

AD 701 233

FTD-HT-23-1211-68

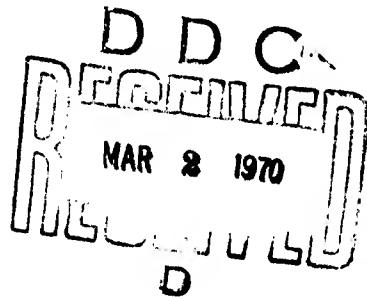
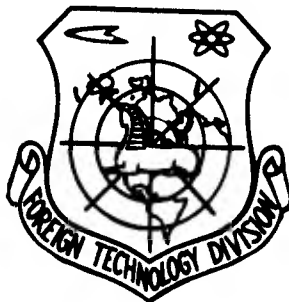
FOREIGN TECHNOLOGY DIVISION



EFFECT OF TEMPERATURE ON THE MECHANICAL
PROPERTIES OF UNIDIRECTIONAL
FIBERGLAS REINFORCED PLASTIC

By

Y. V. Bilida



Reproduced by the
CLEARINGHOUSE
for Federal Scientific & Technical
Information Springfield Va. 22151

Distribution of this document is
unlimited. It may be obtained from
the Clearinghouse, Department of
Commerce, for sale to the general
public.

EDITED TRANSLATION

EFFECT OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF UNIDIRECTIONAL FIBERGLAS REINFORCED PLASTIC

By: Y. V. Bilida

English Pages: 5

Source: AN UKRRSR. Dopovidi. Seriya A. Fizyko-Tekhnichni Ta Matematychni Nauky, (Academy of Sciences of the Ukrainian SSR. Reports. Series A. Physical, Technical and Mathematical Sciences) 1967, Nr. 3, pp. 259-262

Translated Under: F33657-68-D-0865-P002

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

Strength of Materials

EFFECT OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF UNIDIRECTIONAL FIBERGLAS REINFORCED PLASTIC

Y.V. Bilida

(Presented by F.P. Byelyankin Academician of the UknSSR Acad. Sci.)

The effect of temperature on the mechanical properties of unidirectional fiberglas plastics has not been illustrated in literature because of methodological complications in determining tensile strength.



Fig. 1. Specimen for elongation in the shape of two semicircles, joined by parallel linear bars.

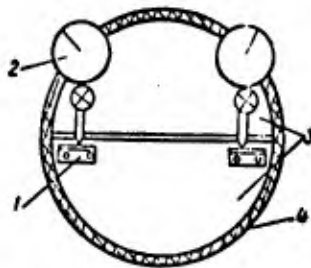


Fig. 2. Elongation of circular specimen by two half-disks: 1) Lug for measuring leg; 2) indicator; 3) half disks; 4) circular specimen.

Fiberglass with longitudinal fiber direction is characterized by high elongation resistance perpendicular to the fiber direction, and finally by very low resistance tangent to the stresses in planes parallel to the fiber direction. Therefore, by an increase of the area of cross section of heads of the specimen, we cannot obtain the necessary adhesion strength in shear and the destruction of the specimens results, as a rule, in the testing machine clamps and does not characterize the limit elongation strength of the material. In this connection, to determine the strength limit, we use specially shaped specimens which make it possible to destroy the specimen in the worked area. These include specimens in the shape of two semi-circles, joined by parallel linear bars. These specimens are put under tension by two half disks (Fig. 1).

The state of stress in the parallel zones is uniaxial, but the production of the specimens is fairly labor-consuming; and requires complicated technical equipment.

Simpler to produce are circular specimens which can be tested by internal pressure and in tension by two half disks (Fig. 2). The tensioning (elongation) method of a circular specimen by internal pressure is complex and is used only on specimens of large diameter.

