

Wake Penetration Effects on Dynamic Loads and Structural Design of Military and Civil Aircraft

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Abstract

The effects on the structural design of military and civil aircraft caused by dynamic loads resulting from the flight through high wake velocities which are generated by different types of aircraft have not been sufficiently investigated in the past. Military aircraft might experience this impact during formation or squadron flight or during combat manoeuvres and civil aircraft could be affected during start and cruise through wakes from other aircraft.

Through the wake the safety of the aircraft might be critical by wrong guidance, uncontrolled movements or by induced dynamic loads which might cause failure of structure or structural fatigue.

The design of aircraft structure accounting for wakes is not state of the art. The standard design includes dynamic loads from PSD gust analysis and buffet or tuned gust analysis, where the intensities of the gust velocities are defined by military or civil specifications and buffet intensities are defined from wind tunnel test results.

Predictions by analysis of wake velocity fields of different aircraft indicate however that the known maximum gust velocities are exceeded and the time history of the velocities experienced by the affected aircraft during penetration is different for example to the 1-cos gust in the discrete analysis. Moreover flight test results of the dynamic aircraft response during wake penetration produced evidence for its criticality in several flight regimes.

This contribution concentrates on military aircraft and demonstrates several examples of predicted critical wake fields and results from calculated dynamic response during different kind of penetration. Also examples from flight dynamic responses are discussed.

Finally some recommendations for future research and activities are given which should lead to a wake and wake penetration specification for military and civil aircraft required for the structural design and clearance.