0307 – The CFD simulation of the flow around a glider

Description

A goal of this verification example is to analyze the fluid flow around the glider according to **Figure 1**. The task is to determine the drag coefficient c_x and lift coefficient c_y with respect to the angle of attack α. These coefficients can be also drawn into the graph of drag polar. From the velocity field can be also determined the limit angle for laminar fluid flow around the wing profile. The available 3D CAD model (STL file) is used in RWIND 2.

Fluid Properties	Kinematic Viscosity	ν	$1.500 \cdot 10^{-5}$	m^2/s
	Density	ρ	1.250	kg/m^3
Geometry	Reference Area	A	19.200	m^2
Load	Fluid Inlet Velocity	u	30.000	m/s

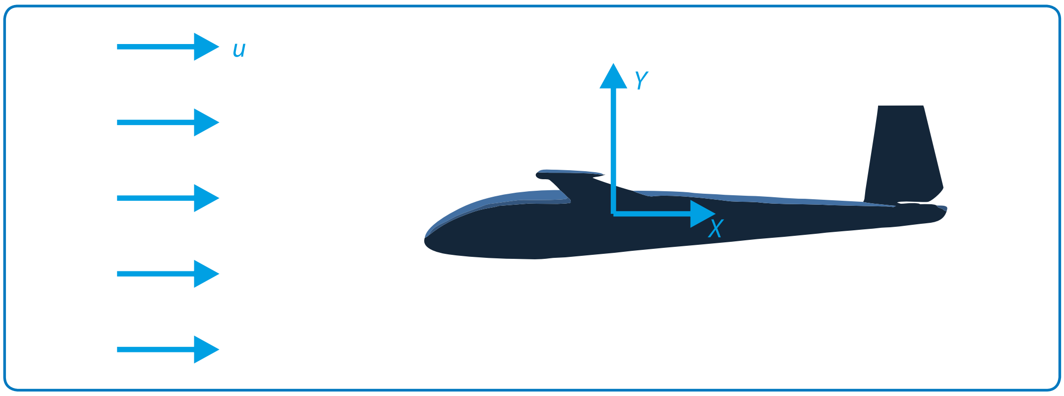

Figure 1: Problem Sketch

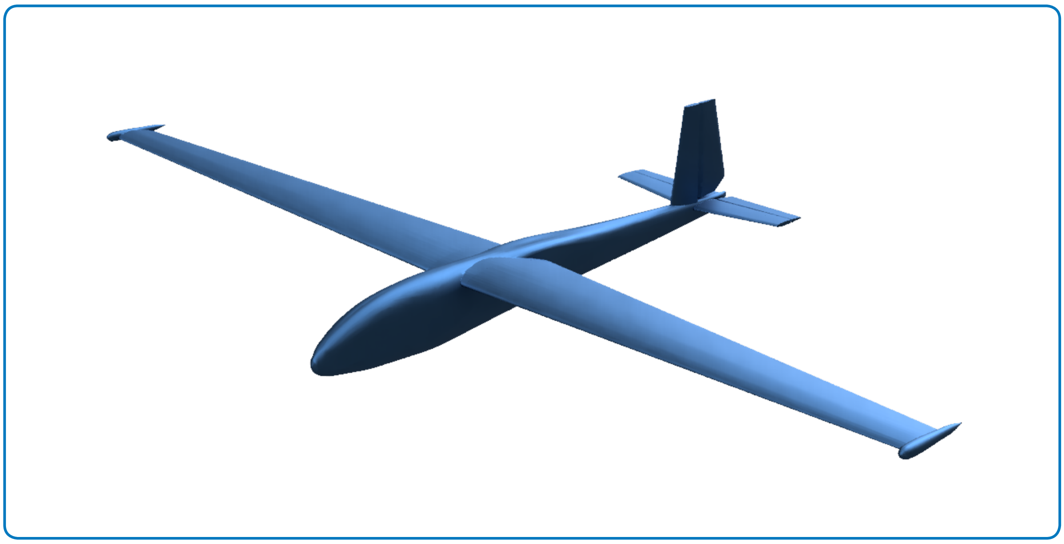

Figure 2: Glider 3D CAD model

RWIND Simulation Settings

- Modeled in RWIND 2.02
- Stady flow simulation type is used
- Mesh density is 30 %
- Number of boundary layers is 5
- RAS k-epsilon turbulence model is used

