Overview

During the last 25 years, Committee D30 of ASTM has sponsored numerous symposia for promoting an exchange of technical information within the composites community. The symposium on Compression Response of Composite Structures is the first ASTM D30 symposium devoted to compression. Of course, many papers on the theoretical and experimental assessment of the compressive properties of composite materials have been presented at previous ASTM D30 symposia, especially the series on Composite Materials: Testing and Design, which now includes 11 volumes. But in the past, most of the literature on the compressive behavior of composites has focused on composite response at the "material" level. In contrast, there have been relatively few papers directed at addressing the performance of composite structures subjected to compressive loads within this same body of technical literature. This symposium was intended to fill this gap by emphasizing composite structural response.

The review process for this STP reflected very strong interest in the subject. We would like to thank the reviewers and especially the authors who took the time necessary to ensure that the STP would be a valuable contribution to the technical literature on the compression behavior of composite materials. It should be noted, however, that despite the efforts reflected in this volume, there is as yet no consensus on methods for analyzing and testing the compression performance of composite structures. There is still considerable need for additional study of failure processes under compressive loading and for further study of the influence of fabrication/processing flaws on compression performance.

Compression Analysis

In this section two papers are presented which cover the effects of nonlinear matrix shear softening on stability. The second paper in this group also incorporated the simple maximum stress failure criterion for modeling compression kink banding. The third paper in this section investigates the effect of viscoelastic creep on the stability of laminated beam columns. Using a parametric analysis, the author begins to isolate the contribution of static and long-term properties. The last two papers in this section discuss the effects of layer waviness on the response of composite laminates and hydrostatically loaded cylinders, respectively. In the first of these papers, actual isolated wavy layers were fabricated into various laminates.

Structural Applications and Performance

All four papers in this section are concerned in some form with external pressurization of thick composite cylinders for submarine pressure-hull applications. Three of the papers deal with the effects of joints. The first paper addresses the feasibility of utilizing an adhesive bond to join thick-walled cylinders to a metallic ring. The next paper discusses the importance of modeling the effects of transverse shear deformations on the structural response of cylinder end plugs. The third paper is concerned with the effects of assembly anomalies on the performance of fit-up joint. Geometric anomalies were machined into thick-section compression specimens to simulate expected fit-up clearance conditions. The last paper in this section

is essentially a parametric performance model that incorporates both stability and material failure terms.

Effects of Constituents

The first two papers in this section discuss the influence of matrix shear modulus and strength on compression strength. In order to limit the influence of other variables, the matrix properties were controlled by testing specimens at various temperatures. Both papers concur that the matrix modulus directly affects observed strengths while the interfacial shear strength was negligible. The last two papers took an even broader look at constituents and included more of the direct effect of the fiber/matrix interphase. The interphase was controlled by using different sizings, surface treatments, and fiber types. The third paper in this section also included the resultant effect of interphase properties on compression fatigue strength.

Compression Fatigue and Lifetime Assessment Properties

The first paper in this section examines the effects of biaxial compression damage development in thick section composites used in possible femoral prosthesis. The second paper investigates the effects of stitching on compression strength. It was shown that inclination of stitching further affected compression fatigue performance. The third paper in this section studied the influence of matrix ductility and two different fibers on fatigue performance. The last paper in this section investigates the effects of various long-term physical changes on compression strength. A micromechanical model is developed to allow the user to predict global results. Emphasis is placed on the fiber/matrix interphase.

Compression Test Methods

In the first paper the authors propose an extrapolation method for determining the ultimate compression strength of composite laminates. Extrapolations are based on tab angle, gage length, and finite element analysis. The second paper describes a new miniature sandwich beam specimen utilizing neat resin as the core in lieu of traditional honeycomb. Finite element analysis was performed to optimize the geometry accounting for skin and core thickness, adhesive layer, tab material, and taper angle. Advantages are claimed by this specimen and other sandwich beams to produce the highest measure of compression strength and complete elimination of buckling. The last paper investigates the effects of cutouts under biaxial compression. A concentration factor based on an average stress criterion that can then be used to correlate the failure strength of notched woven laminates was developed from this investigation.

A Final Note

We would like to thank the session chairmen, William W. Feng, Steven J. DeTeresa, Ozden O. Ochoa, and Eugene T. Camponeschi Jr., for their gracious assistance with organizing the symposium. A very special thanks to Dorothy Savini, Rita Hippensteel, and Therese Pravitz from the ASTM staff for making this experience much easier.

In closing, compression represents one of the most active areas within the D30 standardization group. Readers who do not participate in D30 are strongly encouraged to do so as it has proven to be an effective forum for information exchange and test method development.

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