SYMPOSIUM ON STANDARDS FOR FILAMENT-WOUND REINFORCED PLASTICS

INTRODUCTION

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Filament-wound reinforced plastics are superior to other contemporary structural materials for use in high-strength, light-weight pressure vessels to withstand high stresses for short periods of time. Their superiority for this service has been demonstrated in the upper-stage, solid-propellant rockets of space research vehicles and of deterrent ballistic missiles. Their history of success in these rockets is stimulating their adoption in the construction of larger rockets for lower stages of these vehicles. Other military uses include radomes for guided missiles and aircraft. Commercial uses include pipe, tanks, and towers. Filament-wound reinforced plastics are also under study for possible use in giant space boosters and in deep-submergent submarines. These materials may therefore play an important role in the vehicles and structures of the future.

The superiority of filament-wound reinforced plastics for rocket motor casings and radomes stems from a unique combination of favorable factors. These include: the outstanding tensile strengths of glass fibers; the commercial development of continuous fibers; their adaptability to winding precise patterns on axisymmetric mandrels on automated lathes; the development of structurally efficient vessel shapes and winding patterns; the availability of nonsolvent, laminating resins which impregnate the fibers and, when solidified, bond them together, these steps being aided by roving-sizings containing resins with reactive chemical coupling agents.

Significant improvements in filament-wound materials and processes have been accomplished in recent years, as shown in Fig. 1. The fruits of research and development are appearing as impressive increases in the highest reported strengths. Part of these increases are due to modifications in methods of test. However the corresponding improvements in allowed working stresses, particularly under wet or hot conditions for long periods, are not occurring as rapidly as had been predicted, which improvements are needed in strategic applications and for the growth of the industry.

The gap between attained laboratory strengths and allowed working stresses is widening. Competition with other materials is always keen, particularly for light-weight structures to be used in severe service environments for long periods of stress, as well as for commercial and other uses where cost, rather than weight, is a prime factor. Thus the future rate of progress in this field is of concern to materials suppliers, molders, systems designers, government planners, and industrial engineers.

The use of filament-wound reinforced plastics for advanced applications is being impeded by a number of shortcomings in the present state of the art. These fall into two fields: (I) materials

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shortcomings including impermanence; incomplete knowledge of the microstresses, viscostrains, and fracture mechanics of the materials; incomplete information on the influence of materials properties, design details and process variables on the structural efficiencies, weights, and permanence of complex molded products; inadequate or nonexistent design codes, particularly for filament-wound internal and external pressure vessels; problems of repair; adverse design limitations and complexities which are usually dictated by over-riding systems requirements; and (II) inadequate descriptive and classification codes for the materials; inadequate materials test methods and specifications; inadequate classifications of allowable defects in filament-wound products; and inadequate nondestructive test methods for molded parts.

Progress in research and development programs intended for reducing or eliminating the shortcomings in (I) is being confused and delayed by the shortcomings in (II). Massive efforts are being made in many laboratories to solve the technical problems of (II).

This field is of great mutual interest to the ASTM, the Navy, and other government services. This jointly sponsored symposium is intended for the timely exchange of data and theory in this fast moving technical field.

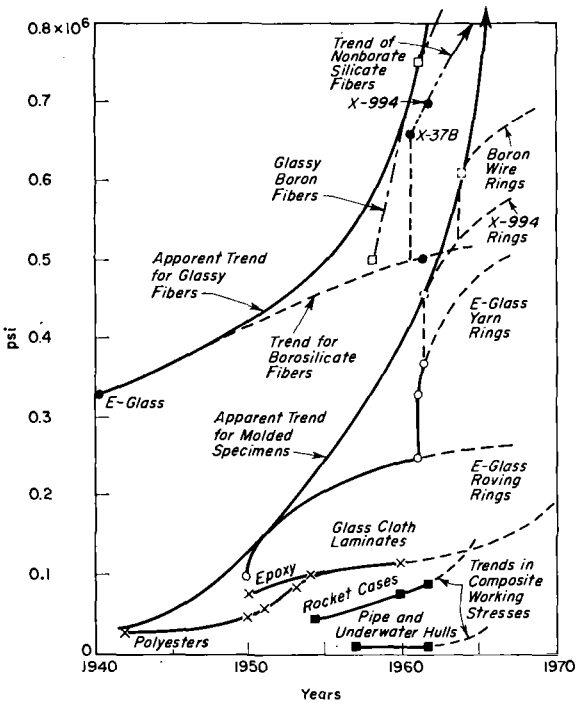

FIG. 1.—Trends in Highest Reported Ultimate Strengths and Practical Working Stresses of Fibers and Adhered Fiber Composites.