Results

Structure Files	Program
0307.01	RWIND Simulation 2

In RWIND Simulation 2 several analysis are performed for angle of attack α in range from -5° to 25°. Lift force (vertical) Y and drag force (horizontal) X are taken as a result from RWIND Simulation 2 and further postprocessed according the following formulas to obtain the desired coefficients.

$$c_x = \frac{2X}{\rho u^2 A} \tag{307 – 1}$$

$$c_y = \frac{2Y}{\rho u^2 A} \tag{307 – 2}$$

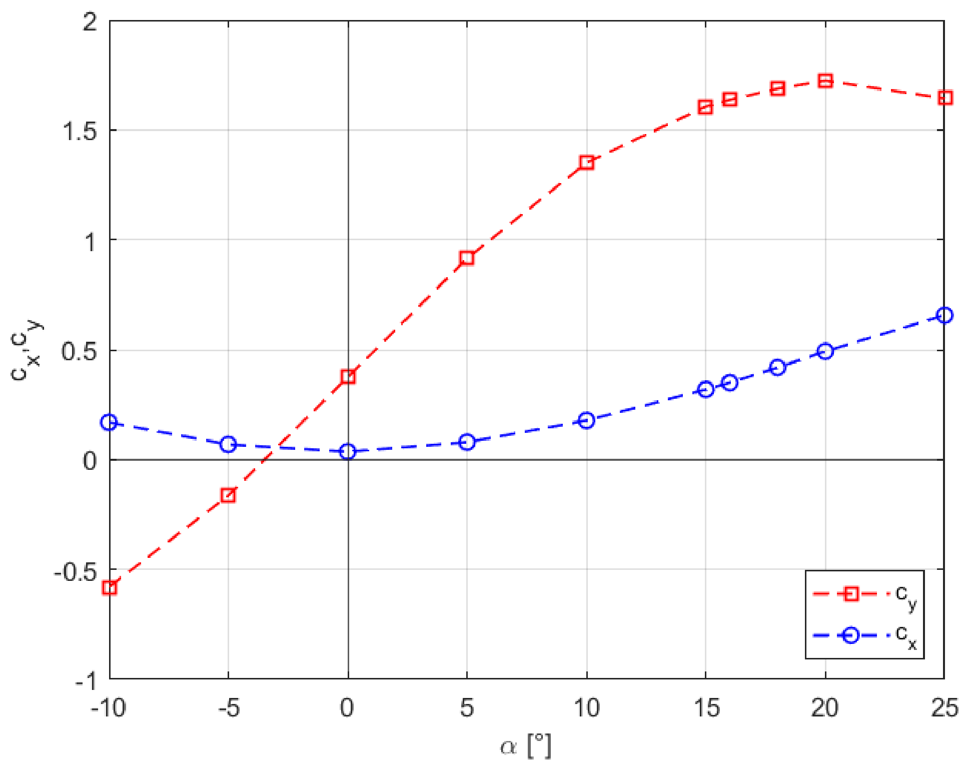

Figure 3: Drag and lift coefficeients c_x, c_y depenedency on angle of attack α

In **Figure 3** there can be seen the rapid increase of the lift and visible point with the maximum lift corresponding to the angle of attack 18°, then gradual decrease follows. Also the increase of the drag coefficient with incrasing angle of attack is evident.

