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A drone motor design and strength analysis

Technological developments have not affected the development of unmanned air vehicles and the development of different types of aircraft. One of these aircrafts is drones that can carry heavy loads. It is common to use Brushless direct current (BLDC) motors in these types of drones. In this article, a BLDC motor construction design has been made for a drone with a heavy payload capacity. The strength analysis of the propeller connection surfaces of this motor with its main design was made. Since lightness and durability are prioritized in aviation designs, the optimum strength-lightness values can be achieved by optimizing the motor construction according to the correct analysis parameters.

3d model, methods, materials.

The 3D model of the design of the drone motor used in this study is shown in Figure 1. Part number 1 acts as a rotor. The propeller is mounted on the rotor flange surface. The motor is mounted to the drone body from the shaft flange surface indicated by the number 5. The rotor consists of aluminum alloy commonly used in aviation. The properties of this material are given in Table 1

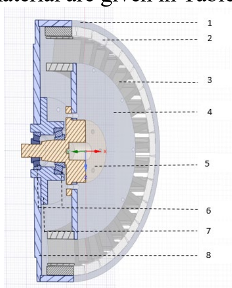


Fig. 1. Brushless DC electric motor 3D Model; 1: Rotor ring, 2: Permanent magnet, 3: Stator Stack, 4: Stator mounted plate, 5: Axle shaft, 6: Bearings, 7: Bearing houses, 8: Rotor ring and rim mounted plate

Properties of material

Table 1

Material	Density	Tensile Yield Strength	Compressive Yield Strength	Tensile Ultimate Strength	Young's Module	Poisson's Ratio	Bulk Module	Shear Module
Unit	kg/m^3	Mpa	Mpa	Mpa	Mpa		Mpa	Mpa

Aluminum alloy	2770	280	280	310	71000	0,33	69608	26692

Mathematical model.

To analyze the strength of the construction, a mathematical model of the rotor to which the propeller is attached is created. This model has 331183 nodes and 189523 elements. The mathematical model is shown in Figure 2.

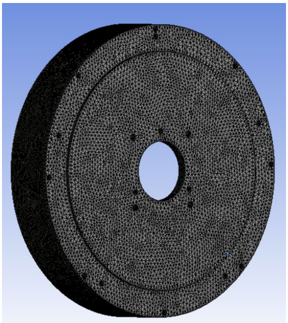
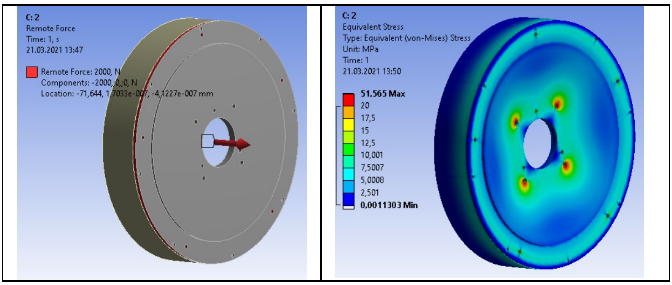


Fig. 2. Mathematical model of rotor

Analysis and Results

The rotor is defined as fixed from the surfaces where the extensions of the parts connected to the drone body of the motor do not have axial movement. Stress, Strain, Safety Coefficient and Total Deformation parameters on the rotor were evaluated by defining 2000 N axial load from the surfaces where the propeller is attached. The representation of the axial load, stress distribution, total deformation and strain distribution are shown defined in Figure 3. It has been determined that the stress is concentrated in the fixing holes of the bearing housing on the rotor flange and is 51 MPa. However, total deformation value is greatest at the outer diameter. These values are shown in Table 2.



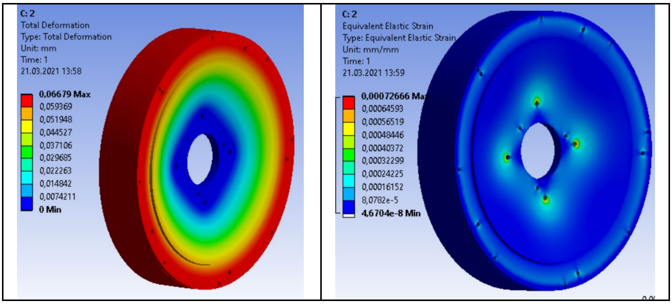


Fig. 3 Axial Load, Stress distribution, total deformation, strain distribution

Results Table 2

Stress, Mpa	Total Deformation, mm	Strain, mm/mm	Safety Factor
51,565	0,06679	0,0007266	5,43

Conclusion

BLDC drone motor with a fixed external rotor shaft has been designed. The rotor's behavior under 2000N axial load was researched that Analyzes are made with these values. For the optimization of the motor design, the loads on the motor should be revised according to the drone design.

Safety factor is kept above 5 for flight safety. Stress and strain are concentrated on the bolt surfaces. To reduce this, the flange connection design may be shape dependent or a larger number of bolts can be used.

Total deformation is highest on the outer diameter of the rotor, the axial move ment of the magnets connected to rotor can affect the motor driving and reduce characteristics and reduce the electrical efficiency.

References

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