Modeling of Unsteady Aerodynamic Characteristics of Delta Wings

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The high angles of attack region has become more accessible to modern aircraft. Therefore, mathematical modeling of the unsteady aerodynamic forces and moments play an important role in aircraft dynamic investigation and stability analysis at high angles of attack. Consideration of separated flow around an airfoil and flow with vortex breakdown around a slender delta wing gives the bases for mathematical modeling using internal variables describing the flow state. This work seeks to create a model for unsteady aerodynamic coefficients, which could be used in simulations in the early design process, and to enable the investigation of static and dynamic forces measurements in water tunnel tests.

The simulation models are based on a representation of C_L using internal state variables. In this approach all the variables have been determined on a geometrical bases, no implementation or parameter determinations have to be done from tests cases. This is to provide full simulation of different delta wing configurations for a low cost without wind or water tunnel tests. All the modeled coefficients are functions of state x(t) and inputs α(t) and q(t). The state variable depends on the flow separation or the vortex breakdown.

The model was applied to oscillatory data in pitch for 70-degree sweep leading edges. The god results obtained show that, this method is applicable to generic delta wing configurations, it is not dependent on specific empirical information, and is economical to use. The method has been validated with comparison with static and dynamic wind tests.

This study has shown that a simple model describing the unsteady characteristics of delta wings undergoing pitching motions can be obtain with good relation to water and wind tunnel tests. The present method can then by used for different purpose, such system simulations or stability and control in an early design stage and will be included in the flight dynamic model used for complete aircraft system modeling at Linköping University.