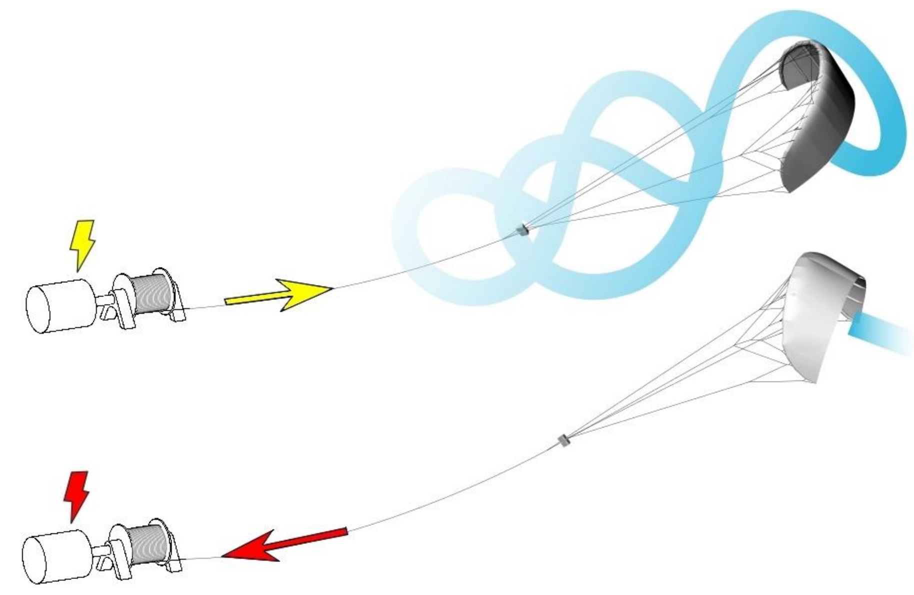
Methodology Improvement for Performance Assessment of Pumping Kite Power Wing

Context - Pumping kite power system

- High altitude winds → strong and constant
- Crosswind motion → strong pulling force
- Generation and retraction phase
- Light and flexible surf-kite wing
- Numerical simulation require C_L, C_D, L/D
- CFD analyses require experimental data