Tensioning by half disks is easy. Nevertheless, the stress state of the specimen is complicated by a bend in the clearance between the half disks and by friction between the surfaces of the specimen and the half disks. Specimen bending can be neglected if the radius r_d of the half disks is not much different from the internal radius of the specimen, i.e., at $r/r_d \leq 0.05$. The friction between the half-disk and specimen surfaces during tension produces an inequality of stresses along the specimen contour, and hence produces deformations.

This inequality can be easily calculated from the formula $P = P_0 e^{-\alpha f}$, which gives the angular force P as a function of the seizure angle α and coefficient of friction f . At $f = 0.2$ (steel - fiberglass) the ratio of the elongation of a circular specimen, including friction, to uniform elongation is 0.86. Thus, the modulus of elasticity for the circular specimen in tension produced by two half-disks can be determined with a fair amount of accuracy according to the formula

$$E = \frac{0.86\pi P_0 r}{F(\Delta l_1 + \Delta l_2)};$$

where Δl_1 and Δl_2 are the readings of the left and right indicators.

Flat specimens make it possible to determine the elastic characteristics of the material without bending because of the effect of attachments which produce tensile stresses. Nevertheless, as has been noted above, it does not appear possible to determine the strength limit because the specimen breaks in the clamps of the testing machine. To strengthen the specimen in the clamps of

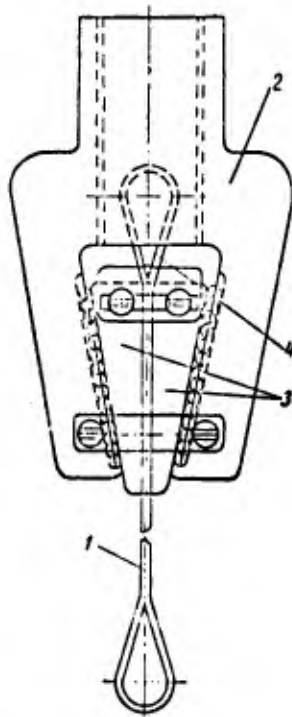


Fig. 3. Flat specimen with looped heads: 1) Specimen; 2) clamps; 3) double-wedge attachment; 4) steel insert.

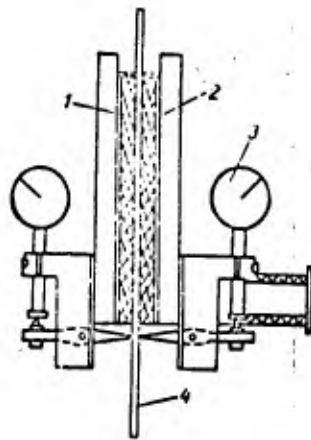


Fig. 4. Tensometer with contact electric heater: 1) Thermal insulation; 2) heating elements; 3) indicator; 4) specimen.

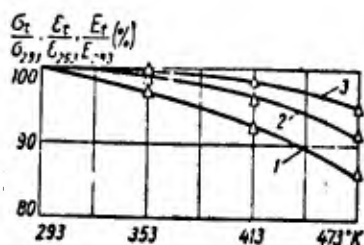


Fig. 5. Relative change in strength limit, modulus of elasticity and relative elongation in tension as a function of temperature: 1) Relative strength limit; 2) modulus of elasticity; 3) relative elongation under tension.

the machine, we can use a flat specimen with looped heads (Fig. 3).

As can be seen from Fig. 3, specimen 1 is mounted in clamps 2 by means of double-wedge device 3 and steel insert 4 in the looped end of the specimen. Such mounting of the specimen in the clamps prevents jumping in the double-wedged device, and the latter reduces the force acting on the looped end of the specimen, thus reducing the probability of a break of the specimen in the loop. It should be pointed out that the use of a looped head also prevents destruction in the operating part of the specimen at normal temperature.

Flat specimens with looped heads are properly used for the purpose of determining the mechanical properties of materials at increased temperatures when contact heating of the operating part of the specimen is used. Contact heating insures even heating of the specimen at the given rate and makes it possible to destroy the specimen during testing precisely in its operating part. For the purpose of measuring deformations on electric contact heating we developed a special tensometer (Fig. 4). However, for this purpose one can also use well-known devices for measuring deformations at increased temperatures.

