An Experimental Investigation of the Noise Generated by Leading-edge Slat Accessories

Raymond Alsaif[1] & Alis Ekmekci[1]
[1] Institute for Aerospace Studies, University of Toronto, Toronto, Ontario, CANADA

Numerous studies have investigated noise produced by high-lift devices in small-scale wind tunnel facilities [1,2]. These investigations have been valuable in identifying and quantifying the far-field noise and the near-field flow properties. Most past experimental and numerical studies aiming to determine slat noise have primarily been conducted on two-dimensional, unswept configurations, thereby overlooking the added spanwise flow present in swept systems. Only a few experimental studies exist on swept high-lift models [3,4], and in all those studies, acoustic tests were done in open-jet anechoic wind tunnels, limiting them to only small angles of attack due to strong susceptibility to flow deflections in open-jet tunnels.

The flow region between the slat and the main airfoil contains several tracks, while the leading edge of the main element has multiple open cavities from which the tracks deploy. These components are primarily designed for operational purposes in current airplanes, without accounting for their interaction with the cove flow or their impact on slat noise. The spanwise flow in swept airfoils causes cross-flow effects on these components, which could contribute to additional noise. Since the tracks don't affect the aerodynamic performance of the slats, redesigning these components may present an opportunity to improve the acoustic performance of the slats without compromising their lift capabilities.

In this investigation, to address the lack of knowledge regarding the effects of sweep angle on slat noise and to assess the impacts of slat accessories, an aeroacoustic characterization of a scaled 30P30N model at a 30° sweep angle was performed, initially without slat accessories for varying angles of attack, and subsequently with slat accessories, such as leading-edge cutouts and slat tracks, considering various layout and shape of these accessories. The underlying mechanisms of noise generation are currently under investigation as part of this campaign.

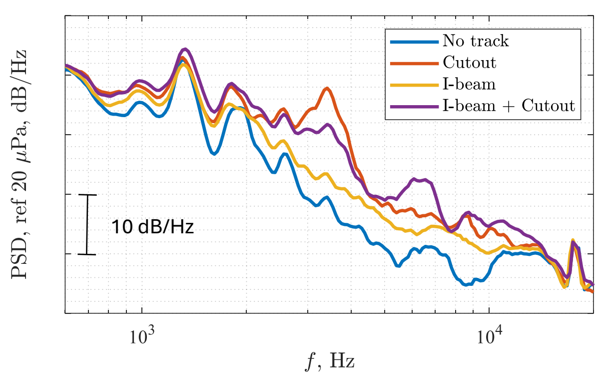

Figure 1. Far-field noise spectra of the swept 30P30N model with the addition of a leading-edge cutout, an I-beam shaped slat track and their combination compared to the clean case - without any tracks or cutouts.

Fig. 1 suggests that the cutout is responsible for the generation of higher levels of noise than the track itself. The far-field power spectral density (PSD) spectrum of the cutout features a prominent hump centered at a frequency of 3.3 kHz. However, when the track is added, this hump associated with the cutout is reduced, and an additional smaller hump emerges at a higher frequency of 6.5 kHz. On the other hand, the noise generated by the track alone is broadband in the frequency range of 2 to 10 kHz.

Email address for correspondence: *author.name@mcgill.ca*

References

[1] Li, L., Liu, P., Guo, H., Hou, Y., Geng, X., and Wang, J., “Aeroacoustic measurement of 30P30N high-lift configuration in the test section with Kevlar cloth and perforated plate,” Aerospace Science and Technology, Vol. 70, 2017, pp. 590 – 599.

[2] Pascioni, K., and Cattafesta, L., “Aeroacoustic Measurements of Leading-Edge Slat Noise,” 37th AIAA Aeroacoustics Conference, 2016. AIAA 2016-2960.

[3] Manoha, E., Davy, R., Pott-Pollenske, M., and Barré, S., “SWAHILI: an experimental aerodynamic and acoustic database of a 2D high lift wing with sweep angle and flap side edge,” 24th AIAA/CEAS Aeroacoustics Conference, 2018. AIAA 2018-3459.

[4] Martinus P. J. Sanders*, Leandro D. de Santana†, Cornelis H. Venner,” The Sweep Angle Effect on Slat Noise Characteristics of the 30P30N High-Lift Model in an Open-Jet Wind Tunnel”, 26st AIAA/CEAS Aeroacoustics Conference, 2020, p. 2557

Email address for correspondence: *author.name@mcgill.ca*