**Aerospace Europe Conference 2023**
**Joint 10th EUCASS – 9th CEAS Conference**

Preferred Topics: STRMAT
Corresponding author: Bara'ah Fraihat
e-mail of corresponding author: 100061877@ku.ac.ae
Type: Oral
Status of corresponding author: Student

# Aeroelastic tailoring of a composite cantilever stiffened-plate

## Authors

*Bara'ah Fraihat [1]*, Rafic Ajaj [2]*

*[1] Bara'ah Fraihat, Khalifa University of Science and Technology, Abu Dhabi, United Arab Emirates ,100061877@ku.ac.ae*
*[2] Rafic Ajaj, Khalifa University of Science and Technology, Abu Dhabi, United Arab Emirates, rafic.ajaj@ku.ac.ae*

## Abstract

There is a trend in the aviation industry to build aircraft with higher aspect ratio lifting surfaces for aerodynamic reasons, such as the Boeing B777x. These lifting surfaces permit substantial structural bending and twisting deformation, which may induce aeroelastic instabilities such as flutter and divergence; hence, methods to control these instabilities have always been a critical part of aeronautical engineering [1]. Aeroelastic tailoring originated from the use of composite stacking sequence to control aeroelastic instabilities; thus, this method is known to be the benchmark concept of tailoring. By using composites, reducing the structural weight while maintaining its integrity can be easily achieved; this lies in their high strength-to-weight ratio compared with traditional and commonly used isotropic materials (e.g., Aluminium). The use of composites alters the bend-twist coupling properties to create different tailoring scenarios which are directly related to the position of the primary stiffness axis. In addition to composites, tailoring can be achieved using special structural layouts such as varying the angle of the wing's parts with respect to each other. Many studies have considered tailoring using either composites or structural layouts; this work aims to couple both methods in order to get the best configuration at which the aeroelastic instabilities are at their maximum. This will be achieved through conducting a comprehensive parametric study on a rectangular, composite, flat, cantilever stiffened-plate. A multi-layered graphite/epoxy plate will be modelled in Nastran using the laminate element for structural representation and the Doublet Lattice Method (DLM) for aerodynamics. Then, the plate is to be stiffened by fixed-geometry aluminium stringers modelled using Euler Bernoulli beam element theory. A structural mesh of 12 chordwise by 48 spanwise elements will be coupled to an aerodynamic mesh of $18 \times 72$ elements using a Finite Plate Surface (FPS) spline. The fibre angle convention for the composite will be $0^{o}$ fibre parallel to the flow velocity vector, and $90^{o}$ fibre travels along the semispan of the plate. Two design variables will be employed in this study; one related to the use of composites, which is varying the laminate ply orientation (e.g., $[\theta, 45°, -45°]_s$). The other design variable is using different stringer's angle with respect to the spanwise axis (e.g., $25^{o}$ forward or backwards stringers) and this lies under the use of special structural layouts. For comparison purposes, the first part of this work will focus on analysing the stiffened-plate when varying the ply orientation. In the second part, the angle of stringers in addition to the ply orientation will be varied.

## References

[1] C. V. Jutte and B. K. Stanford, "Aeroelastic tailoring of transport aircraft wings: state-of-the-art and potential enabling technologies," NASA/TM-2014-218252, 2014.