11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

NUMERICAL INVESTIGATION OF AN AIRFOIL WITH SELF-ADAPTIVE CAMBER

S. Türk[1,2], M. Schäfer[2], C. Tropea[3] and D.C. Sternel[2]

[1] Graduate School of Computational Engineering, TU Darmstadt, Dolivostraße 15, 64293 Darmstadt, tuerk@gsc.tu-darmstadt.de, http://www.graduate-school-ce.de
[2] Institute of Numerical Methods in Mechanical Engineering, TU Darmstadt, Dolivostraße 15, 64293 Darmstadt
[3] Institute of Aerodynamics and Fluid Mechanics, TU Darmstadt, Alarich-Weiss-Str. 10, 64287 Darmstadt

Key words: *Fluid-Structure Interaction, Turbulence, Aerodynamics, Flow Control.*

Despite the fact that the computational resources have been constantly growing for the last decades, the simulation of complex fluid dynamics problems such as the simulation of turbulence by using Direct Numerical Simulations (DNS) or also Large-Eddy Simulation (LES) is still limited to either simple geometries or moderate Reynolds numbers. Thus, RANS models are still the preferred method in industrial applications for pratical relevant Reynolds numbers.
Especially in multi-physics problems like fluid-structure interaction (FSI) the costs for simulations in the turbulent regime can be easily doubled due to the iterative process between the fluid and the structural side. This leads to the fact, that turbulence resolving methods such as LES and DNS are hardly feasible for FSI problems in the foreseeable future. Despite the drawbacks arising from the modelling assumptions made in RANS models, the main aspects of not statistically stationary flows can be captured by URANS if the time and length scale of the coherent structures are much larger than the scales of turbulence. For a rather slow structural motion, these conditions are fulfilled.
In the present work, URANS is applied to a FSI problem, where an airfoil with self-adaptive camber (shown in figure 1) is investigated. By adapting its camber based on the inflow conditions, Lambie [1] proved that the lift curve can be significantly altered for a given steady inflow as shown in figure 2. This behavior offers a big potential to rotor blades on wind turbines in terms of load reduction and life span. The results in the present work obtained from simulations will be compared to the experiments from Lambie [1], in order to evaluate the performance of URANS methods in this specific scenario and will serve as the groundwork for further parametric studies.

This work was supported by the "Excellence Initiative" of the German Federal and State Governments and the Graduate School of Computational Engineering at Technische Universität Darmstadt.

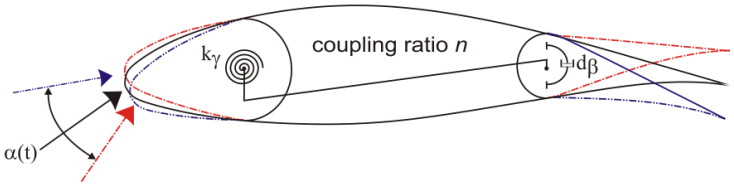

Figure 1: Schematics of airfoil with self-adaptive camber for different angle of attack, based on [1]

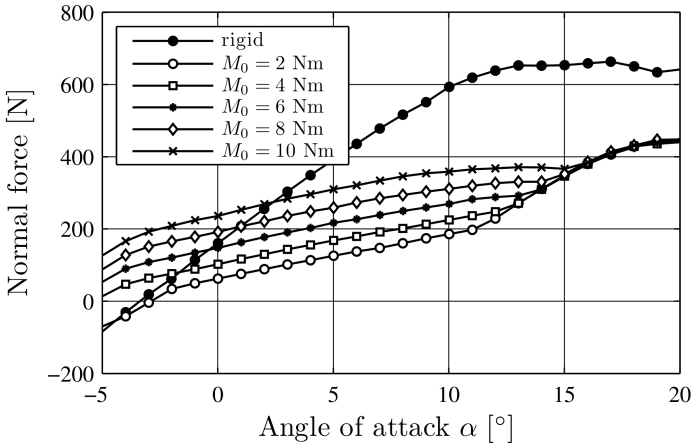

Figure 2: Different lift curves depending on preload moment of the torsional spring at the leading edge, [1]

REFERENCES

[1] Benjamin Lambie. Aeroelastic Investigation of a Wind Turbine Airfoil with Self-Adaptive Camber. *PhD Thesis*, TU Darmstadt, 2011.