AD-Vol. 52, Proceedings of the ASME Aerospace Division
ASME 1996

DURABILITY AND DAMAGE TOLERANCE CERTIFICATION OF COMPOSITE STRUCTURES

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Several recent applications of polymer matrix, graphite fiber composites to operational aircraft structures have illustrated a need for well defined approaches or methodologies to demonstrate compliance with airworthiness certification requirements. This paper presents a review of the currently used compliance criteria, substantiating data required, and the methodologies available to address durability and damage tolerance certification of aircraft composite primary structures.

The set of static design allowables required for composite structures, the tests that need to be conducted, and a methodology to derive the allowables from the test data is discussed. Tests that are unique to a design feature, such as extensively bonded structures or honeycomb sandwich construction, and the allowables required are described. The statistical confidence required, i.e., the number of replicates to be tested, depends on the stages of a project where material selection may not be finalized till the comprehensive design review. Techniques for statistical analysis of design allowables data for a limited number of tests, and to determine the knock-downs associated with this small data set are also described.

Durability in composite structures is for the most part designed-in due to the various knock-downs applied to the static design allowables. However, fatigue allowables are required to ensure durability of bolted joints, mixed metal and composite structures and unique design features where out-of-plane failure modes are dominant. In some applications long term environmental durability of the materials is a concern. A durability philosophy that addresses this concern is proposed.

Composite structures are designed for damage tolerance in practice by using an impact damage static design allowable. Application of this allowable across-the-board for static design can result in significant weight penalties. A systematic approach to applying the static post-impact strength allowable after identifying the damage tolerance critical areas is described and the weight sensitivity to this allowable for a point design is illustrated. In commercial transport aircraft several additional damage tolerance and damage arrestment criteria apply. A review of compliance methodologies where available is also presented.