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AEROELASTIC ANALYSIS OF AIRCRAFT WINGS

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Aeroelasticity phenomena involve the study of the interaction between aerodynamic and elastic forces (static aeroelasticity), and aerodynamic, inertial, and elastic forces (dynamic aeroelasticity). Modern aircraft structures, making more and more use of lightweight composite structures, may be very flexible making the aeroelastic study an important aspect of the aircraft design.

Flutter is a dynamic aeroelastic instability characterized by sustained oscillation of structure arising from interaction between those three forces acting on the body. The present work aims to study the flutter behavior on three-dimensional subsonic aircraft wings, using a computationally efficient method. For that, a new computational aeroelasticity design framework was created using a panel method to solve the fluid flow approximated as potential flow and a commercial software for the structural analysis. A validation of the fluid solver is made using wind tunnel data, while the structure solver is verified using the available tests. The coupling of the two domains is made with a main script using two different time discretization schemes: the Conventional Serial Staggered procedure and the Improved Serial Staggered procedure.

The results are presented for a wing example which is denoted as reference case. Later, a study of the influence of different parameters is performed, namely the free stream velocity, the spar location, the sweep angle, the skin material density and Young modulus, concluding with the comparison between the many values tested. This step made it possible to verify qualitatively the dynamic behavior caused by changes in the flow, internal and external structure and materials. It is concluded that the framework shows very good agreement to the theoretical influences of the parameters studied. Despite the simplification of the fluid flow, which was assumed to be potential, this method proves to be a very useful tool in aircraft preliminary design.