Characterization of the Flow around a Helicopter Fuselage Equipped with Vortex Generators for Drag Reduction

R. Jimenez1,*, F. De Gregorio2, M. Legrand1, J. Nogueira1
1: Dept. of Thermal and Fluids Engineering, Carlos III University of Madrid, Spain
2: Aerodynamic and Icing Measurement Methodologies, Italian Aerospace Research Centre (CIRA), Capua, Italy
* Correspondent author: rojimene@ing.uc3m.es

Keywords: Helicopters fuselage flow, passive flow control devices, bluff bodies aerodynamics, PIV, pressure taps measurements

HIGHLIGHTS

- Study of the effect of Vortex Generators as passive flow control system on a helicopter fuselage.
- Measurements: 2 longitudinal-vertical PIV planes, 5 cross-vertical SPIV planes, pressure taps
- PIV error analysis: peak locking and CCD readout error assessment using Δt variations.
- Baseline configuration: switches from detached flow to counter-rotating trailing vortices for angles of attack below -7°.
- The VGs reduce the separation zone size, increase the circulation of the trailing vortices and lock the longitudinal vortices topology.

ABSTRACT

The fuselage can be responsible for around 50 to 70% of the total drag of a helicopter. In the particular case of helicopters with a flat aft loading ramp, two flow phenomena can be produced with an associated drag increase: (i) flow separation (Eddy flow), or (ii) a pair of counter-rotating trailing vortices (Vortex flow). In some occasions, a sudden swap between the dominating flow topologies can be associated with an abrupt drag change. In order to mitigate these undesired effects, a helicopter fuselage mock-up was equipped with an arrangement of vortex generators (VGs). The dominating flow topology, as well as the transition angle of attack (AoA), are determined by means of PIV, Stereo-PIV and pressure tap measurements. Error analysis on the PIV measurements indicates that uncertainty of the measurement is in the range of 2% of the flight velocity. The clean fuselage has a predominance for the eddy flow from 0° to -5.5° (AoA), and then shifts to Vortex flow at -6.8° AoA. The VGs arrangement lock the Vortex flow topology for the whole range of AoA studied. At 0° there is not a clear pressure drag difference between both configurations and at -8.2° the VGs configuration seems to generate smaller drag. Extension of PIV measurements to better estimate drag would be subject of further work.

Fig. 1 Left: example of the SPIV measurements, where the longitudinal vortices can be appreciated. Right: Circulation of the longitudinal vortices