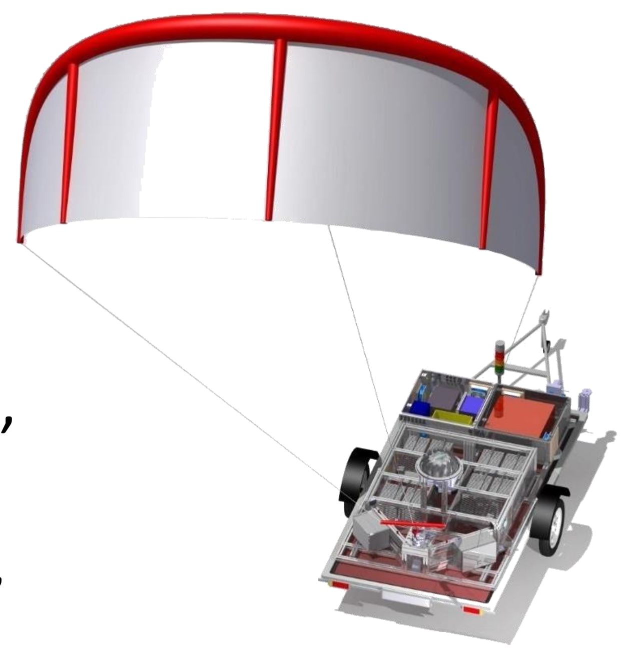


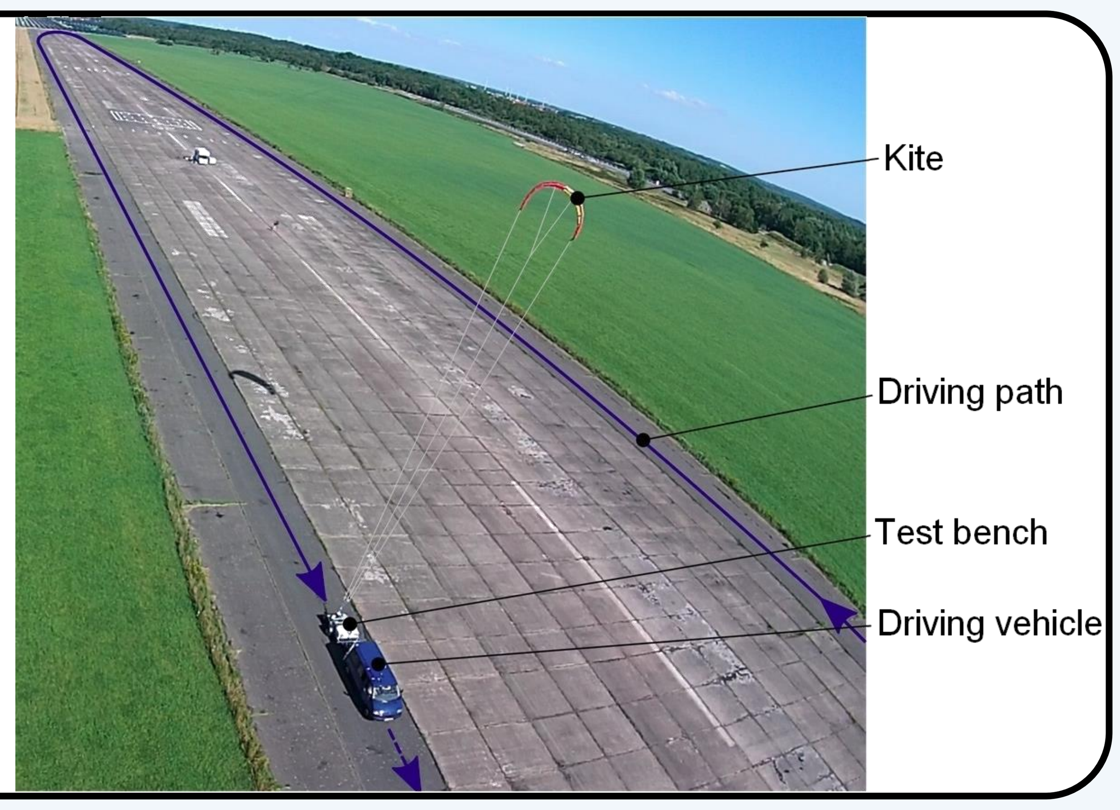
Objective

To improve the assessment methodology of the aerodynamic properties of the Kitepower wing by:

- Conducting investigation with the TU Berlin setup,
- Comparing two testing methodologies (dynamic/static),
- Considering the kite mass, tether mass, tether lift and drag,
- Investigating the sag of the tether,
- Relating the aerodynamic properties to the angle of attack,

in order to provide relevant data for ongoing numerical research.





