Space Renaissance Project report

Objective

To design a 3 blades based Vertical Windmill setup (blades should be made of low cost light weight and hard material) and show the minimum force for rotation of the blades.

Assumptions

1. It is assumed that the vertical windmill is of the Darrieus wind turbine type with H- rotor turbine type supports
2. For problem realisation and airfoil selection purposes, it is assumed that the required angle of attack is 0 degrees
3. Hence airfoil NACA 6409 is taken as airfoil design for the wind turbine for the purpose of this problem statement.[1], but due to computational difficulties NACA 0018 was chosen[2]

Setup

1. CAD modelling was done on Solidworks 2020 with Rigid Dynamics modelling and analysis done on Ansys 2019
2. Due to problem statement specifying the need for low cost hard and light weight material, the structural steel material sample from the Ansys datasheets was taken as the material implemented on the windmill.
3. NACA position coordinates were taken from [3], the NACA airfoil tool online.
4. Windmill blades were made as a separate component with the windmill shaft put in consequently as an assembly component
5. It was assumed that the ball bearing housed in the shaft itself gives zero resistance, i.e. frictionless, hence the only load on the revolute joint(ball bearing) would be rotational displacement and standard earth gravity acceleration pointing downwards.

Observation/Result

The minimum force to turn the blades required was approx. 246.46 Newton

[1]Md. Robiul Islam, Labid Bin Bashar, Dip Kumar Saha, & NazmusSowad Rafi. (2019). Comparison and Selection of Airfoils for Small Wind Turbine between NACA and NREL's S series Airfoil Families. International Journal of Research in Electrical, Electronics and Communication Engineering, 4(2), 1–11. http://doi.org/10.5281/zenodo.3520469

[2]ROGOWSKI, Krzysztof; HANSEN, Martin Otto Laver; MAROŃSKI, Ryszard. Steady and unsteady analysis of NACA 0018 airfoil in vertical-axis wind turbine. **Journal of Theoretical and Applied Mechanics**, [S.l.], v. 56, n. 1, p. 203-212, jan. 2018. ISSN 1429-2955. doi:10.15632/jtam-pl.56.1.203.

[3] http://airfoiltools.com/airfoil/details?airfoil=naca0018-il