICAL MODEL TO CHARACTERISE SECTION MECHANICAL PROPERTIES

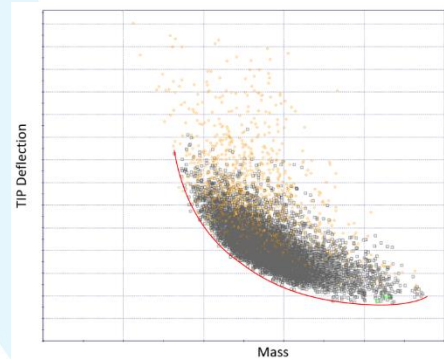
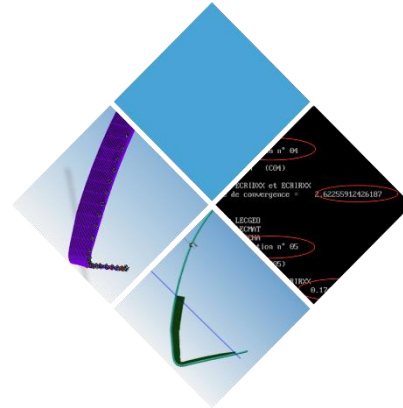
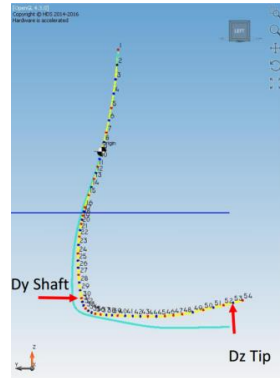


+ BEAM MODEL



POSSIBILITIES

+ OPTIMIZE THE STRUCTURE OF APPENDAGES



+ Optimization for VPPs (Pareto Frontier)

+ TUNE APPENDAGES



+ Find cant* and rake angles to reach target loads (sideforce/upforce) needed for boat equilibrium



OPTIMIZATION - HYPERSTUDY

IN-HOUSE SOFTWARE

Optimization

- Optimization algorithm : MOGA Genetic
- Variables (42)
 - UD width (BUD)
 - Shear web thickness (e)
 - Webs width (L)
- Goals (3)
 - Min. Mass
 - Min. Vertical Tip Deflection
 - Min. Horizontale Shaft Deflection
- Constraints (76)
 - UD Stress Compression
 - UD Stress Traction
 - Web Shear stress

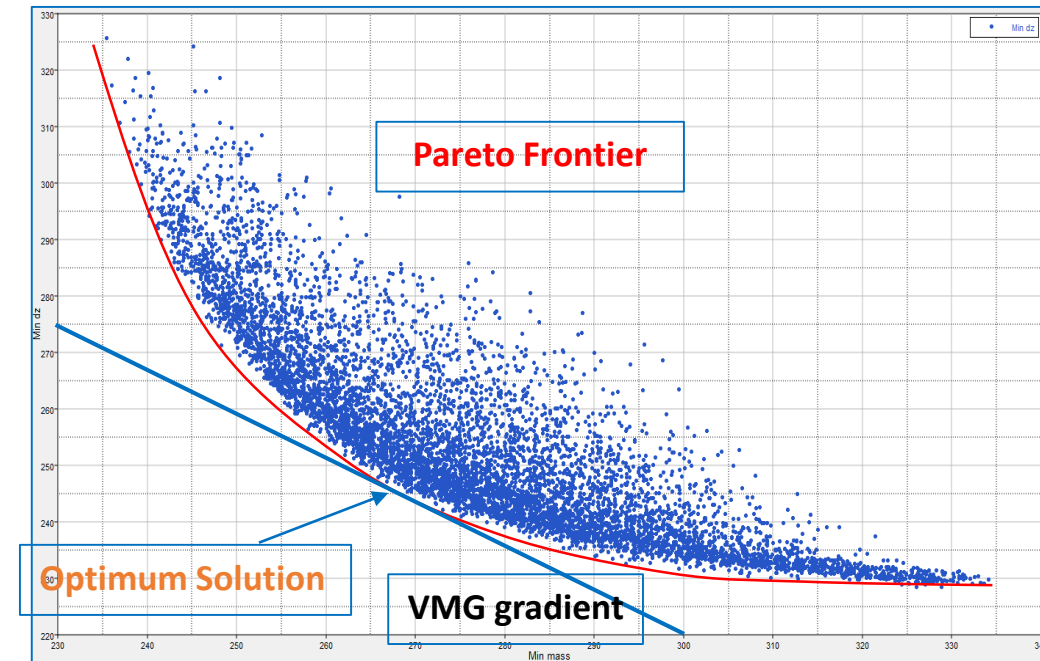
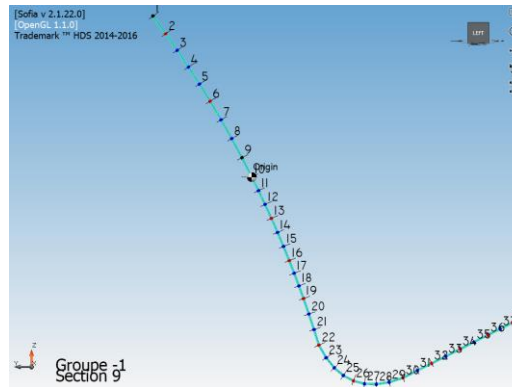
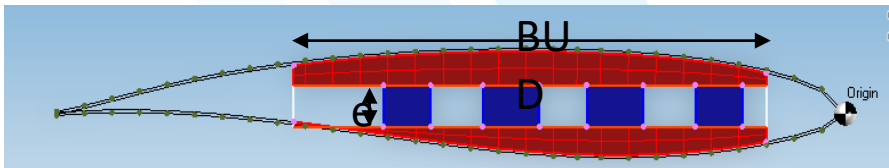
Calculation loop

SOFIA / FSI

Calculation time

- Optimization time = 12h
- Loop time = ~7.5 s / loop
- Model numbers = 7500
- 27 generations

Goal :
To bring up Pareto frontier
Stiffness/Mass





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