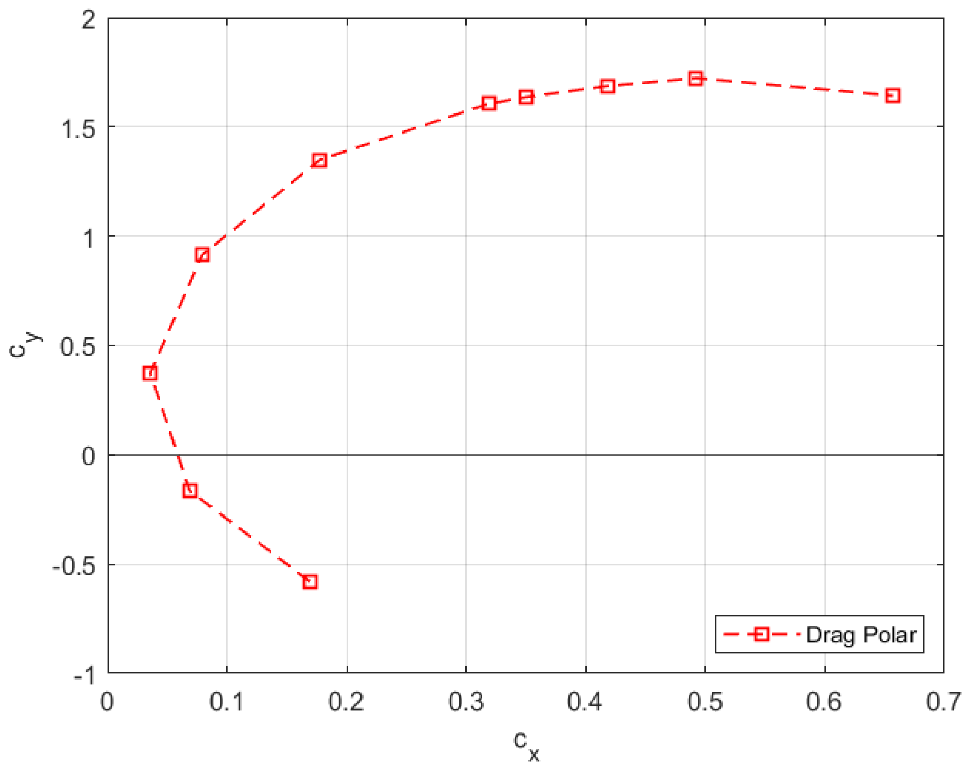

Figure 4: Drag polar of the glider

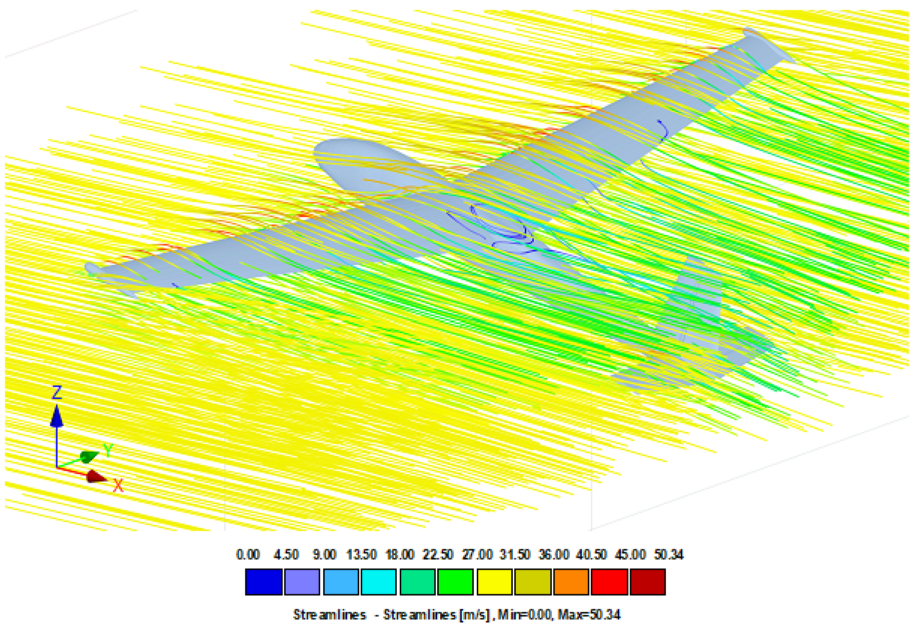

Figure 5: Velocity streamlines for angle of attack $\alpha = 18°$

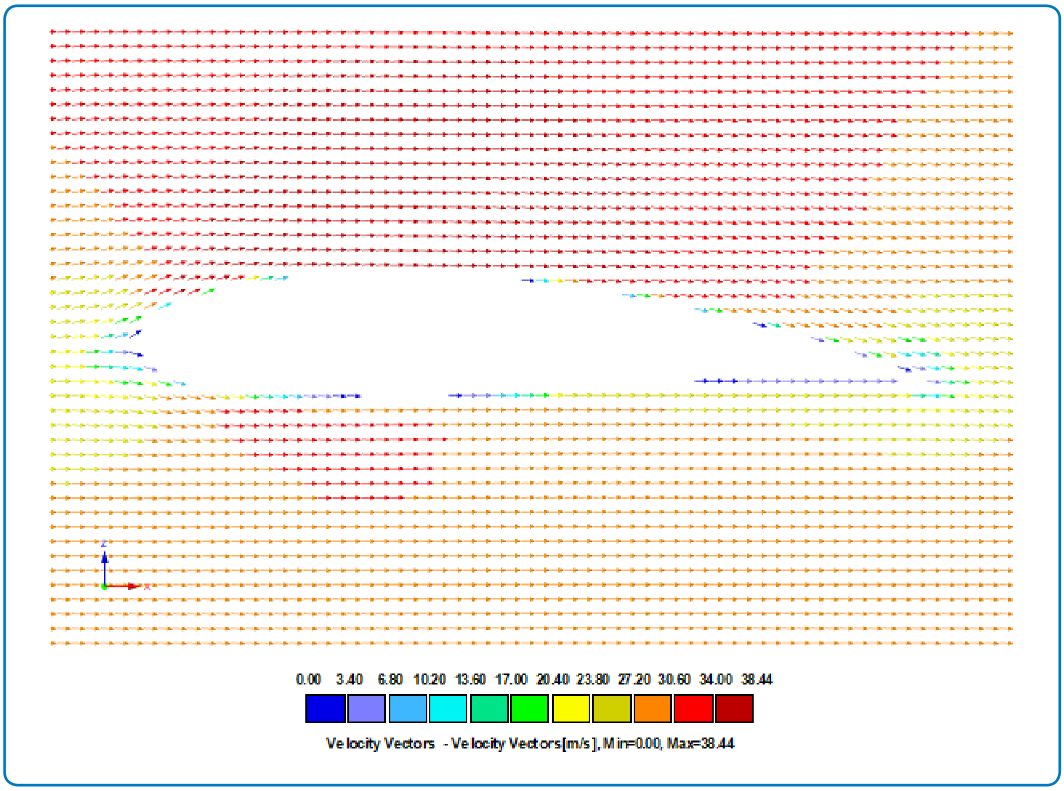

