Mechanics & Machines Course

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Bird Wing Simulation
CAE Analysis
Report

Presented To: **Oleg Bulichev**

Introduction:

Our goal is to make **static structural analysis** for the mechanism (which simulates the motion of the bird wing) to determine the stresses, strains, and the displacements, resulted from the forces in the structure. I chose this type of analysis because there are no time-varying forces/loads in the mechanism. Hence, we will study how steady-state inertial forces affect on the mechanism structure. The tool used is Fusion360.

Forces Calculations:

Using the simplified mechanism model used in dynamics analysis, I computed the inertial forces caused by wings and links weights as follows:

- Knowing the masses of each link and wing extracted from Fusion360.

$$M_{link} = 13.388\ gram \qquad Mass\ of\ each\ link$$
$$M_{wing} = 18.783\ gram \qquad Mass\ of\ each\ wing$$

- We can estimate the gravity forces as follows:

  - For right and left links, each have $F_{g\ links}$:

$$F_{g\,links} = (2\ M_{link}) * g$$
$$F_{g\,links} = (2{*}13.338) * 9.8$$
$$F_{g\,links} = 26.776\ \ N.m \tag{1}$$

  - For right and left wings, each have $F_{g\ wing}$:

$$F_{g\,wings} = (3\ M_{wing}) * g$$
$$F_{g\,wings} = (3{*}18.784) * 9.8$$
$$F_{g\,wings} = 59.679\ \ N.m \tag{2}$$

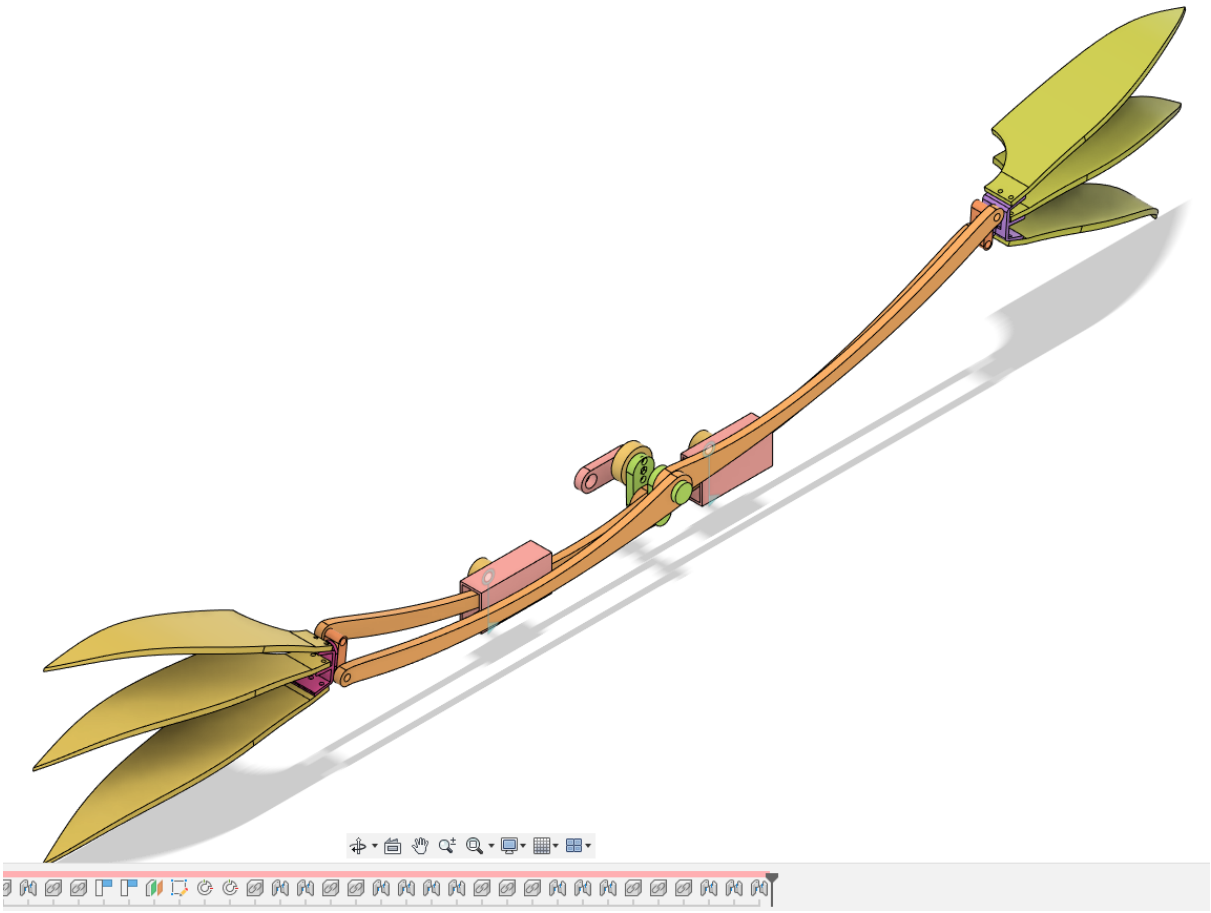
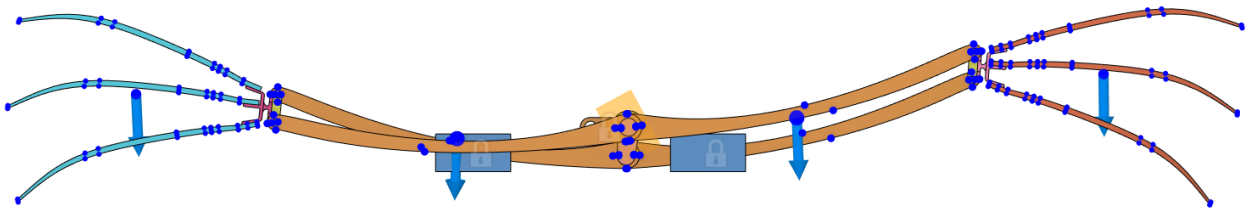


