Authors pre-print; publisher's version available in Journal of Sound and Vibration, 427:201–202, August 2018, DOI: 10.1016/j.jsv.2017.10.016.

2016 Highlights - Airframe Noise (AFR)

Low-Noise Technologies for Wind Turbine Blades

M. Herr, michaela.herr@dlr.de; R. Ewert; B. Faßmann; C. Rautmann; S. Martens; C.-H. Rohardt, A. Suryadi

Broadband trailing-edge scattering noise (TEN) represents a canonical source mechanism that expresses in a wide range of technical situations like the noise generation at aircraft high-lift systems, at turbomachinery components, cooling fans or wind turbine blades. At modern wind turbines TEN as generated in the outer 20-25% of the rotor radius constitutes the most relevant noise contributor.

The German national wind energy project BELARWEA (BMWi ref. 0325726) aims at the development and validation of improved methods to support the design of both efficient and low-noise wind turbine rotors [1]. 2D CFD/CAA-based predictions with 4D stochastic source reconstruction using the Fast Random Particle-Mesh Method (FRPM) [2, 3] were successfully applied to predict the TEN emission of a newly designed wind turbine blade profile RoH-W-18%c37. Corresponding validation results are shown in Fig. 1 for varying test angles-of-attack and turbulent boundary-layer transition locations.

When transposing these results to approximate operational conditions (here: to conditions at the outer rotor portion of a small-scaled experimental turbine), the new airfoil design is expected to bring about an overall 2-4 dB TEN reduction when compared to a NACA 64-618 reference profile, cf. Fig. 2.

The noise emission of such an aeroacoustically driven design can be further significantly reduced by the adaptation of TEN reduction concepts known from aerospace-related studies (porous, slotted or brush-type extensions) to the new application conditions [4], see Fig. 3. Compared to standard trailing-edge serrations as currently applied at todays' wind turbine rotors, the proposed concepts appear less susceptible to excess noise generation.

References:

[1] M. Herr, R. Ewert, B. Faßmann, C. Rautmann, S. Martens, C.-H. Rohardt, A. Suryadi, Noise Reduction Technologies for Wind Turbines, in: A. Dillmann, G. Heller, E. Krämer, R. Radespiel, C. Wagner (eds.), Notes on Numerical Fluid Mechanics and Multidisciplinary Design, New Results in Numerical and Experimental Fluid Mechanics XI, Springer, Berlin-Heidelberg-New York, 2017 (in print)

[2] R. Ewert, J. Dierke, J. Siebert, A. Neifeld, C. Appel, M. Siefert, and O. Kornow, CAA Broadband Noise Prediction for Aeroacoustic Design. Journal of Sound and Vibration, 330(17):4139–4160, 2011

[3] C. Rautmann, Numerical Simulation of Wind Turbine Trailing-Edge Noise, Dissertation, Technical University Braunschweig, Germany, 2017 (not yet published)

[4] A. Suryadi, S. Martens, M. Herr, Trailing-Edge Noise Reduction Technologies for Applications in Wind Energy, 23rd AIAA/CEAS Aeroacoustics Conference, 5-9 June 2017, Denver, CO, USA

Authors pre-print; publisher's version available in Journal of Sound and Vibration, 427:201–202, August 2018, DOI: 10.1016/j.jsv.2017.10.016.

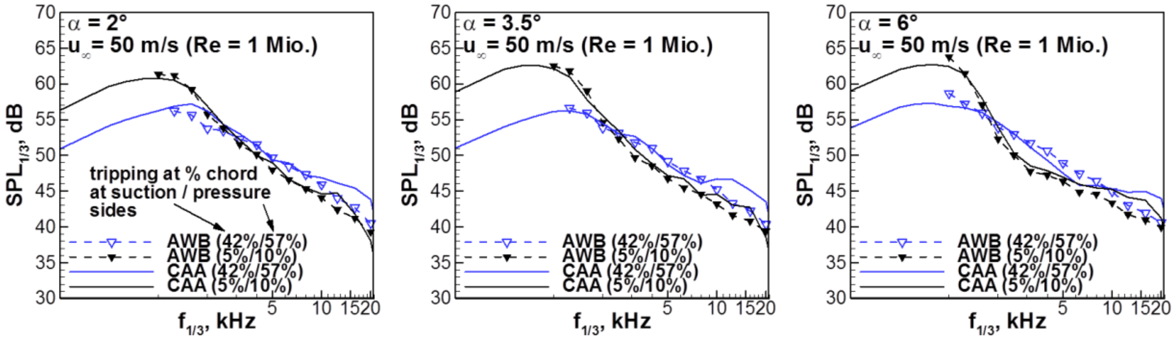

Fig. 1. Comparison of CAA predictions with results from measurements at a 2D RoH-W-18%c37 blade section in the Acoustic Wind-Tunnel Braunschweig (AWB).

