Computational Investigation of C-130 Afterbody Drag Reduction by Finlets

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Motivation

The Lockheed Martin C-130H is the main cargo aircraft that is used in the Turkish Air Forces. Several projects have been established so far to evaluate the flight performance characteristics of the C-130. Evaluation of the aircraft drag coefficient is one aspect of these projects. Because of mission requirements and need for prompt loading, the shape of the aft fuselage section keeps military transport aircrafts separated from other aircrafts. Possible increment in total drag due to the highly up-swept afterbody is the main investigation topic.

Problem statement

As other military transport aircrafts, C-130 has a high aft-body up-sweep angle. This fuselage up-sweep angle may cause strong adverse longitudinal pressure gradients, leading to big vortices and associated flow separation around aft body. Consequently, this flow separation will be the leading contributor of the overall aircraft drag. In this study, flow separation around afterbody and its prevention via finlets is evaluated.

Approach

Computational Fluid Dynamics with RANS methods is performed to analyze the flow field around base C-130 aircraft. The method is validated via wind tunnel test results in a study carried out by Pinsky[1] et al (Figure 1).

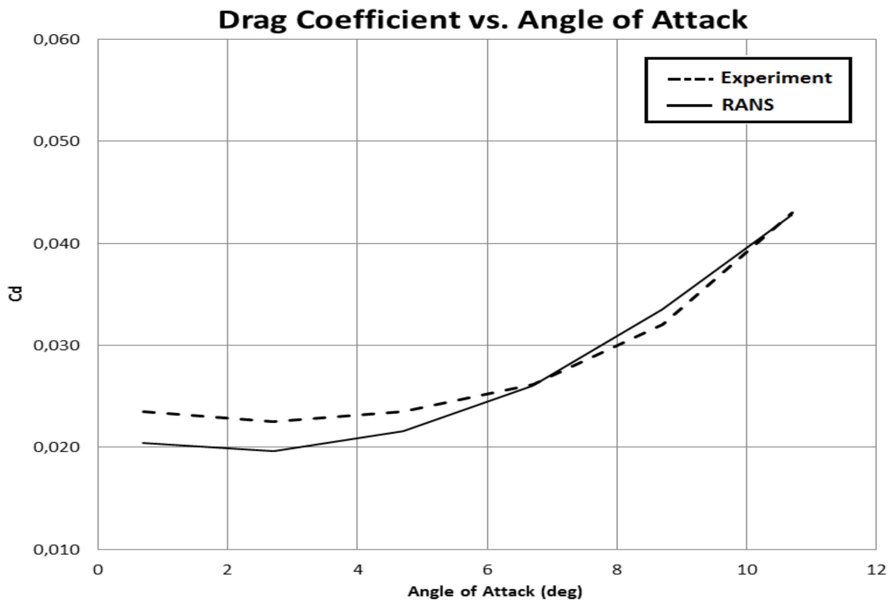

Figure 1 - Validation Results of C-130

The difference between experimental and CFD results is thought to be due the dissimilarities between the models used. CFD results will be enhanced at the main article.

Base finlet configuration is installed on the afterbody lower surface to examine its drag reduction potential (Figure 2Figure 1). Design parameters are finlets' shape, cross-section, number, incidence angle and distance between each other. Created vortices via finlets are capable of increasing boundary layer energy to induce small and strong longitudinal vortices which reattach separated flow along the undersurface of the afterbody.

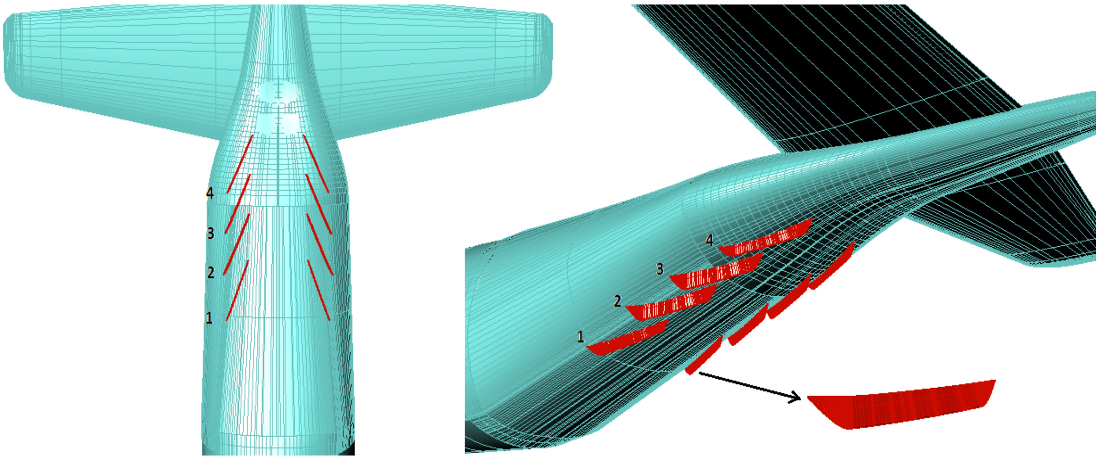

Figure 2 - Finlet Configuration Installed on C-130 Afterbody Undersurface

Grid size is increased up to 15 Million cells including grid adaption to catch the vortices correctly. CFD simulations are performed with commercial flow solver FLUENT.

Results & Conclusions

Various finlet configurations which are implemented on lower surface of C-130 afterbody have been investigated. Considering 1 drag count as 0.0001, around 15 drag counts of drag reduction is achieved with the addition of finlets up to now. More drag reduction is aimed to be reached via modifications.

In the full article; the usage of different designs and detailed information about how design parameters affect the results will be given. Moreover, final analyses will be performed by using DES(Detached Eddy Simulation) for comparison.

References

[1]Heather G. Pinsky "Evaluation of the Drag Reduction Potential and Static Stability Changes of C-130 Aft Body Strakes", AIAA 2009-1721