Experimental Investigation for the Torque-Ladder System Present in the Daisy Kite Airborne Wind Energy System.

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Introduction

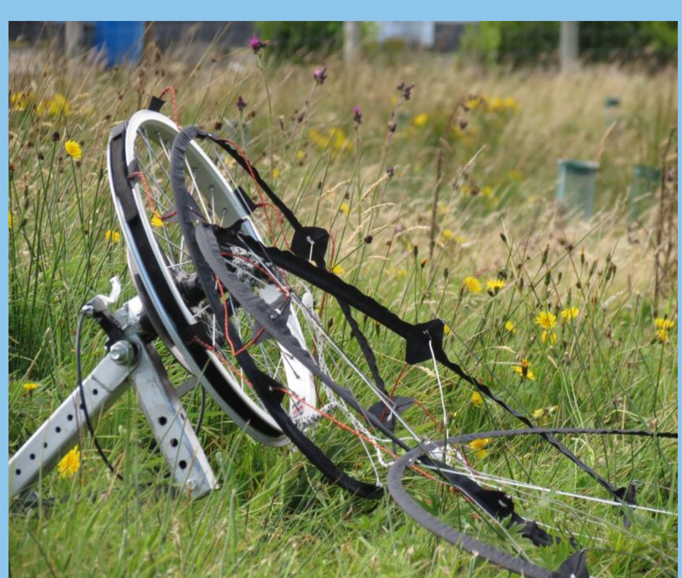
As the United Kingdom's need for energy rises, standard forms such as Coal, Nuclear and mainly Gas are used more, so other forms of energy have to be considered to meet the demand.

Airborne Wind Energy Systems are a generation of systems that looks to provide power through free flying systems that are either based in the air or tethered to the ground like a kite[1]. Theoretically, this technology should be a cheaper alternative to wind turbines, as it removes the need of the expensive towers.

The aim of the internship was to see if the factors considered negligible in a computer simulation of the system, could be assumed negligible in an experimental set-up.

Daisy Kite Airborne Wind Energy System

The Daisy Ring Kite is an AWES that is tethered to a ground based generator. Attached to the spinning central shaft, are tethers fixed to the rings. As the kite rotates, the tethers skew. By creating an angle, a component acts in the plane of the ring causing torsion. This torque is transferred down the system. Torque is lost as it travels down the system through factors such as line drag and friction.

