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Introduction

It is now clearly evident that composites have become viable engineering materials. Prime examples of this are the components now being used in the aerospace, ground transportation, recreational, and appliance industries. In the advanced applications, Northrop's YF-17 contains 900 lb of graphite-epoxy secondary structure, while the Air Force's F-15 has boron-epoxy horizontal stabilizers, vertical stabilizers, and rudders. Two phenomena have recently occurred, however, which could potentially accelerate advanced composite systems toward high-volume structural use in the civilian sphere of technology. The first is a breakthrough in producing high-performance carbon fibers from a low-cost pitch precursor. This will eventually result in a tenfold cost reduction for carbon fibers and thereby contribute to placing carbon-epoxy composites in the economic ball park with metal systems. The second boost toward new high-volume markets arises from a consideration of the total life-cycle cost of an end product. In many cases it can now be demonstrated that it is more efficient on a life-cycle basis to invest a pound of hydrocarbon in an optimized, lightweight composite structure, through advanced materials technology, than to burn that pound of hydrocarbon to transport a heavier structure. Thus, the combined effects of a decreasing initial cost and lower total life-cycle cost are now driving advanced composites, particularly the resin matrix systems, toward successful economic competition with traditional technologies in such high-volume industries as auto and truck transportation and household appliances.

With the advent of structural composite systems in high-performance military and civilian aircraft and particularly in the people-intensive transportation industry, the question of system reliability and durability takes on primary importance. We must know what fraction of the structural items produced will exhibit a specific lifetime under a given-use environment (reliability), as well as how long a given structural item will survive under a specified-use environment (durability). Both factors are indeed indispensable in accurately evaluating the total life-cycle cost of a structural end product. As Colonel Keating pointed out in his opening remarks to the conference, the consumer today obtains a product which is well defined by specifications, codes, and safety factors, but ill defined in terms of reliability and durability, and hence very expensive on a life-cycle cost basis.

With the need to conserve our valuable energy resources becoming more and more evient and with an attendant skyrocketing energy cost, society is now looking to the technical community to use advanced technology to drive reliability and durability up and cost down. This conference attempts to answer that call by bringing together leading scientists and engineers who are attacking the reliability and durability problem from a number of different viewpoints. Roughly half of the conference is devoted to the material performance behavior aspects of reliability, including strength, fracture, creep, impact and fatigue, utilizing both theoretical and experimental approaches. In addition, several papers discuss the very important area of nondestructive testing as a means of assessing damage and incipient failure. Equally important are several papers dealing with the effects on reliability brought about by exposure of the composite material to various extremes of temperature and chemical environment. Taken as a whole, the conference proceedings provide a balanced, state-of-the-art look at composite material reliability and should be a welcome source of information to those in the technical community concerned with optimizing composite structures to reduce total life-cycles costs.

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