Figure 6: Velocity vector field for angle of attack $\alpha = 0°$, laminar flow

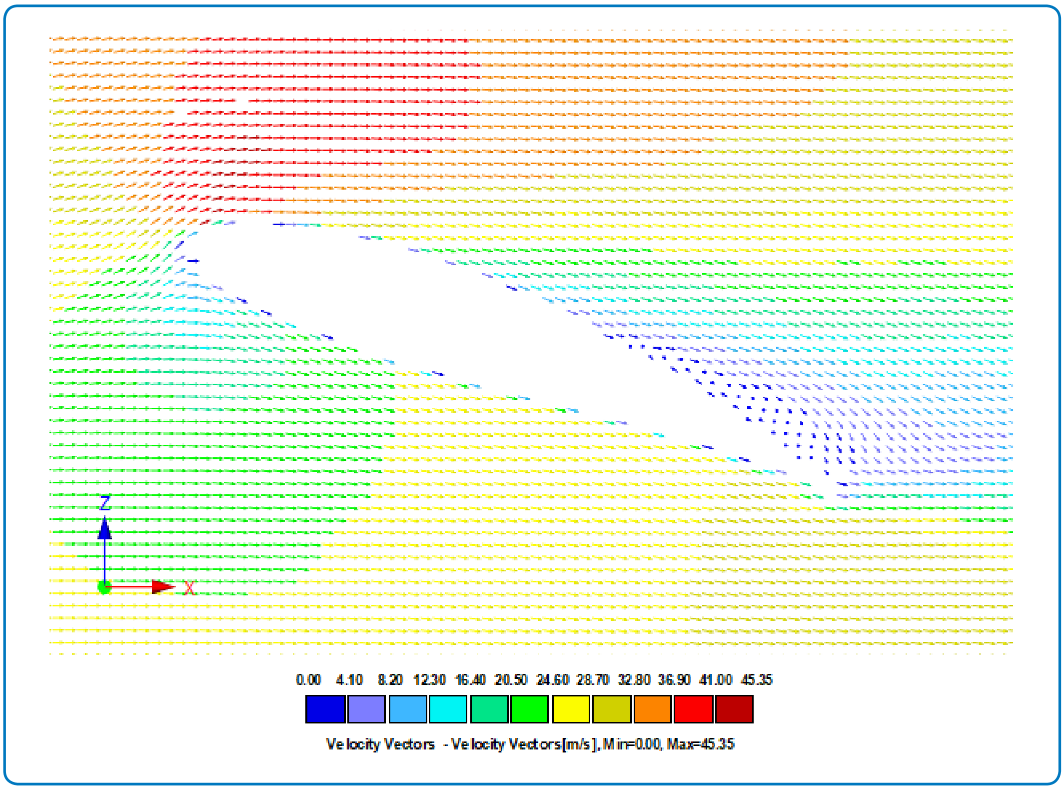

Figure 7: Velocity vector field for angle of attack $\alpha = 18°$, visible vortices on the wing