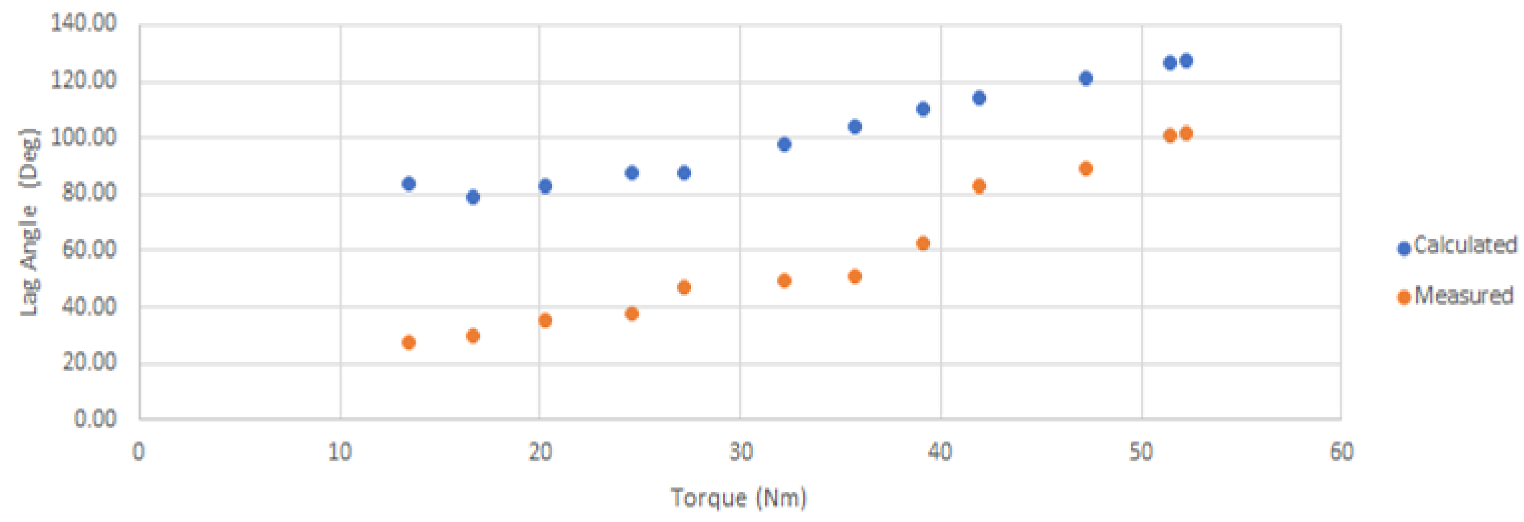


Methodology

- Place two bike wheels opposite each other and attach six inextensible strings of the same length between them. These represent the two lowest rings of the Daisy Kite system.
- Cover the wheels in equal widths of tape and number them.
- Rotate one of the wheels at a constant speed whilst keeping the other wheel at a constant torque opposing the action.
- As the wheels spin, take multiple photos of the system.
- For each photo, enter the two numbers the pointers are adjacent to, into the excel document to calculate the angle of skew.
- Different torques are applied using a pulley system and varying combinations of bags of weight.

Results

The first mass we used was 5kg with a tether length of 0.646m. The graph below shows that both the calculated values taken from excel, and the measured experimental values follow a similar pattern. However the two sets are far apart suggesting that torque is being lost within the system.



As the mass doubled to 10kg, the two datasets got closer together. Though the measured data was still lower than expected due to losses in the system, the similarity in the pattern of the data suggested that the results were reliable.

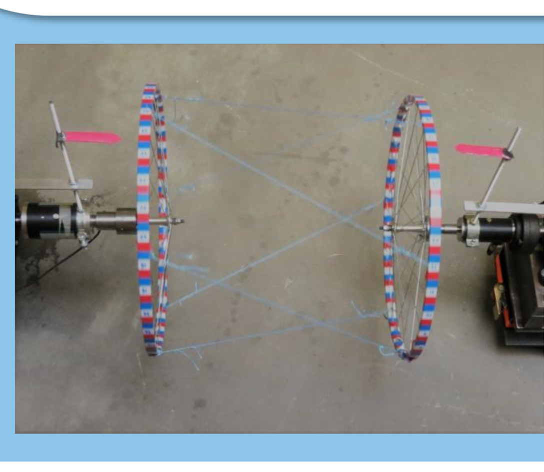
The third test completed was for a mass of 20kg.The narrowing in the spread of datasets suggest that higher masses, with greater tension in the system, the rig is quicker to overcome the force of friction and react to the torsion.

Our final test was based on 30kg. The recorded data after 60N became erratic and the wheel stopped resisting the applied torque. This is the point at which the rig is believed to have broken, ending the data collection for my internship.

Conclusion and Future Work

To conclude, the higher the mass the more accurate the results. This is because the tension is enough to overcome the friction in the system. Moreover, at higher weights, the calculated and measured results are similar that we can assume that the factors such as line drag can be considered negligible when making calculations on the concept.

For future work, it is important to ensure that the wheels are secured to the shaft of the motor so that wheel continues to resist the torque. Moreover, future work would include creating a graph showing the Lag Angle against Torque for a wider range of masses.



References

[1] A. P. R. M. A.Cherubinia, "Airborn Wind Energy Systems: A review of the technologies," Renewable and Sustainable Energy Reviews, vol. 51, pp. 1461-1476, 2015.

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