Landing Gear Models Toward Preliminary Various Simulations of Used Loads

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Abstract- The design of an appropriated landing gear is one of important requirements in aircraft system. In this paper, the landing gear model is shaped to two various models, and two approaches of used loads on the top surfaces of each model are preliminarily simulated by a 3D finite element analysis (ABAQUS) for analysing these landing gears. Different simulations of tested conditions have been considered for both models, as well as the safety factor of each model is calculated for every tested condition. A conclusion is drawing about a better geometry to serve its future purposes.

Keywords Landing Gear, Finite Element Analysis, Simulation, Carbon Fiber Composite.

1. Introduction

With the current development of technologies, material system has been extensively applied in different research fields and practical applications [1-12]. Among them, an aircrafts' system has plenty of various configurations [13-17], especially for landing gears, and thus the differently used loads and stress behaviors are able to exhibit in plenty of various configurations. Besides, the landing gear configuration utilizing in unmanned aerial vehicles is quite different comparing to the conventional ones [17]. To attain the landing gears with good properties, the selection in material classes is required significantly, such as aluminum alloy is considered as a good choice to apply in the landing gears. Nonetheless, a carbon fiber composite is chosen in this preliminary simulation models, as well as the composite material system is able to be favorable that can be owing to low generations in stress comparing to the conventional counterparts.

As known, technological advances have enabled the simulation of aircraft and spacecraft crashes in a reasonable time using detailed finite element models [18, 19]. In this work, the models of landing gear are designed to two different three-dimensional (3D) structures, which are applied in these preliminary simulation models, using a 3D finite element analysis (ABAQUS) for the cases of used loads on the top surface of models. Hence, it is necessary to complete many steps for procuring accurate results, including appropriate assumptions, at same time that safety factors of the 3D structure-shaped models are also calculated and evaluated for each case.

2. Finite Element Modeling

2.1. Geometric Models

In this work, the landing gear models are designed to two various 3D landing gears for unmanned aerial vehicles, i.e., landing gear 1 (LG1) and landing gear 2 (LG2). The material applied for the 3D finite element analysis is chosen by carbon fiber composite (Table 1). The geometries and 3D structures of models are described in Figure 1.

Table 1. Material properties.

Carbon fiber	Tensile Modulus (MPa)	Tensile Strength (MPa)	Density ($g.cm^{-3}$)
High strength	160–270	3,500	1.8
Intermediate Modulus	270–325	5,300	1.8
High Modulus	325–440	3,500	1.8
Ultra-High Modulus	440–600	2,000	2.0

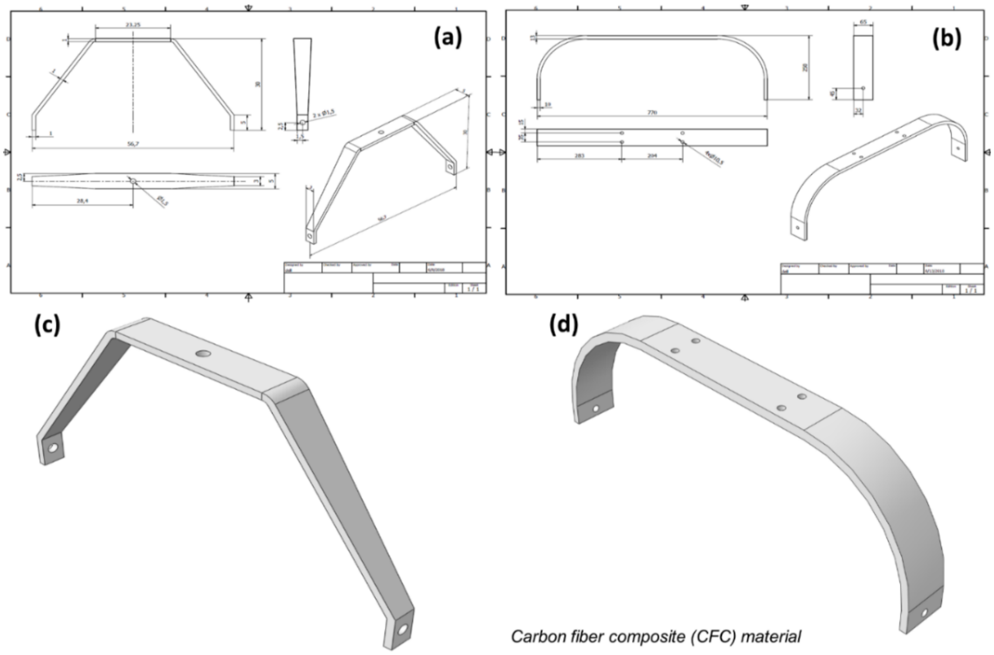

Fig. 1. Geometry details (a, b) and 3D structures (c, d) of models: LG1 (a, c) and LG2 (b, d).