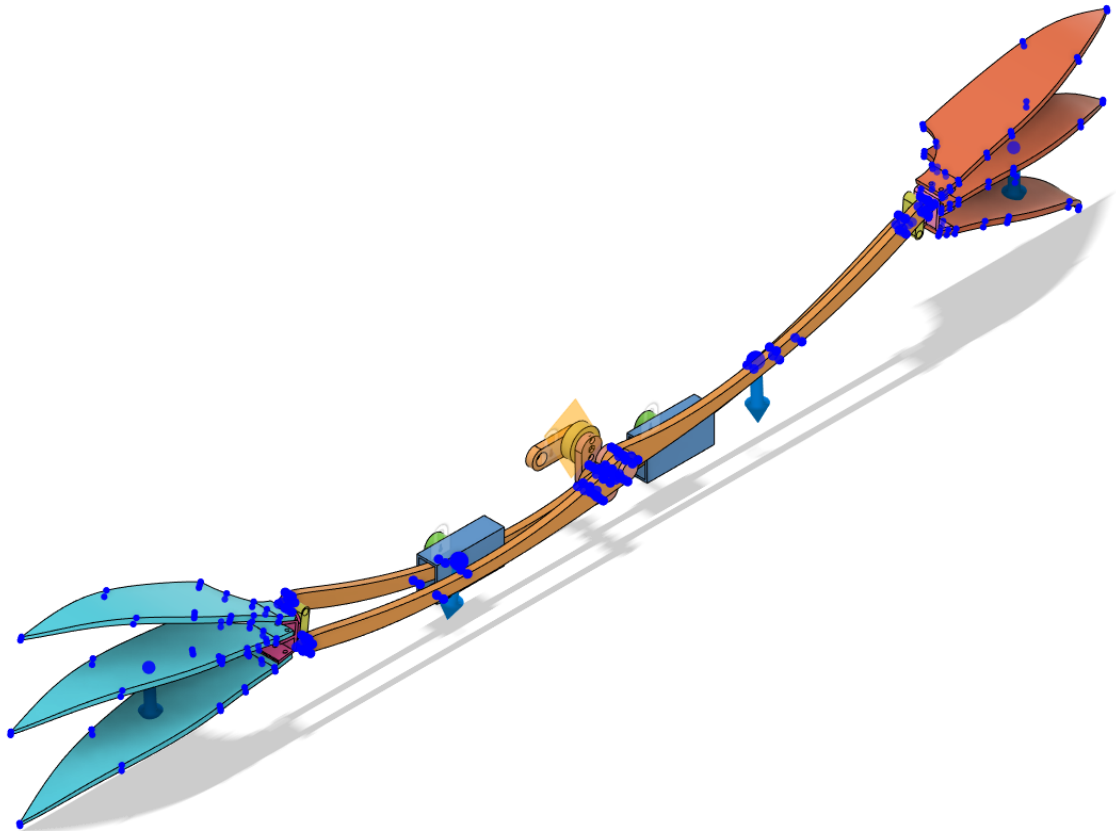
Figure 1: Simplified Mechanism

Simulation Setup:

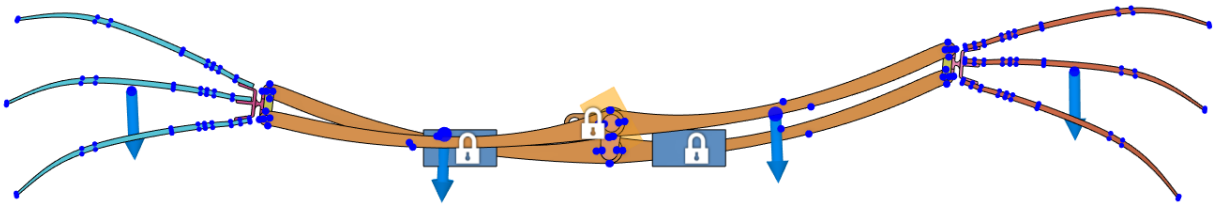
Knowing the positions of centers of mass for left and right group of links & left and right group of wings with respect to the middle of the structure, $L_{c\,links} = 125\ mm$, $L_{c\,wings} = 321\ mm$.

- We can place the forces $F_{g\,links}$ and $F_{g\ wings}$ on this distances one the right