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PROBABILISTIC OPTIMUM DESIGN OF AIRCRAFT STRUCTURES

By

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Abstract:

This paper discusses the application of probabilistic design methodology for the optimum design of aircraft structures. Material properties and loads are considered as stochastic data in formulating the optimization model for the design. The procedure accommodates various types of sensitivity analyses. Attention is focused on studies in which both the aerodynamic and structural designs are optimized simultaneously. Tradeoffs between drag and structural weight for aircraft wings are affected by two aerodynamic-structural interactions. First, structural weight affects the required lift and, thus drag. Second, structural deformations change the aerodynamic shape.

Design results obtained using the Monte Carlo simulation method, and the limit state function approach, are presented. The limit state function method applies the Most Probable Point (MPP) search approach. Some of the approximate methods that have been applied for the search are FORM, AMV, AIS, etc.

Introduction:

Several methods have been proposed in the past for optimum design of aircraft structures. Most of these methods have utilized deterministic design optimization techniques to obtain what could be considered satisfactory design parameters. For conceptual design, structural weight and aerodynamic performance have traditionally been estimated by algebraic expressions. These expressions have allowed designers to examine many configurations with little computational effort. These tools have recently been combined with deterministic optimization. The two mayor concerns with the results of the deterministic approach are: the inability to deal with uncertainties in material properties, and over conservative design. Whereas the deterministic approach has served the industry fairly well in the past, new analytical techniques based on probabilistic methods can provide more optimal results. The probabilistic analysis methodology seeks to account for uncertainties in material properties, loading conditions and disparate failure modes.