**FINAL PROJECT**

# ANALYSIS OF WING SPAR CROSS-SECTIONAL PROFILE VARIATION ON THE NATURAL FREQUENCY OF AN UNMANNED AERIAL VEHICLE

Submitted to The Mechanical Engineering Department of Andalas University in Partial Fulfillment of The Requirement for The Degree of Sarjana Teknik (S. T.)

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PADANG, 2020

# APPROVAL FORM

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## ABSTRACT

The Unmanned Aerial Vehicle (UAV) performance during flying is mainly affected by the structural stiffness of the wing. For low stiffness wing structure, the wing deflection due to aerodynamic force is large in comparison with that using a high stiffness wing structure. This condition can affect the UAV flight maneuvering and reduce safety. An alternative method for increasing the wing stiffness is by increasing the wing natural frequency. The natural frequency can be increased by reducing mass or increasing the cross-sectional moment of inertia. The dynamic response during resonance conditions on the wing of the aircraft is very undesirable since the vibrations of wings are adverse and dangerous. The reason why this final project needs to be conducted is due to the low stiffness of the AFRG 006 UAV structure, meaning that the natural frequency of the UAV structure is also low. This is known when flight-test, the wings were flapping appreciable. This condition is dangerous that can failed the UAV. To avoid this condition, it is necessary to add a slight stiffener spar to the UAV structure so that the natural frequency can be increased. The spar is positioning stretched and coincide along the center of gravity of the UAV so that the resultant torque produced due to the gravitational force vanishes, and thus that it does not affect the stability of the UAV. Previous research found that the addition of the spar is directly proportional to the natural frequency[1]. The main aim of this final project is to avoid resonance condition by increasing the stiffness of AFRG 006 UAV's structure using variation of spar cross-sectional profile. This effect can increase the natural frequency so that the AFRG 006's structure is more resistant to dynamic load than before. In this final project, there are 7 different spar variations based on their area moment of inertia, namely U profile, circular, T profile, square, L profile, I profile, and Z profile. The optimum stiffener that solve this problem is the T profile spar which could increase the first elastic natural frequency by 22.95% with only 3.43% increase in mass.


Key words: spar, stiffness, moment of inertia, modal analysis, natural frequency.