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Simulation of Quadcopter Flying Electric Vehicle Chassis

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ABSTRACT

The increase in population means that the need for transportation is also increasing, causing more or less air pollution. Besides that, fuel oil is also a non-renewable natural resource. Oil fuel comes from plants and animals that have been dead for millions of years which have become fossils and which have been formed for a very long time automatically become expensive. Therefore, people need vehicles that have many advantages, including environmentally friendly, do not produce air pollution, do not produce noise, avoid traffic jams, and are easy to maintain. Flying electric vehicles are the right choice to overcome this problem. Electric car is a car driven by an electric motor that uses electric power stored in a battery. One of the advantages is that the engine construction is simpler compared to combustion engines which have so many components because there is combustion in the engine. Electric vehicles certainly need a chassis. The chassis that will be used is a tubular chassis type using fiberglass. The aim of this research focuses on planning electric flying vehicles, more precisely on static simulation of chassis design. The results of this research can be used as consideration for designing the chassis structure of flying electric vehicles. This research is expected to be the beginning of the development of an electric quadcopter flying vehicle chassis.

Keywords: design, simulation, chassis, electric car, flying electric vehicle, quadcopter

1. INTRODUCTION

The increase in population means that the need for transportation is also increasing, causing more or less air pollution. Besides that, fuel oil is also a non-renewable natural resource. Oil fuel comes from plants and animals that have been dead for millions of years which have become fossils and which have been formed for a very long time automatically become expensive. People need vehicles that have many advantages, including environmentally friendly, do not produce air pollution, do not produce noise, avoid traffic jams, and are easy to maintain. Flying electric vehicles are the right choice to overcome this problem. The challenge of designing and simulating a chassis that can support flight functions while remaining light and durable is critical. Apart from that, aspects of energy efficiency and stability control in various flying conditions also require special attention to realize reliable flying electric vehicles.

Electric car is a car that is driven by an electric motor that uses electric power stored in the battery [1], [2]. Utilizing electrical energy is one of the most efficient ways to reduce the use of fuel oil in vehicles. It can be considered efficient because it does not cause air pollution and the energy used is environmentally friendly. Air pollution is also one of the causes of global warming. One of the advantages is that the engine construction is simpler compared to combustion engines which have so many components because there is combustion in the engine. Electric vehicles certainly need a chassis.

The chassis is a car component that supports the load of the vehicle, engine and passengers [3], [4], [5]. The chassis made on a vehicle must be sturdy, strong, light and resistant to loads. Based on the construction, the place where the body is attached to the frame is divided into 2 types, namely separate construction and integrated construction. Separate construction is made for vehicles [6], [7]
that support heavy loads, for example buses, trucks and pick-ups. Meanwhile, integrated construction is made for vehicles that support loads that are not too heavy, such as private cars. To strengthen planning, software simulation methods are used. The numerical analysis method can be called FEA which is used to solve problems in many mechanical engineering sciences from simple to complex. Simulation is an application of FEA which aims to solve engineering problems such as heat transfer, stress, vibration frequency, deflection and fluid flow [8], [9], [10].

From the background above, the problem facing society is that there is a lot of air pollution, to reduce air pollution in the midst of rapidly growing combustion motor vehicles and increasing traffic jams. One of the most efficient ways is to switch to flying electric vehicles to save fuel, reduce air pollution and avoid traffic jams [11]. It is possible that when the vehicle has been used, there will be problems where the chassis bends,cracks orbreaksdue to its lack of resistance to the load received. This greatly affects vehicle performance, comfort, security and driver safety. Until now, there are still no researchers who have conducted published research on plans for flying electric vehicles, but there are alreadymany flyingelectric vehicle products on sale.

Quadcopter is a flying robot which is a type of Unmanned Aerial Vehicle (UAV). A quadcopter has a physical appearance like the letter X, has four brushless motors and a propeller as a driving force, which rotates clockwise and counterclockwise. The advantage of a quadcopter isthat it can move flexiblyinall directionsanthe difference is that it takes off vertically and is balanced [12].

Fig 1. Quadcopter

Therefore, researchers focus on planning electric flying vehicles, more precisely on static simulations of chassis design. The results of this research can be used as consideration for designing the chassis structure of flying electric vehicles. This research is expected to be the beginning of the development of an electric quadcopter flying vehicle chassis. Currently, the automotive world is starting to become busy with electric bicycles, electric motorbikes and electric cars. Therefore, this research focuses on the simulation of quadcopter flying electric vehicles. The simulation process is used to obtain research data.

The aim of this research is to simulate the design and performance of a quadcopter-based flying electric vehicle chassis. Through this simulation, it is hoped that it can be analyzed how the frame structure supports stability, maneuverability and energy efficiency in flight.

