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EFFECTS OF CANARD CONFIGURATION ON THE AERODYNAMICS OF BLENDED WING BODY AT LOW MACH NUMBER

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The Blended Wing-Body (BWB) aircraft is an unconventional aircraft that offers the aerodynamics performance advantages compared to the conventional aircraft. This type of aircraft has a unique design where the main body is blended together with the wing that gives the additional lift of the aircraft. In contrast to the conventional aircraft, the BWB has a poor stability due to the absence of the tail. A possible solution is by using a horizontal control surface, the canard, to improve the stability of the BWB. For this purpose, a comprehensive investigation of the aerodynamic behavior of the BWB with canard is important. The Computational Fluid Dynamics (CFD) and experimental testing were conducted to obtain the aerodynamics parameters of the BWB; lift, drag and moment coefficient. The BWB with different canard aspect ratio (AR) were compared with the BWB without canard to study the effect of the canard to the BWB and to assess which aspect ratio of the canard is beneficial to the BWB aerodynamics performance. In this study, the canard has a fixed area and the aspect ratio, AR that varies at 2, 4, 6 and 8. The computational analysis was made on a CFD code, NUMECA. The experimental works were performed on a scale model and tested in a low speed wind tunnel. Angles of attack, α varied from -10 to 10 degree, as well as canard setting angles, δ. The investigations were carried out at Reynolds Number of 3×10^5. The results show that the canard contributes a small lift forces but with the increase of drag to the BWB. On the stability issue, the canard with higher aspect ratio has a significant effect towards the moment coefficient of the aircraft configuration where it improves the trim angle and moment at zero lift. All these results are encouraging enough for the canard to be considered as mechanism for controlling the longitudinal mode of the BWB aircraft.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

Aircraft transportation has traversed eras of evolution. In 1903, the Wright brothers pioneered the building of Flyer 1 when it became the first powered aircraft that had marked the beginning of the aircraft industry. Since then numerous versions of aircraft have been designed and manufactured for various purposes, namely, commercial, surveillance, observation and war, to name a few. Although new aircraft concepts have been introduced and many more are still in progress, yet the configuration of the aircraft remains the same. Fuselage, wings, tail, engines and landing gears are still the main components of what configured an aircraft. Years of studies have encouraged the researchers in finding ways and solutions in making aircrafts or any flying object reaching the maximum capability in speed, performance, maneuvering abilities and prediction of forces and moment. Studies show that the aircraft industry has evolved to a "dominant design" and that factors such as cost are becoming increasingly important. One way to reduce cost is to conceive a family of aircraft that shares common parts and characteristics, such as planform and systems. However each aircraft satisfies a different mission requirement [1]

Blended Wing Body (BWB) in Figure 1.1 is a new concept of aircraft design. The BWB is an unconventional aircraft that blends the fuselage, wing and tail together, with the advantage of reducing drag interference between them [2]. The BWB concept over conventional aircraft is that the fuselage will generate lift together with the wing thus increasing effective lifting surface area. Due to the drag reduction, the lift to drag ratio, L/D of the BWB is higher when compared to the conventional aircraft [3]. Other advantages of BWB are lower fuel burn, takeoff weight, operating empty weight and total thrust.