1. INTRODUCTION

1.1. Background

Most of the aircraft wings have a removed tip, which streamlines the outer end of the wing [1]. As a result of discarded winglets, most aircraft suffered losses during flight. Hypothetically, the addition of winglets will increase the value of system stiffness and change the geometry of the system itself. As a result, the system dynamic responses will alter mathematically. This altered condition will make the dynamic response of aircraft-wing only is different from aircraft-wing-winglets when the aero elasticity phenomena occur. Resistance to dynamic loading is an important factor in the design of aircraft. In this case, the natural frequency, mode shape, and displacement of the structure are three dynamic parameters which have a very important role in determining the dynamic characteristics [1]. If the excitation frequency of the applied external force approaches the natural frequency, resonance will occur which causes the amplitude of the response to be increasingly larger [2]. To avoid the phenomenon of resonance, the value of the natural frequency of the structure must be quite far from the excitation frequency [3].

During this thesis, winglets in many models will be compared and proceed to an Impact Hammer Test and Shaker Test to see its effect on aircraft during the vibration occurs. The experimental results will also compare to simulation software results. This experimental test and commercial software simulation aim to determine dynamic parameter analysis consists of natural frequency, damped frequency, and mode shapes. This thesis also analyzes the number of displacement during resonance and the number of displacement during applied external forces.

1.2. Problem Formulation

An aircraft wing attends to has a higher natural frequency of bending mode, compress-tension mode, and twisting mode besides, it needs to have less displacement during resonance. This thesis intends to know the better dynamic response on the existing aircraft winglets.

1.3. Objective

a. Gathers dynamic parameter consists of natural frequency, mode shape, and displacement on each winglet model with impact hammer test and shaker test.
b. Gathers dynamic parameter consists of natural frequency, mode shape, and displacement on each winglet model with commercial software simulation.
c. Determine the best winglet model based on dynamic parameter data.

1.4. Outcome

The result of this thesis may help the aviation industries to select the higher natural frequency and lower displacement of the winglet model on their next-generation aircraft.

1.5. Idealization

In this thesis SC (2) – 0610 Airfoil will be used as a model airfoil. The model consists of rib, spar, skin, and winglets. Winglets in this model will be variated and the model taken from the Airbus website. The A300-100, A330-300, and A350-1000 winglet model will use in this thesis. Rib, spar, skin, and winglets will assume as a solid body, the relation between them bounded rigid. The root airfoil will be fix-supported and will assumed as cantilever beam behavior. The original design from Airbus will re-sketched with commercial software with 1:0.006 scaled geometry. The re-sketched model will uniformly have made from Polylactic Acid (PLA) materials. In commercial software simulation, the assigned PLA will have 3.5 GPa modulus of elasticity and 0.35 Poisson Ratio. Elasticity will assume linear. Damped free vibration analysis will use in this thesis.

1.6. Report Outline

This thesis consists of five chapters. The first chapter contains the introduction that describes the background, problem formulations, objectives, outcome, problem scopes, and the outlines of this thesis. The second chapter explains basic aero elasticity and Fundamental of Mechanical Vibration. The explanation about basic aero elasticity consists of dynamic aero elasticity, mass, and stiffness matrix for the aero elastic system. The third chapter explains the methodologies of this thesis. This methodology explains how the dynamic responses gathered by experimental as well as by commercial software simulation. The fourth chapter will describe every result regarding experimental results and commercial software simulation. This chapter also describes the percent of an error on dynamic response results by experimental method compares with software simulation. In the fifth part of this thesis, the conclusions of this thesis will explained.