5th International Conference
"Computational Mechanics and Virtual Engineering"
COMEC 2013
24- 25 October 2013, Braşov, Romania

INFLUENCE OF TEMPERATURE ON MECHANICAL PROPERTIES OF POLYMER MATRIX COMPOSITES SUBJECTED TO BENDING

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Abstract: *This paper presents the influence of temperature on the mechanical characteristics of a composite material. Results are presented in an attempt to rupture in bending of a lot of samples made from glass fiber fabric on one stand. Various attempts were made on samples heated at different temperatures.*
Keywords: *composite material, rupture in bending, glass fiber fabric, bending testing.*

1. INTRODUCTION

In this paper are presented the results obtained from rupture on test bending bench, applied of a lot of composite material samples.

2. THE METHOD USED FOR EXPERIMENTAL TESTS

The working principle is as follows:
The test piece is supported as a lever, between two suports and subjected to a bending constant speed rupture. During the test are measured the force applied to the specimen and its arrow deformation (displacement of a midpoint of to the test piese between the supports). These measurements are embodied in a force-arrow graphic.
The scheme of the three-point of bending of test specimen is shown in Figure 1.
As shown in the figure, the test piece is placed on the two cylinders at 80 mm rest against each other, and of the center of the upper is operating force F by the pusher. Under the action of F force by pressing, the test piese are deforms with *f* arrow.
The test piece is considered broken at the first fall of the force-arrow deformation graphics.

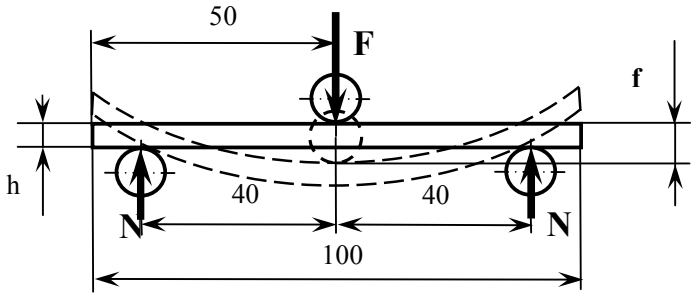

Figure 1: Application scheme in three-point bending of specimen

For the test sample of the specimen to rupture in bending was made a sheet of composite material with 15 layers of glass fiber fabric. This layer has a thickness of 0.8 mm and is shown in Figure 2.
The achieved plate thickness is 12 mm. From this plate were cut 20 samples of dimensions: (Figure 3.)
- Length 100 mm;
- Width 14,5 mm;
- Thickness 12 mm.

Figure 2: Glass fiber fabric

Figure 3: The specimens used

Then, were measured their gauge dimensions.
These test pieces (specimens) thus obtained were divided into four groups.
The first group contains the test pieces marked with numbers 1, 2, 3, 4, 5, and 6. These samples were tested to breaking in flexure at room temperature or 20 °C.
Test pieces of the second group, those marked with the numbers 7, 8 and 9, were heated to a temperature of 50 °C and tested in bending at this temperature.
The test specimens of numbers 10, 11 and 12, of the third group, were heated to a temperature of 65 ° C, after which they were tested.
The fourth group was made up of the test specimens with the numbers 13, 14 and 15, which have been heated to a temperature of 100 ° C and then was allowed to cool to ambient temperature (20 ° C), they were tested for breaking bending ..
The speed of pressure was 0.1 mm/s
In Figure 4, is shown the specimen on the stand during bending testing.

Figure 4: Testing glass fiber fabric on the stand

For each specimen tested was carried out a chart force-arrow. In figure 5 is shown chart of the registration bending test for No. 1 specimen and in Figure 6 is the force-arrow chart in aggregate for the bending test of the other six specimens.
Maximum values recorded during the application of bending test of the three samples tested, dimensions and values for the bending load [δ] are shown in Table 1.

