The 4th International Conference
″Advanced Composite Materials Engineering ″
COMAT 2012
18- 20 October 2012, Brasov, Romania

TENSILE TEST MECHANICAL IDENTIFICATION OF POLYMER MATRIX COMPOSITES USED IN CAR BUILDING

A. Modrea
PETRU MAIOR University, Târgu Mures

Abstract: *The paper presents tensile properties of a few types of materials: low-density polyethylene (LDPE) reinforced with short fiberglass, polyester composite reinforced with fiberglass RT300 (test material taken from the warp direction), polyester composite reinforced with fiberglass RT300 (test material from weft direction) as well as polyester composite type LDPE and HDPE reinforced with short fiberglass. In order to use composites in cars parts design it is necessary the knowledge of their mechanical properties, so that loads can be calculated for conditions of use.*
Keywords: *RT300 glass fabric, tensile test, polymer matrix composites, high-density polyethylene*

1. INTRODUCTION

Fiberglass reinforced plastic materials and composite resins are frequently used in car manufacturing. Their use requires knowledge of their mechanical properties. There are different theoretical methods to calculate these values [1], [2] but, in practice, it is seen that these methods give values that differ from real values. Therefore, it is necessary to determine experimentally the characteristics of these types of composites. Tensile tests allow for the determination of these values [3-6].

2. TYPES OF SPECIMENS USED

A series of identical specimens have been carried out of high-density polyethylene (HDPE). They were grouped according to the type of test, each sample being made of ten specimens with some spares for each sample. When the grip end broke, a spare has been used to replace the specimen. For the tensile test, LDPE and HDPE specimens' sets have been used. Specimens were used in accordance with ISO 294-1 and ISO 294-3 in order to carry out tensile tests. Figure 1 shows a series of specimens of low-density polyethylene (LDPE).

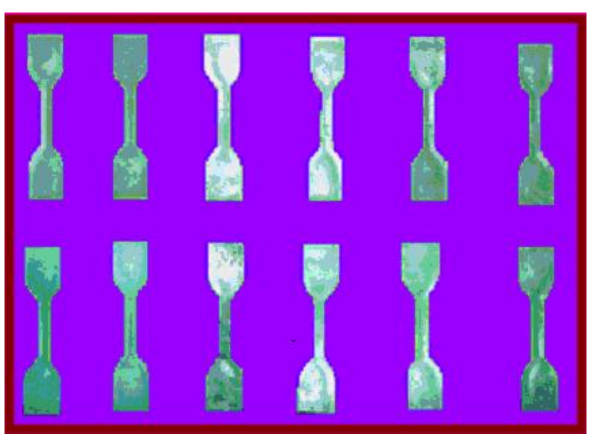

Figure 1. Specimens of glass fiber-reinforced low-density polyethylene (LDPE)

Specimens were also made of fiberglass reinforced polyester resins along the warp direction (FSU) (fig. 2) and on a weft direction (FSB) (fig. 3), for tensile tests in accordance with ISO 527-4.

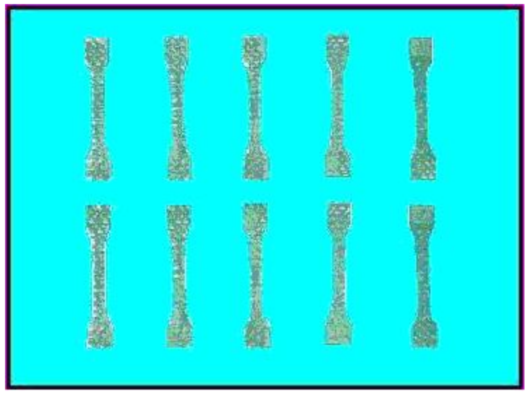

Figure 2. RT300 glass fibers-reinforced polyester resin specimens along the warp direction

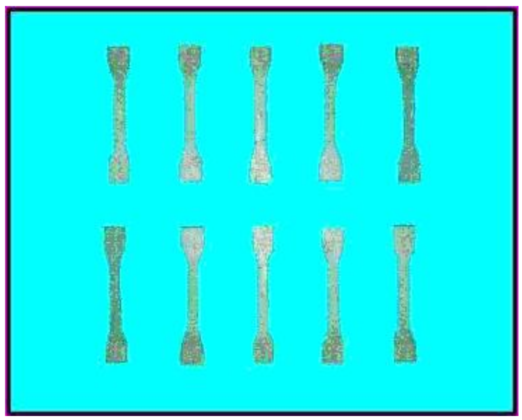

Figure 3. RT300 glass fibers-reinforced polyester resin specimens along the weft direction

Tensile tests have been carried out on specimens cut at 45^o to the warp direction (fig.4).