2. RESEARCH SIGNIFICANCE

This research is important because The potential for developing a Quadcopter Flying Electric Vehicle provides an innovative solution in developing future electric vehicles that are more efficient and flexible. By combining quadcopter and electric vehicle concepts, this research can introduce new designs that enable air-ground-based mobility with higher energy efficiency and better adaptability in various terrains. This simulation also provides an important basis for the development of environmentally friendly transportation technologies, supporting the need for sustainable transportation systems and reducing dependence on conventional land infrastructure..

3. RESEARCH METHODS

The method used to obtain data is simulation. Before entering the manufacturing process, first prepare a complete system design so that the research objectives can be achieved optimally. The design uses a tubular chassis model structure. The tubular chassis is formed using molded pipe pieces. The pipe positions are in various directions so that it can produce a rigid chassis shape. Simulation is a great concept to use, especially conducting experiments to find the best feedback on system components. This is because the costs are expensive and require a long time when the experiment is carried out in real time. With the help of simulation studies, the right decisions can be taken in a short time and the costs are not too high, because everything can be done using a computer.

4. RESULTS AND DISCUSSION

Fig 2. Chasis design

With the following specifications: 1. Using fiberglass material, 2. 1.5 inch in diameter, 3. Total length 2000 mm, 4. Total width 1900 mm, 5. Total height 1200 mm, Initial load

A. 900 N Load

In the simulation the initial load stress on the chassis is 900 N with a maximum stress value of 5.868e+06 N/m2 and a yield strength value of 5.206e+08 N/m2. It can be seen in fig 3.

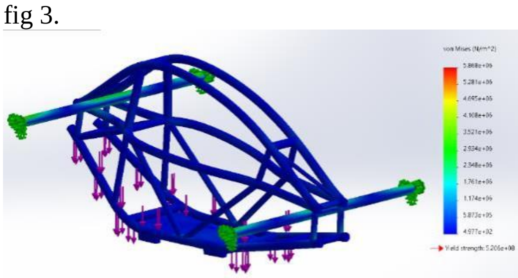

Fig. 3. Stress Value at 900 N Load

In the displacement simulation that has been carried out, the displacement value is greatest at a load of 900 N. Can be seen in the red image with a value of 1.677e-01 mm.

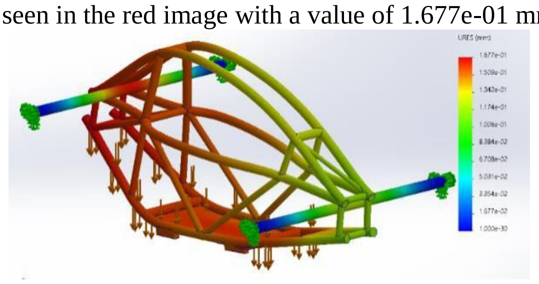

Fig. 4. Displacement Value at 900 N Load

In the strain simulation that has been carried out, the strain value is greatest at a loading of 900 N. The maximum strain value of 7.294e-05 can be seen in the red image below.

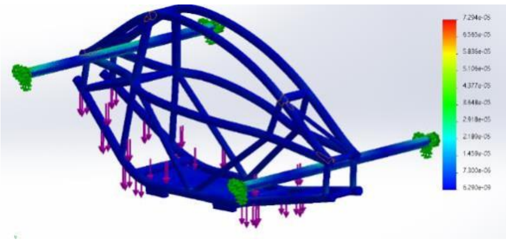

Fig 5. Strain Value at 900 N Load

Determine the safety factor value for the 900N load of the quadcopter flying electric vehicle chassis, the safety factor (yield strength/stress) value can be calculated, namely:

$$S_f = \frac{5{,}206e + 08}{5{,}868e + 06}$$

= 8,87e+01

So the result of the safety factor value for a load of 900 N is 8.87E+01 which exceeds the specified value, so the chassis design that has been made for loading on electric quadcopter flying vehicles is very safe to withstand a load of 900 N.

B. 1100 N Load

In the simulation the initial load stress on the chassis is 1100 N with a maximum stress value of 7.172e+06 N/m2 and a yield strength value of 5.206e+08 N/m2. It can be seen in Fig. 6.

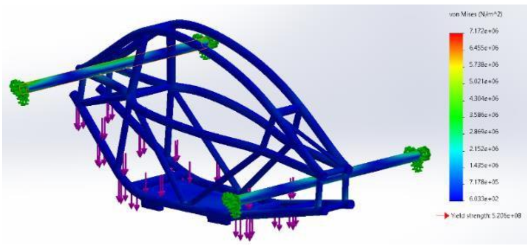

Fig. 6. Stress Value at 1100 N Load

In the displacement simulation that has been carried out, the largest displacement value is at a load of 1100 N, which can be seen in the red image with a value of 2.049e-01 mm.