and left with respect to the middle of the structure as shown in the following images.





- We can fix the following surfaces as constraints to prevent the mechanism from moving in these directions.



Simulation Results:

- We can notice that the structure could afford the stress results from the current forces.

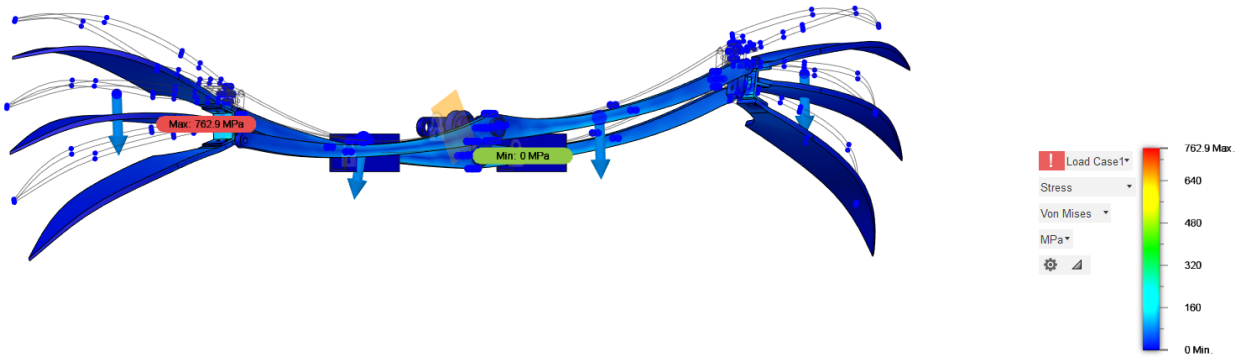


Figure 2: Stress

- We can notice that some deformation will happen.