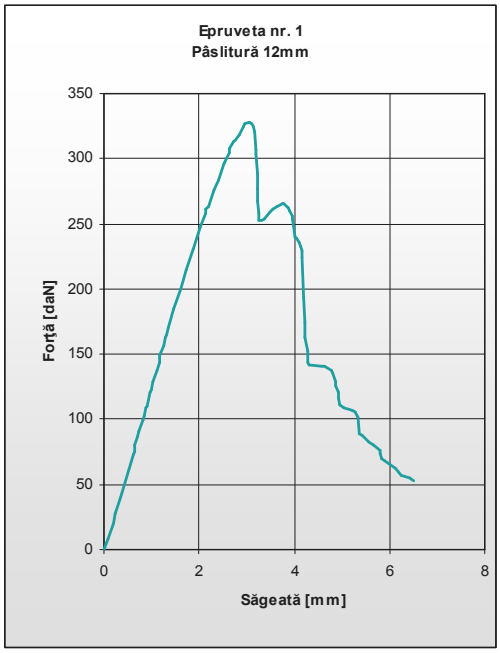

Figure 5: Arrow-force graph registered for specimen no. 1

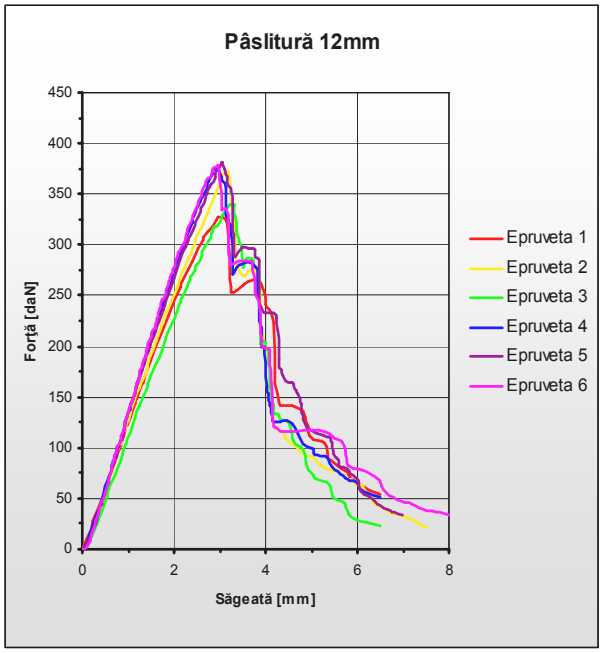

Figure 6: Arrow-force graph registered cumulated for bending test of all specimens

Table 1: Maximum values recorded during the application of bending test of the three samples tested

Glass fiber fabric	Downforce	Arrow	Specimen dimensions		Bending load
			Width	Thickness	δ
	[daN]	[mm]	[mm]	[mm]	[MPa]
Specimen no. 1	328,00	3,05	14,50	11,20	21,64
Specimen no. 2	372,00	3,19	14,50	11,40	23,69
Specimen no 3	340,00	3,31	14,50	11,10	22,84
Specimen no. 4	377,00	2,94	14,50	11,80	22,41
Specimen no. 5	381,00	3,05	14,50	11,90	22,27
Specimen no. 6	379,00	2,95	14,50	11,90	22,15

When the specimens in the second group reached 50 ºC, were tested to the bending breaking. The temperature of the specimen was checked on the stand, with an electronic thermometer (Figure 7).

Figure 7: Checking on the stand, of the specimen temperature, using an electronic thermometer

Flexural breaking test at 50 ºC was done on the specimens with numbers 7, 8 and 9.
The sample was performed at the same speed push to the specimen at 0.1 mm/s.
In Figure 8. is shown the force-arrow chart, cumulated, for the bending test of the three samples.