Result

- Testing methodology

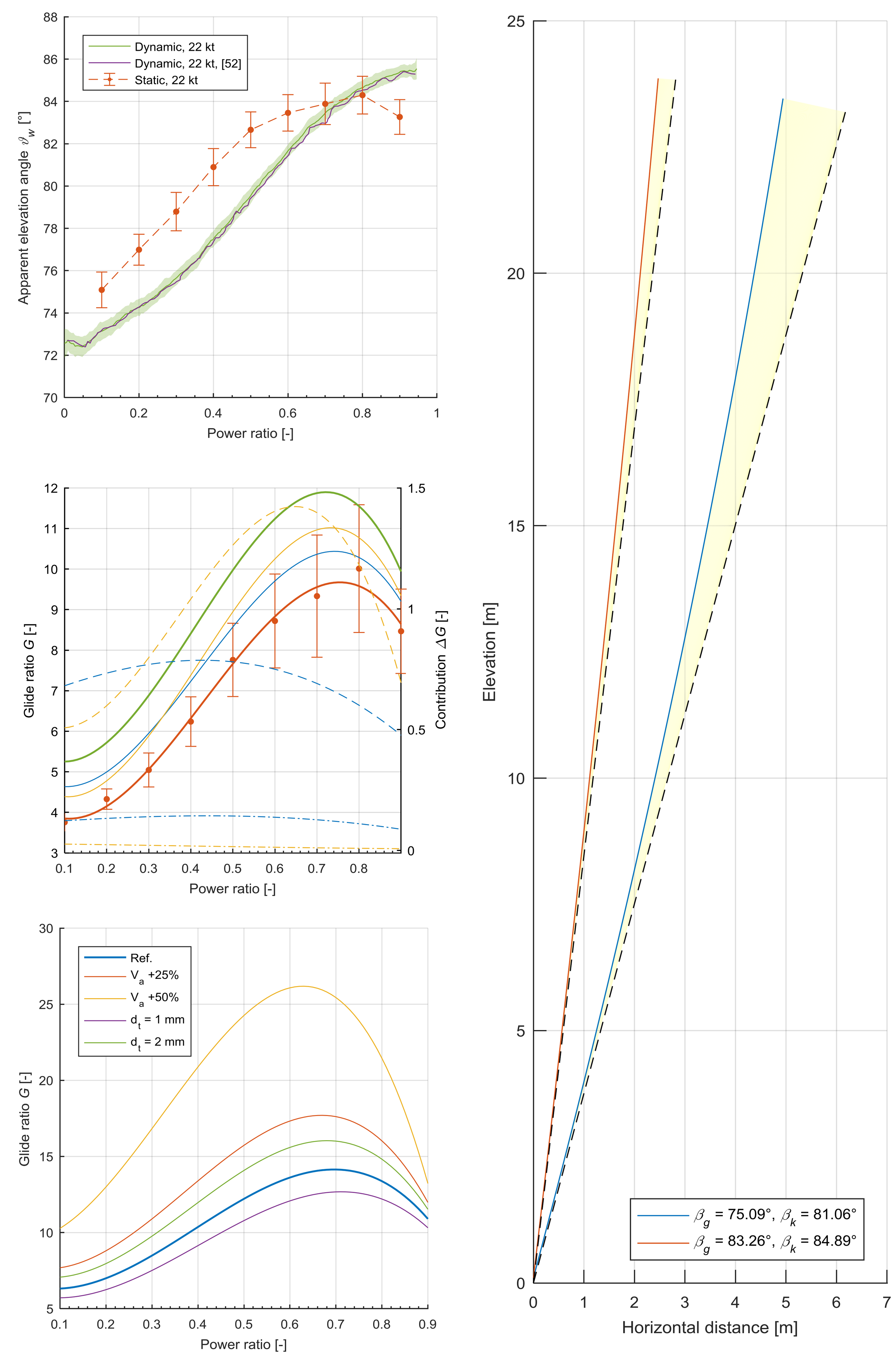
- With static maneuvers, the kite first gains altitude and then drops after 80% of power ratio.
- With dynamic maneuvers, the kite never reaches its equilibrium position: lower elevation for power ratio below 75%. Past this point, the kite overshoots its equilibrium position. A small loss in altitude occurs at the beginning of the maneuvers.

- Effects of M_k, M_t, D_t, L_t

- Tether lift has a limited effect on the aerodynamic properties.
- The tether weight has a light effect whereas the weight of the kite notably affects the aerodynamic properties.
- Although variable, the major effect stems from the tether drag.
- Together, these effects lead to: C_L : +16%, C_D : -10%, L/D : +29%.

- Sag of the tether

- The sag increases as the power ratio decreases.
- At kite, greater elevation angle (+2.5°), lower tether force (-15N).
- Tether sag leads to: C_L : +16%, C_D : -25%, L/D : +54%.
- Strong sensitivity of both apparent speed and tether diameter.



Conclusion

The dynamic behaviour of the kite and its slow respond should be considered in the analytical model. If not, the static maneuvers are recommended. The tether lift can be neglected while M_k, M_t and D_t should be considered as well as the sag of the tether.

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