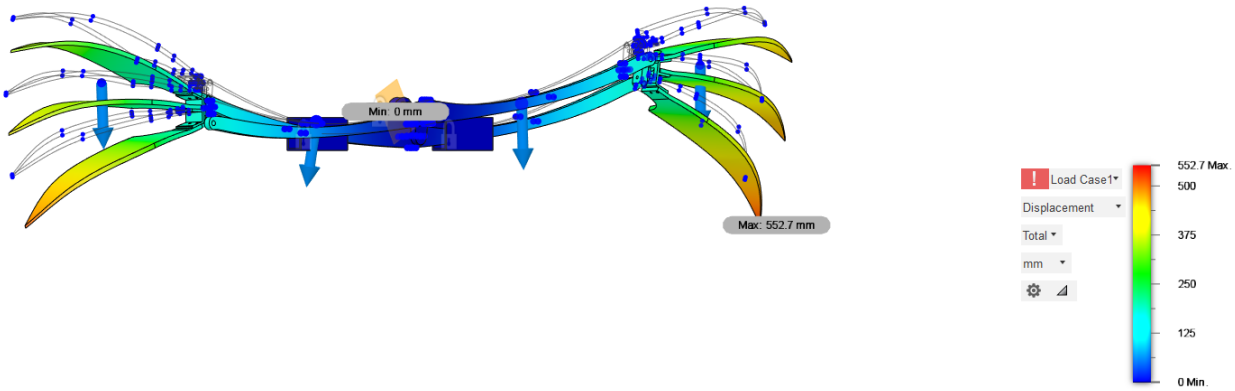


Figure 3: Displacement

- From the Safety factor we can notice that the design will bend/break under the current conditions.

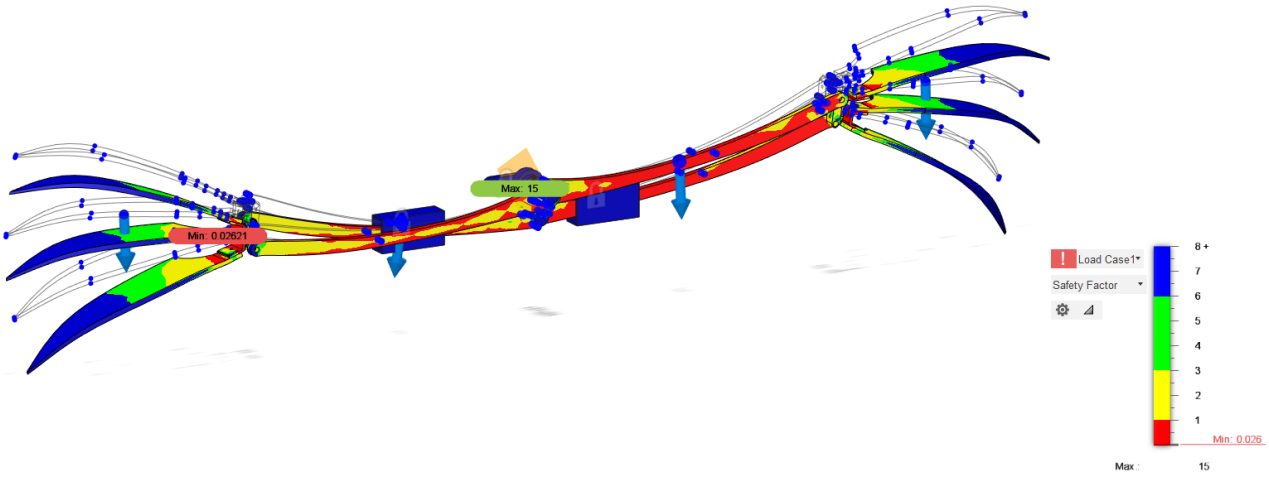


Figure 4: Safety Factor

- So one solution is to modify the design and strengthen the links which have the weakest areas. which accordingly will give better results.

Conclusion:

In conclusion, we have discussed the static stress analysis of the mechanism, to check the weakest areas in the structure and modify it to make sure that the structure of the mechanism will endure the stresses and strains from the internal forces.
