1. INTRODUCTION

1.1 Background

The landing gear of aircraft, particularly unmanned aerial vehicles (UAV), plays a critical role in ensuring safety and operational performance during the landing and take-off phases. However, during this process, landing gear is often subjected to excessive vibration, which can arise from various factors such as structural design, runway surface conditions and dynamic interactions between aircraft components and the environment. High vibration not only risks damaging mechanical components, but can also disrupt the functioning of sensitive electrical systems within the UAV, potentially jeopardizing mission effectiveness and flight safety.

Excessive vibrations in the landing gear can cause damage to critical components such as gears and hydraulic systems, posing serious risks to flight safety[1]. Furthermore, the effects of these vibrations can impact the UAV performance and stability, particularly during landings on uneven surfaces. Therefore, it is essential to develop effective solutions to mitigate the impacts of vibrations on landing gear.

One way to overcome excessive vibration is to use passive dampers. One type of passive damper that is often used is the metallic damper, which can absorb energy from dynamic loads, thereby reducing the level of vibration that occurs. Among the various types of metallic dampers, Butterfly-Like Metallic Dampers (BLMD) were chosen because of their innovative design and effectiveness in controlling vibration. BLMDs are specially designed to absorb and dissipate the dynamic energy generated during the landing process, thereby minimizing the vibration sensed by the landing gear structure. With the ability to undergo plastic deformation, BLMD can effectively dissipate dynamic energy and reduce the dynamic response of the structure as a whole.

Previous research has demonstrated that BLMD exhibits excellent energy dissipation behavior and can enhance structural stability in various applications. For instance, Huang (2021) conducted experimental tests on BLMD in various mounting configurations and found that this damper displayed a superior hysteretic curve with adequate ductility and effective energy dissipation. Additionally [2], Arya (2023) evaluated the performance of fuse dampers under seismic loads, highlighting the importance of selecting appropriate damper systems to improve structural response [3]. Bayu (2018) has conducted static and dynamic analysis on the main landing gear with various variations of the main landing gear model to get the optimal model of the main landing gear[4].

In this final project, static and dynamic analyses will be performed to evaluate the effectiveness of BLMD in landing gear applications. Through this analysis, it is expected that data will show the potential of BLMD to reduce the dynamic response of landing gear, thereby enhancing overall UAV safety and performance. Thus, the development and application of BLMD in landing gear can serve as an innovative solution to address vibration issues and improve the durability and reliability of landing systems.

1.2 Problem Formulation

The landing gear of an unmanned aircraft (UAV) is essential for ensuring safety and operational performance during take-off and landing. However, a significant challenge that often arises is excessive vibration during these critical phases. High levels of vibration can result from various factors, including structural design, runway surface conditions, and dynamic interactions between the aircraft components and their environment. Excessive vibration during UAV landing poses a risk of damaging sensitive electrical components, potentially compromising the aircraft's functionality. Therefore, this final project focuses on conducting a comprehensive static and dynamic analysis of the Butterfly-Liked Metallic Damper (BLMD) applied to the nose landing gear. The objective is to evaluate the dynamic response of the BLMD in this application and to understand its effectiveness in mitigating vibrations.

1.3 Aim

The Aim of this Final Project Report are:

1. To obtain the most effective model for the BLMD damper from its dimensional variations by calculating the stiffness, maximum strength, and dissipation energy using the finite element method.

2. Develop a computational program to calculate the displacement and acceleration responses of landing gear structures using BLMD, and compare the responses for each variation of BLMD geometry.

1.4 Benefits

The benefit of this research is to help provide static and dynamic modeling of BLMD that can be applied to the nose landing gear.

1.5 Problem Scope

The limitations of problems in this final project are:

a. The static analysis was performed with an in-house computational program based on the non-linear finite element method. The static analysis was performed for one seismic loading cycle.
b. The BLMD stiffness used in the dynamic analysis of the landing gear is an elastic stiffness and has a constant value taken from the Hysteresis curve.
c. The stiffness and damping of the plane wheels are ignored.
d. The dynamic analysis was performed when the aircraft landed and the aircraft mass was assumed to be 80% of the total aircraft mass. The aircraft mass is modeled as a coupled mass and the mass of the BLMD is negligible..

1.6 Report Outline

This final project consists of five chapters. The first chapter describes the background, problem formulation, purpose, outcome, problem scope, and report outline. The second chapter provides an overview of the literature that becomes a reference in the final project. The third chapter describes the research methodology. The fourth chapter contains the results and discussion. The last chapter is the conclusion of the final project.