2.2. Boundary Conditions and Finite Element Meshing

The mechanical boundary conditions of each finite element model (LG1 and LG2) are shown in Figure 2. Besides, there are two cases of finite element analysis, i.e., one used load and two used loads on each model. Specifically, boundary conditions are forced between fuselage and landing gear (orange points) occurring on the top surface of each model, and hence the displacements are displayed as equation (1). The model weight (Load 1) is utilized in the negative y-direction at the top surface of each model [equation (2)]. Safety factor is calculated from equation (4). The used load at the bottom of each model is applied along the positive y-direction [equation (3)].

In addition, the finite element simulation is performed by ABAQUS software. The finite element meshes of designed models are produced by eight-node-linear brick lowered integration elements (Figure 3). In particular, two designed models, i.e., LG1 and LG2, are same in all tested conditions.

$$u_x = u_y = u_z = 0 \quad (1)$$

$$F_y = -mg \quad (2)$$

$$\text{Load} = F \quad (3)$$

$$Safety\ factor\ = Ultimate\ Strength/Allowable\ Strength \quad (4)$$

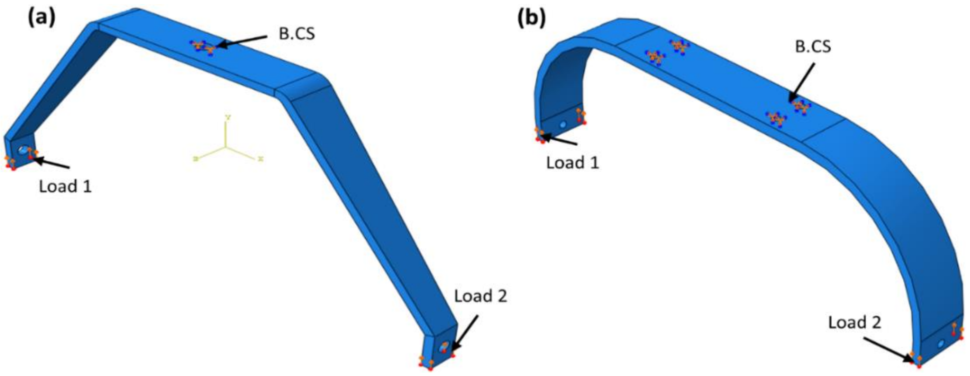

Fig. 2. Boundary conditions for LG1 (a) and LG2 (b).

3. Results and Discussion

As shown in Figure 3, two cases, i.e., one used load and two used loads on each model, are well used and simulated for both models, as well as which have been solved according to the respective loading conditions. Besides, safety factor is calculated from Equation 4. As a result, the safety factor of LG2 is higher than that of LG1, at same time that this factor is above one, i.e., a safety factor range of 5.2–1.5 and 6.5–1.7 corresponds to LG1 and LG2. Obviously, the safety factor is in all cases above one, suggesting that this material is appropriate for producing the landing gear system. Concomitantly, the LG2 is safer than the LG1 for any tested conditions, as well as the LG2 possesses the higher mechanical properties for each case comparing to the LG1 (Figure 4), thus leading to designing conservatively more. Nonetheless, this study is only a preliminary approach that can support for future studies, as well as a comparison of simulated and experimental results should be revealed more.

This study is seen as our preliminary estimations for simulation models through various geometric models and number of used loads. Herein, it is not complete, the future proposes can be completed the task such as: design of wheel strut shock absorber system linked with LG1 and LG2, design and sizing of shock absorbers for these wheel struts, checking lateral stability in taxiing manoeuvers, and so on.