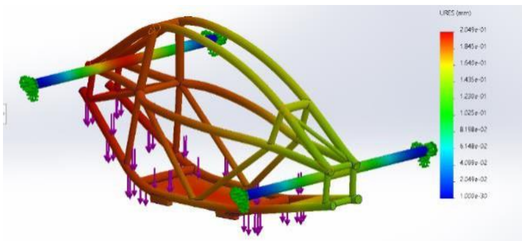

Fig. 7. Displacement Value at 1100 N

Load in the strain simulation that has been carried out, the strain value is greatest at a loading of 1100 N. The maximum strain value of 8.916e+05 can be seen in fig.8.

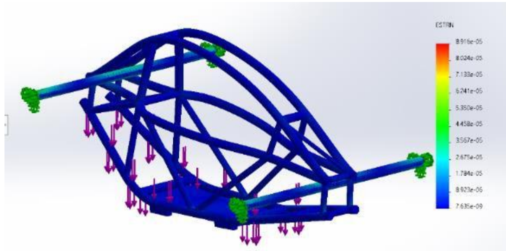

Fig. 8. Nilai Strain Pada Beban 1100 N

Determie the safety factor value for the 1100 N load of the quadcoper flying electric vehicle chassis, the safety factor value (yield strength / stress) can be calculated, namely:

$$S_f = \frac{5{,}206e + 08}{7{,}172e + 06}$$

= 7,26e+01

So the result of the safety factor value for a load of 1100 N is 7.26E+01 which exceeds the specified value, so the chassis design that has been made for loading on electric quadcopter flying vehicles is safe to withstand a load of 1100 N.

C. 1300 N Load

In the simulation the initial load stress on the chassis is 1300 N with a maximum stress value of 8.476e+06 N/m2 and a yield strength value of 5.206e+08 N/m2. It can be seen in Fig. 9.

Fig. 9. Stress Value at 1300 N Load

In the displacement simulation that has been carried out, the displacement value is greatest at a load of 1300 N. Can be seen in the red image with a value of 2.422e-01 mm.

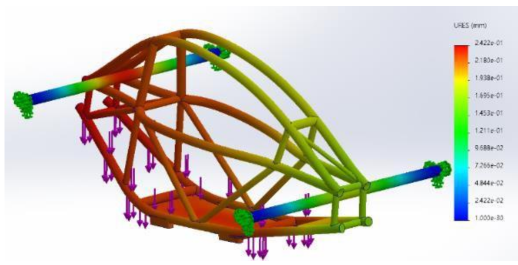

Fig. 10. Load Displacement Value 1300 N

In the strain simulation that has been carried out, the strain value is greatest at a loading of 1300 N. The maximum strain value of 1.064e+04 can be seen in fig. 11.

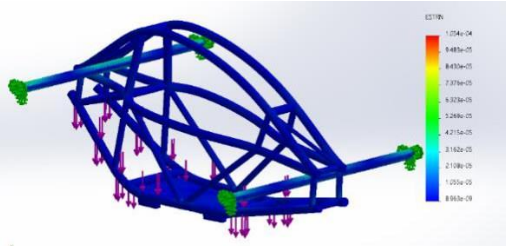

Fig. 11. Strain Value at 1300 N Load

Determine the safety factor value for the 1300N load of the quadcopter flying electric vehicle chassis, the safety factor (yield strength/stress) value can be calculated, namely:

$$S_f = \frac{5{,}206e + 08}{8{,}488e + 06}$$
$$= 6{,}14e{+}01$$

So the result of the safety factor value for a load of 1300 N is 6.14E+01 which exceeds the specified value, so the chassis design that has been made for loading on flying electric vehicles is very safe to withstand a load of 1300 N.

5. CONCLUSION

The simulation of a 1300 N load shows a maximum stress of 8.476e+06 N/m², which is below the yield strength of 5.206e+08 N/m². This confirms that higher loads lead to higher stress but remain within safe limits. The displacement for the 1300 N load is 2.422e-01 mm, indicating that greater loads increase displacement. The strain at 1300 N is 9.48E-05, showing that higher loads result in more strain. The safety factor for a 1300 N load is 6.14E+01, well above the required value, confirming that the chassis design is very safe. However, as load increases, the safety factor decreases, increasing risk.

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7. AUTHOR CONTRIBUTIONS

Conception and design: Sugeng Hadi Susilo, Kurniawan.
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Data acquisition: Sugeng Hadi Susilo, Eko Yudiyanto.
Analysis and interpretation of data: Sugeng Hadi Susilo
Writing publication: Kurniawan
Approval of final publication: Eko Yudiyanto
Resources, technical and material supports: Bakti Indra Kurniawan
Supervision:. Sugeng Hadi Susilo

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