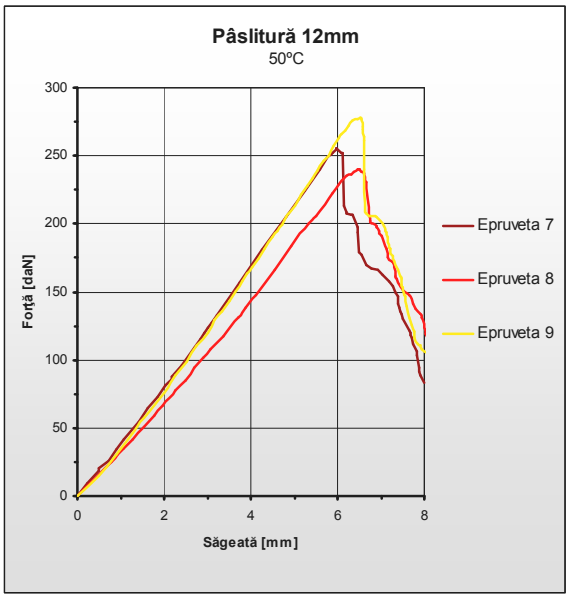

Figure 8: Arrow-force graph registered cumulated for bending test of all specimens

Table 2 presents the maximum values recorded during bending breaking test for the three specimens tested.

Table 2: Maximum values recorded during bending breaking test for the three specimens tested at 50ºC.

Glass fiber fabric 50ºC	Downforce	Arrow	Specimen dimensions		Bending load
			Width	Thickness	δ
	[daN]	[mm]	[mm]	[mm]	[MPa]
Specimen no. 7	255,34	5,96	14,50	11,10	21,64
Specimen no. 8	240,00	6,49	14,50	11,00	23,69
Specimen no. 9	278,00	6,52	14,50	11,60	22,15

Flexural breaking test at 65 ºC was done on the specimens with numbers 10, 11 and 12 (third group).
Specimen temperature was checked this time too, with an electronic thermometer (Figure 9).

Figure 9: Checking on the stand, of the specimen temperature, using an electronic thermometer

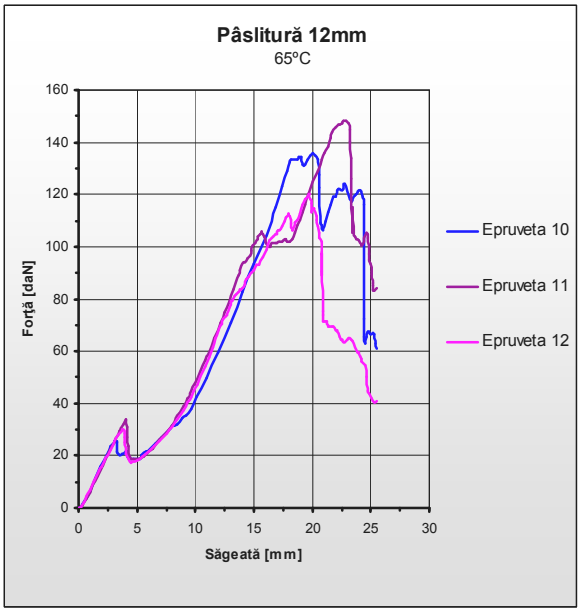

Figure 10: Arrow-force graph registered cumulated for bending test of all specimens

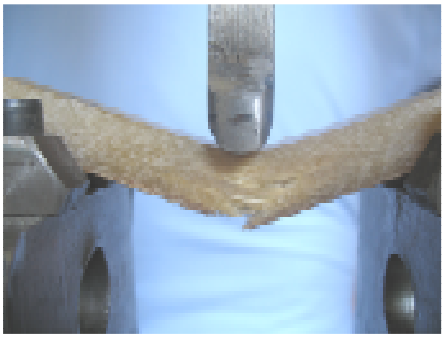

Figure 11: Test of glass fiber fabric specimen on stand

Specimen deformation rate was 0.1 mm/s.
In Figure 10 is shown the force-arrow chart, cumulated, for the bending test of the three samples tested at 65 ° C
Table 3 presents the maximum values recorded during bending breaking test for the three specimens tested.