Thus, flat specimens made of unidirectional fibreglas are properly used for the determination of the elastic properties of materials. In tests at elevated temperatures with contact heating such specimens can also be used to determine the strength limit under tension.

Circular specimens are properly used to determine the strength limit and modulus of elasticity for fibreglas in the direction of glass-fiber distribution at reduced, normal and elevated temperatures.

The effect of temperature on the mechanical properties of unidirectional fibreglas with epoxyphenolic binder 3Ф5-4М was investigated on circular specimens: diameter 80 mm, width 10 mm and thickness 1 mm, and on flat specimens with looped heads measuring 300 × 10 × 2 mm.

Circular specimens were heated in a thermostatic chamber, and flat specimens were heated by contact electric heating.

Tests were conducted on a universal "Emery Baldwin" machine with a constant load rate of 4000 m/min per specimen. The results of experimental determination of the relative change in the strength limits, modulus of elasticity and relative elongation in tension are cited in Fig. 5. The curves show that temperature has significant effect on change in the strength limit, less on the modulus of elasticity, and virtually none on the relative elongation under tension.

At all experimental temperatures the elongation patterns are practically linear to rupture.

Institute of Mechanics
UkrSSR Acad. Sci.

Submitted to the
Board of Editors
September 27, 1966

Manu-
script
Page
No.

Transliterated Symbols

2	д = d = disk = disk
2	л = l = livo = left
2	п = p = pravo = right

Summary

Brief analysis of various methods of determining major mechanical characteristics of high strength unidirectional glass plastic during extension is given. Temperature effect in the range from 293° K to 473° K on the tensile strength, modulus of elasticity, and elongation to break of glass plastic with epoxyphenolic binder of ЭФБ-4М type have been investigated.

DATA HANDLING PAGE

01-ACCESSION NO. 76-DOCUMENT LOC PP9001342	30-TOPIC TAGS tensile strength, fiberglass elasticity, thermal effect, elongation
09-TITLE EFFECT OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF UNIDIRECTIONAL FIBERGLAS REINFORCED PLASTIC	
07-SUBJECT AREA 11, 20	

12-AUTHOR CO-AUTHORS BILIDA, Y. V.	18-DATE OF INFO ----67
--	----------------------------------

03-SOURCE AN UKRRSR. DOPOVIDI. SERIYA A FIZYKO- TEKHNIChNI TA MATEMATYCHNE NAUKY (UKRANIAN)	FTD- 08-DOCUMENT NO. HT-23-1211-68 09-PROJECT NO 72301-78
--	--

03-SECURITY AND DOWNGRADING INFORMATION UNCL. O	04-CONTROL MARKINGS NONE	07-HEADER CLASS UNCL
---	--	------------------------------------

76-REEL FRAME NO. 1890 0049	77-SUPERSEDES	78-CHANGES	08-GEOGRAPHICAL AREA UR	NO OF PAGES 5
---------------------------------------	----------------------	-------------------	-----------------------------------	-------------------------

CONTRACT NO. F33-67-68-D- 0805-P002	X REF ACC. NO. 65-BC8004822	PUBLISHING DATE 94-	TYPE PRODUCT TRANSLATION	REVISION FREQ NONE
--	---------------------------------------	-------------------------------	------------------------------------	------------------------------

STEP NO. 02-1R/0441/67/000/003/0259/0262	ACCESSION NO.
--	----------------------

ABSTRACT

(U) The mech. properties of glass fiber-reinforced plastic having fibers oriented in one direction and made with epoxy resin, EPI-4M, were studied by stretching at 293-473 degrees K. With increasing temp. the elasticity modulus and, in a more pronounced manner, the tensile strength of the plastic decreased, while the elongation at break remained practically unchanged.