

# **INFLUENCE OF MATERIAL PROPERTIES ON THE AEROELASTIC RESPONSE OF A T-TAIL STRUCTURE MADE OF COMPOSITE LAMINATES**

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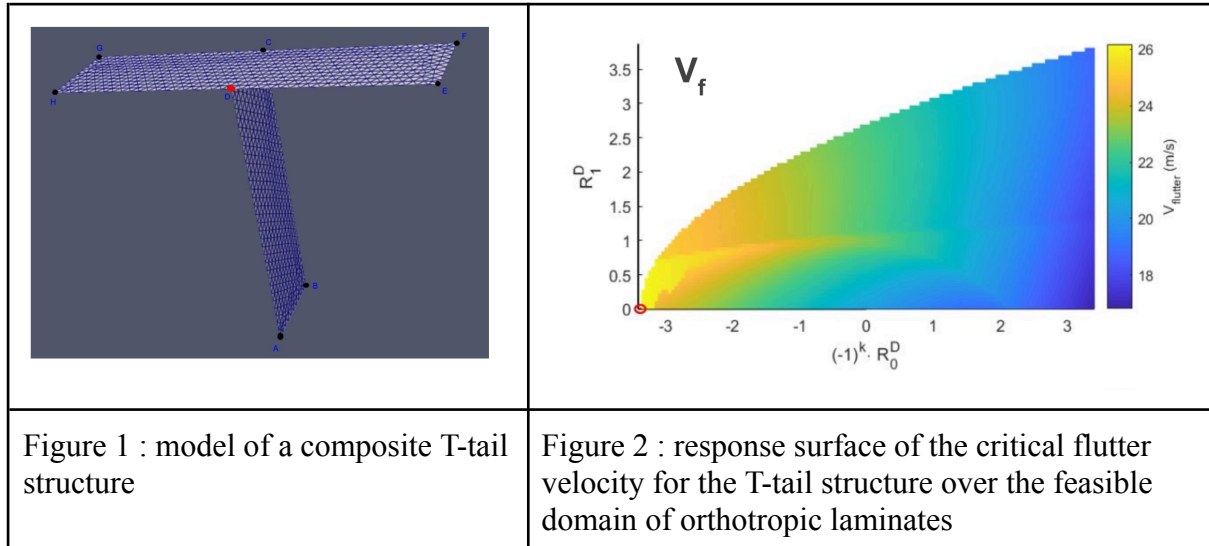
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The general framework of this study concerns the prediction of the aeroelastic response of aeronautical structures made of composite laminates and the quantification of the influence of material properties on the predicted aeroelastic behaviour. As a matter of fact, composite materials are widely applied in aeronautics due to their high mechanical performances in terms of strength-to-weight and stiffness-to-weight ratios. Besides, composite laminates allow a large freedom of design, thus opening the way to the optimisation of the response of composite structures. Despite these advantages, tailoring the elastic properties of a composite laminate is not an easy task because of its anisotropy and potential elastic couplings, which arise from the combination of ply angles in the laminate stacking sequence. Moreover, the aeroelastic response of a composite structure can be strongly affected by the numerous sources of errors on the composite constitutive parameters, particularly ply angles and thicknesses.

In past works, the authors established a two-level approach based on the use of the polar representation of anisotropic elasticity [1] in order to perform both uncertainty quantification [2], as well as deterministic [3] and robust [4] optimisation of the aeroelastic response of relatively simple academic configurations, such as plate composite wings (straight or swept, tapered or not). The aeroelastic coupling is established in a linear framework and it is based on a finite-element model for the structural modal analysis and a Doublet Lattice Method (DLM) for the approximation of the aerodynamic loads. The aeroelastic response is evaluated by a p-k solver and its variation is studied in terms of the composite material properties in order to globally explore the whole feasible domain of composite laminates described by the corresponding relevant elastic polar parameters. This approach allows to globally optimise the aeroelastic response of aeronautical composite structures (i.e. maximise their stability margin at a given flight speed or maximise their critical flutter velocity) in terms of the homogenised composite polar elastic parameters, and then the corresponding laminate can be retrieved by solving an identification problem in terms of the laminate constitutive parameters (essentially, the sequence of ply angles).

The aim of the present work is to apply the proposed two-level approach in order to perform the aeroelastic optimisation of composite T-tail structures (Figure 1), which are configurations of interest in modern aircrafts or UAVs (Unmanned Aerial Vehicles) [5]. Optimisation can be performed by searching over the whole domain of feasible composite laminates thanks to the polar representation of the composite elastic properties (Figure 2), either considering a uniform or variable distribution of stiffness over the structure. As it can be seen in the preliminary results of Figure 2, discontinuities appear in the response surface of the critical flutter velocity of the T-tail structure, due to aeroelastic mode switches. As a consequence, the

aeroelastic response of the optimal composite configuration, that are obtained in a deterministic framework, should be evaluated under the effect of uncertainties on the composite constitutive parameters: the polar approach allows to consider uncertainties on both ply angles and thicknesses, without any simplifying hypothesis in the representation of the composite behaviour.



## REFERENCES

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