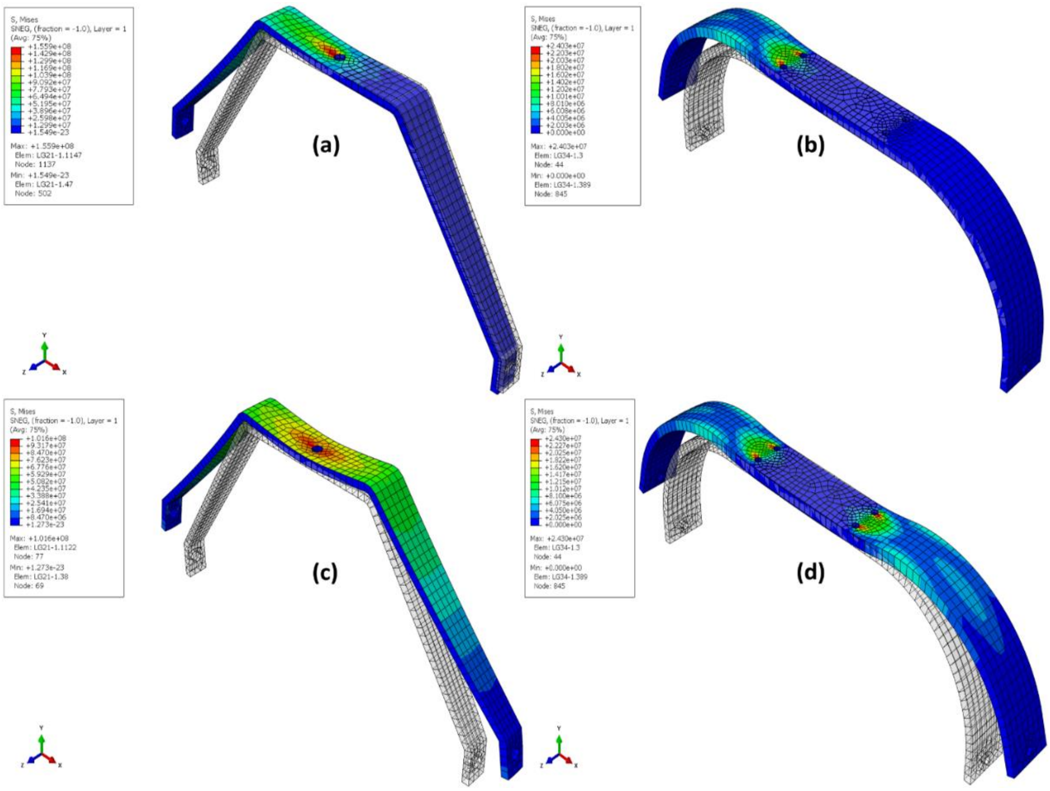

Fig. 3. Deformations of LG1 (a, c) and LG2 (b, d) with two cases: one used load (a, b) and two used loads (c, d).

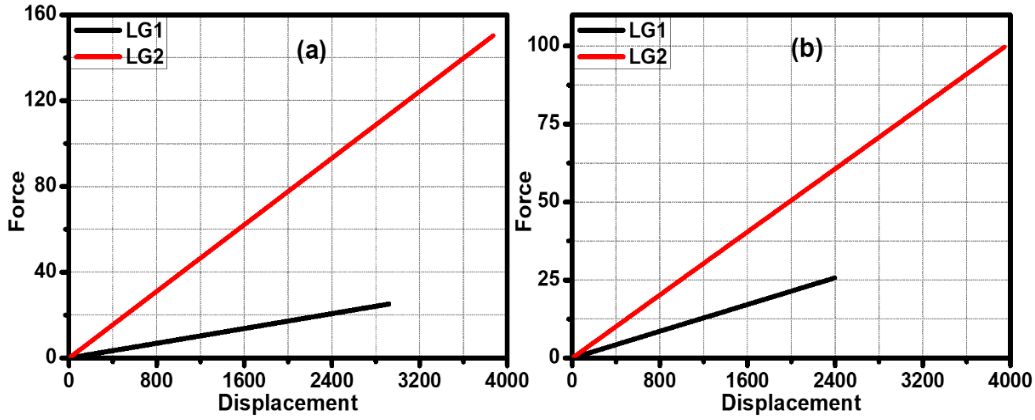

Fig. 4. Force-displacement curves of models in two cases: one used load (a) and two used loads (b).

4. Conclusion

In brief, the landing gears are designed and simulated by using the 3D finite element analysis (ABAQUS) in differently tested cases. This study aims to the preliminary simulation models for designing the landing gear geometric characteristics. A great range of safety factor is calculated from these preliminary simulation models, which is agreed in the mechanical properties of each landing gear in cases. Also, this deflection is allowable, owing to the good nature of carbon fiber composite. Although the study is not completed, the designs are able to be relatively stable to serve their future purposes.

Conflicts of Interest

No conflict of interest was declared by the authors.

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