Table 3: Values recorded during the application of bending test of the three samples tested at 65ºC

Glass fiber fabric 65ºC	Downforce	Arrow	Specimen dimensions		Bending load
			Width	Thickness	δ
	[daN]	[mm]	[mm]	[mm]	[MPa]
Specimen no. 10	25,84	3,17	14,50	12,00	1,49
Specimen no. 11	33,77	4,02	14,50	11,00	2,31
Specimen no. 12	30,13	3,84	14,50	10,80	2,14

The final three samples were heated to a temperature of 100 °C. They were allowed to cool to room temperature, after which the breaking bending tests were repeated. We wanted to see the influence of temperature on the behavior of this material.
Finaly to the breaking bending test were take the pieces numbered 13, 14 and 15. The sample test was also performed at a push speed of 0.1 mm /s. In Figure 11, is shown the specimen on the stand during bending test.
In Figure 12 is shown the force-arrow chart, cumulated, for the bending test.
The values recorded during the application of bending test of the three samples tested, dimensions and values for the bending load [δ] are shown in Table 4.
In Figure 13 is shown the force-arrow chart, cumulated, for the bending test to one of four groups tested specimen.

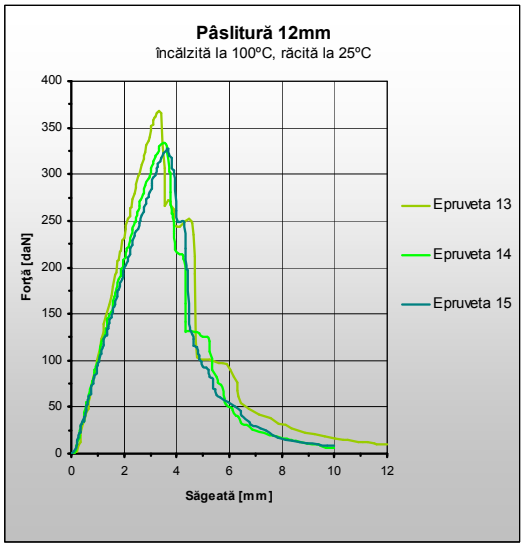

Figure 12: Arrow-force graph registered cumulated for bending test of all specimens

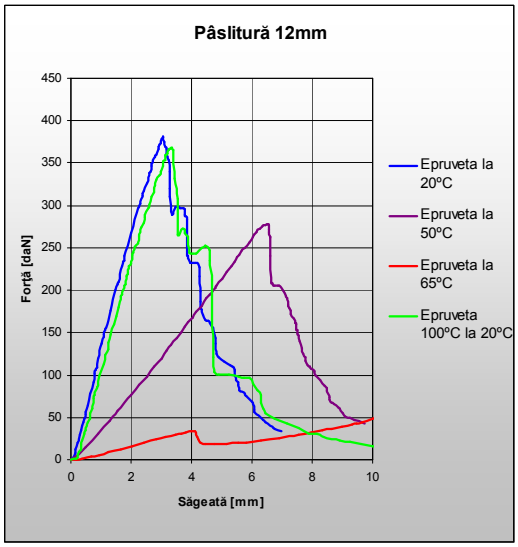

Figure 13: Arrow-force graph registered cumulated for the four groups

Table 4: Values recorded during the application of bending test of the three samples tested at 100ºC

Glass fiber fabric 100ºC	Downforce	Arrow	Specimen dimensions		Bending load
			Width	Thickness	δ
	[daN]	[mm]	[mm]	[mm]	[MPa]
Specimen no. 13	368,00	3,34	14,50	11,70	22,25
Specimen no. 14	333,92	3,53	14,50	11,90	19,51
Specimen no. 15	327,00	3,69	14,50	11,30	21,19

3. CONCLUSION

Temperature influences the characteristics of the composite material. As the temperature is higher, the performance of the material decreases. Note that even if heated to a high temperature, the composite material regained initial strength once the return to baseline temperature.

4. ACKNOWLEDGEMENT

PROGRAMUL OPERAŢIONAL SECTORIAL „CREŞTEREA COMPETITIVITĂŢII ECONOMICE”
„Investiţii pentru viitorul dumneavoastră”
Proiect: Dezvoltarea de componente din materiale compozite avansate cu aplicatii in industria auto civilă şi militară. Proiect cofinanţat de Uniunea Europeană prin Fondul European de Dezvoltare Regională

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