Influence of Aspect Ratio and Thickness on Dynamic Stall of a Finite Wing

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Abstract

This project aims towards characterizing the effect on aspect ratio and thickness of a finite wing when it undergoes unsteady pitching motion. Modelling of the flow over NACA0009, and NACA0012 wings with aspect ratios of 3,4, and 5 has been done. Dimensions of the geometry and constants of the simulation have been taken from [1]. The wings were subjected to sinusoidal pitch oscillations between 4 and 22 degrees at frequency of 27 rad/s and Reynold's number of 4×10^5. From the generated OpenFOAM data, it can be proven that decreasing aspect ratio can help in reducing nonlinear unsteady pitching and postponing the dynamic stall, which also matches with experimental results. Using thicker airfoil facilitates in delaying the dynamic stall since flow keeps sticking to the surface for a larger angle of attack.

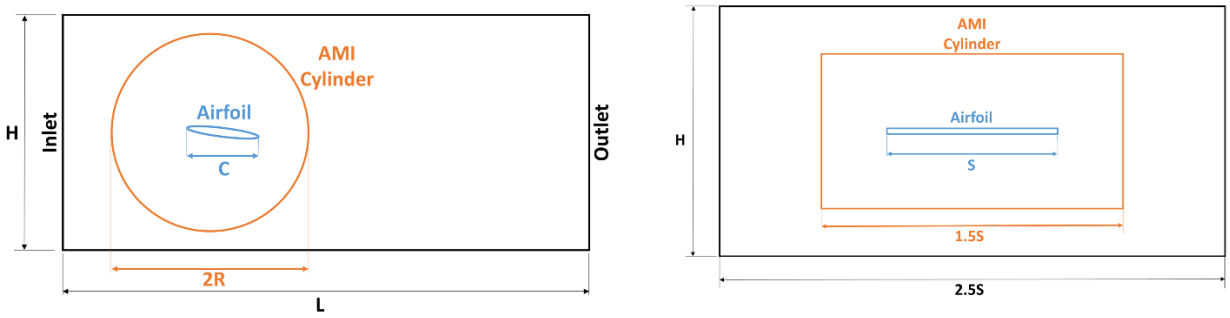

Figure 1: Geometry used for the simulation (Side and Front View)

Parameter	Unit	Value
Density	kgm^{-3}	1
Dynamic Viscosity	$kgm^{-1}s^{-1}$	1.562×10^{-5}
Turbulent Intensity	%	3.19
Turbulent Kinetic Energy	m^2s^{-2}	1.765
Turbulent Mixing Length	m	0.008548
Specific Turbulent Dissipation Rate	m^2s^{-3}	283.7574

Table 1: Fluid Properties and Turbulent Parameters

Reference

[1] Andreu Angulo, I. and Ansell, P.J., "Influence of Aspect Ratio on Dynamic Stall of a Finite Wing," AIAA Journal, Vol. 57, No. 7, pp. 2722-2733, 2019. doi: 10.2514/1.J057792