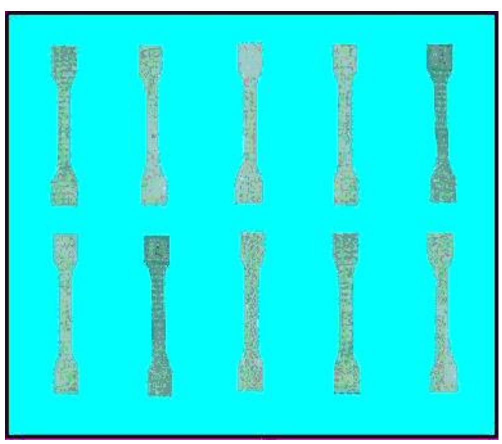

Figure 4. RT300 glass fibers-reinforced polyester resin specimens along the warp direction after tensile tests

3. RESULTS

For tensile tests, the equipment found at the Faculty of Materials Science as well as the one in the Materials Strength Lab have been used. The results of the series of tests T01 are shown in fig. 5. The mean values of the tensile tests of four types of series T01 – T04 (ten specimens each) are presented in tables 1-4.

Table 1. Basic mean mechanical properties of glass fibers-reinforced LDPE series T01 in tensile tests

Feature	Value
Load (N)	1036
Extension (mm)	9.17

Table 2. Basic mean mechanical properties of glass fibers-reinforced LDPE series T02 in tensile tests

Feature	Value
Load (N)	826
Extension (mm)	9.72

Table 3. Basic mean mechanical properties of glass fibers-reinforced LDPE series T03 in tensile tests

Feature	Value
Load (N)	887
Extension (mm)	9.28

Table 4. Basic mean mechanical properties of glass fibers-reinforced LDPE series T04 in tensile tests

Feature	Value
Load (N)	697
Extension (mm)	8.53

For the four sample trials, following values have been obtained for the Young's modulus on the length: E_{T01}=271.145MPa; E_{T02}=203.951 MPa; E_{T03} = 229.396 MPa; E_{T04} = 196.108 MPa. Specimens made of RT300 glass fibers-reinforced polyester resins, (named FSU and FSB), cut on the warp and weft respectively have been subjected to tensile tests. They have been denoted as samples T05 and T06. These specimens broke by explosion, demonstrating a good bond between the fibers and the matrix. Regarding the RT300 glass fibers-reinforced polyester specimens the failure mode is neat, which leads to the conclusion that the bond between matrix and fiber broke and the composite behavior is weaker. A detail of the tensile test is presented in fig. 6. Aspects of the breaking section are presented in fig. 7-11.

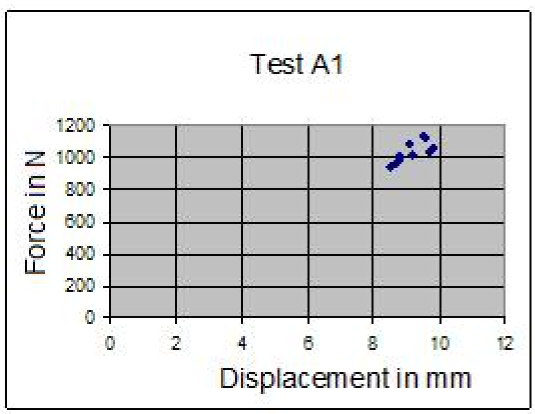

Figure 5. Experimental results for series T01

The geometric features of the test specimens are presented in table 5.

