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Optimization of an aircraft fuselage assembly to minimize radiated sound power

Jordan Howes[1], Adam McKenzie[1], Wesley Dossett[1], Luke Crispo[1], Il Yong Kim[1]
[1] Queen's University, Kingston, Ontario, K7L 3N6, Canada
E-mail: kimiy@queensu.ca

During the structural design of an aircraft fuselage, the acoustic performance is generally not considered. However, vibrations transmitted through the fuselage generate noise leading to passenger discomfort. Currently, the main source of noise reduction comes from the addition of damping material to the fuselage. This work investigates the use of various design optimization techniques to reduce radiated sound power by changing the fuselage structure's geometry which consists of a skin panel, frames, and stringers. Design optimization tools, such as topology, size, and shape optimization were used to determine an optimal design for each design variable that minimized radiated sound power in the fuselage assembly. The design variables that were studied included skin panel thickness and design, frame and stringer spacing, and frame and stringer cross section. Equivalent radiated power was used as an objective function for numerical optimizations within Altair OptiStruct as an indirect method for minimizing radiated sound power numerically. To understand the source of the sound power improvements, a physics analysis was conducted for each design variable that compared sound power, equivalent radiated power, and radiation efficiency.

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