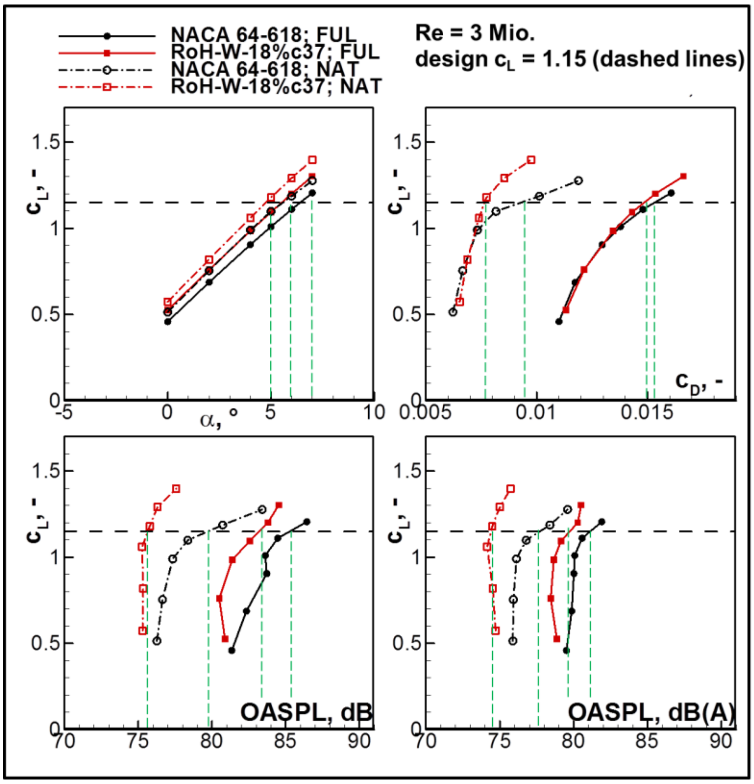

Fig. 2. Predicted aeroacoustic performance of the RoH-W-18%c37 compared to the NACA 64-618 reference for operational conditions, analysis for the cases 'FUL' (fully turbulent boundary-layer from the leading edge) vs. 'NAT' (natural boundary layer transition).

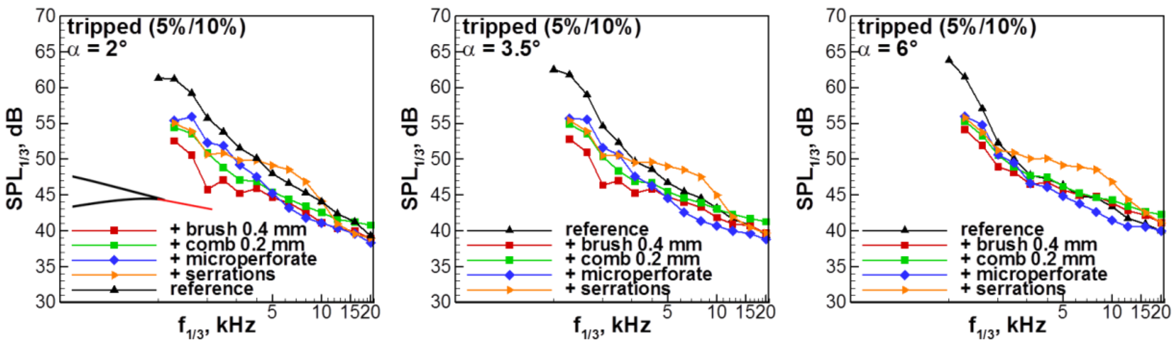

Fig. 3. Effect of selected trailing-edge extensions on TEN spectra for the RoH-W-18%c37. AWB measurement results for conditions as in Fig. 1.