Fundamental aeroelastic properties of a bend–twist coupled blade section

The effects of bend–twist coupling on the aeroelastic modal properties and stability limits of a two-dimensional blade section in attached flow are investigated. Bend–twist coupling is introduced in the stiffness matrix of the structural blade section model. The structural model is coupled with an unsteady aerodynamic model in a linearised state–space formulation. A numerical study is performed using structural and aerodynamic parameters representative for wind turbine blades. It is shown that damping of the edgewise mode is primarily influenced by the work of the lift which is close to antiphase, making the stability of the mode sensitive to changes in the stiffness matrix. The aerodynamic forces increase the stiffness of the flapwise mode for flap–twist coupling to feather for downwind deflections. The stiffness reduces and damping increases for flap–twist to stall. Edge–twist coupling is prone to an edgetwist flutter instability at much lower inflow speeds than the uncoupled blade section. Flap–twist coupling results in a moderate reduction of the flutter speed for twist to feather and divergence for twist to stall.

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