Comparative Research of Wings with Riblets and Wings without Riblets in Terms of Drag Reduction and Lift Produced During Cruising Using Wind Tunnel

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Abstract: ***Energy conservation and aerodynamic efficiency are the reason behind the research into methods to reduce turbulent skin friction drag on aircraft. Skin friction reductions as small as 10 per cent provide the potential for a 250 million dollars per year fuel savings for the commercial airline fleet. One of the ways for passive drag reduction concept is the implementation of longitudinally grooved surfaces aligned with the stream velocity. These grooves are called riblets. For further understanding of the riblets, prototypes of wings with and without riblets will be made and test using wind tunnel. Result from both types of wings will be compared and analysed to determine which type of wing is the better one.***

Keywords: Riblets, drag reduction, lift, wind tunnel

I. INTRODUCTION

Research on various areas regarding aviation has been encompassing many areas, including aircraft maintenance [1], ergonomics [2-5], management [6-7], avionics [8-11], and also educational research on theoretical concepts [12-15] and technology [16-19]. Particularly for drag reduction, research methodologies relevant to flight vehicles have received considerable attention during the past 2–3 decades. Drag has been one of the major problems in utilizing aircraft efficiency. Drag itself will limit or restrain the aircraft efficiency in terms of performance wise and waste a lot of money and energy. There are several ways to reduce drag and one of them is by introducing riblets on aircraft wings and this paper will touch on the subject of drag reducing capability by using wind tunnel to analyze it. By studying the riblets ability to reduced drag and produce lift, the aircraft efficiency will be able to improve. By comparing the analysis between wings with riblets and wings without riblets, we can determine whether riblets are efficient or not. The testing will be using two prototype wings made using 3-D printer with and without riblets. Apart from that, this research is to set a platform for other students if they wish to perform this research on different types of wing. The limitation of this project would be the inefficiency of wind tunnel facility in Universiti Kuala Lumpur – Malaysian Institute of Aviation Technology (UniKL MIAT), Malaysia.

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II. LITERATURE REVIEW

Riblets are streamwise surface striations that are aligned with the local freestream velocity. The optimum and most practical riblet have sharp valleys and sharp peaks. The purpose of the riblets is to modify the near-wall structure of the turbulent boundary layer. The spanwise surface variation down in the cross section imposes a strong spanwise viscous force that creates a wall slip Iayer. Riblets are also small surface protrusions aligned with the direction of flow, which confer an anisotropic roughness to a surface. They are one of the few techniques that have been successfully applied to the reduction of the skin friction in turbulent boundary layers, both in the laboratory and in full aerodynamic configurations. Riblets of very different geometries have been tested in wind tunnels, demonstrating drag reductions of the order of 10 per cent over flat plates. Walsh & Lindemann tested several shapes, including triangular, notched-peak, sinusoidal and U-shaped riblets, obtaining maximum drag reductions of 7–8% for riblet spacings of approximately 15 wall units .

Fig. 1 Riblets on a wing

The physical mechanism of the drag reduction by riblets has been investigated in detail, although some aspects remain controversial. Mean and local velocity profiles and turbulent statistics within and above the riblet grooves have been reported for experiments in wind tunnels.

Walsh & Lindemann showed that the Reynolds number dependence of the effect of riblets on the skin friction could be expressed in large part in terms of the riblet dimensions expressed in wall units,

L+ =Lut/n

Equation 1