Table 5. Geometric features of test specimens

Material Type	Width b (mm)	Thickness h (mm)	Area (mm^2)
FCM	16.4	4.5	73.8
FCT	10.5	4.5	47.25
FSMB	15.5	4.0	62
FSMU	15.5	4.5	69.75
FS 45^o	10	4.3	43
FSB	10	4.5	45
FSU	10	4.5	45

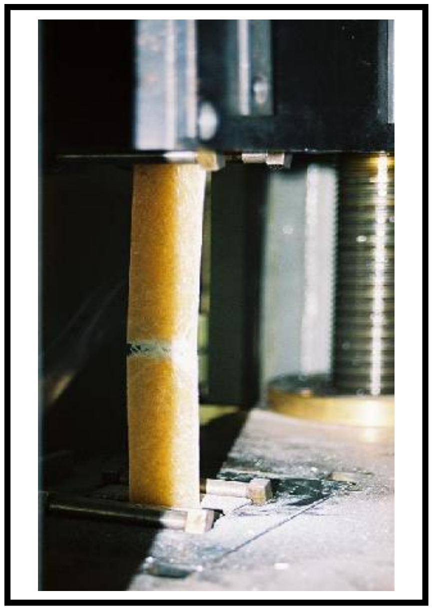

Figure 6. Failure mode in the center of the RT300 glass fiber-reinforced polyester specimens

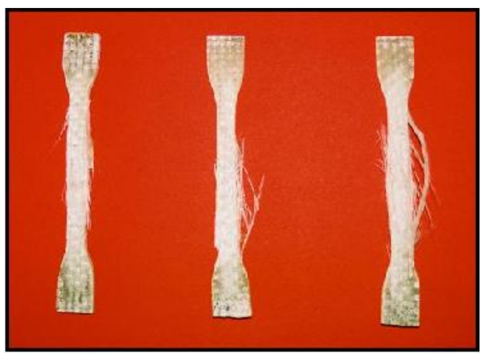

Figure 7. Broken specimens of RT300 glass fiber-reinforced polyester resins, cut on weft direction

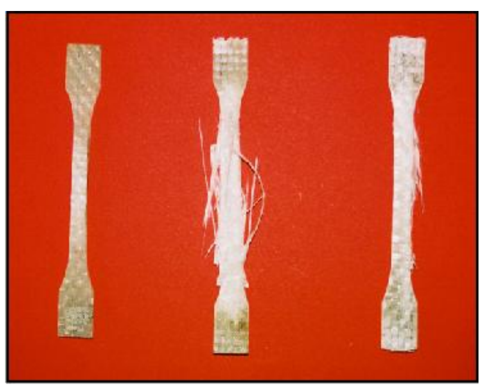

Figure 8. Broken specimens of RT300 glass fiber-reinforced polyester resins, cut on warp direction

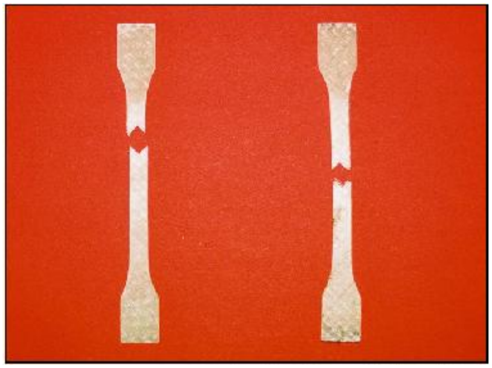

Figure 9. Broken specimens of RT300 glass fiber-reinforced polyester resins, cut at 45^{o} to the warp

Figure 10. Broken glass fiber-reinforced LDPE composite specimens

Figure 11. Broken glass fiber-reinforced HDPE composite specimens

4. DISCUSSION

Fiberglass reinforced composites type RT300 have good mechanical features and show good tensile strength and these materials are suitable for big structures. Specimens cut from weft direction show a bending strength of 290 MPa while their tensile strength is 220 MPa.

5. CONCLUSIONS

Theoretical methods will generally need to be doubled by mechanical tests in order to determine mechanical constants experimentally.

The calculations for the analyzed specimens [2] compared to experimental results show that for a series of specimens, the measured properties are outside the margins calculated in theory in ideal conditions. It can be seen that tensile tests are a relatively cheap and quick method to determine the characteristics of fiber reinforced composite materials.

REFERENCES

[1] N.D. Cristescu, E.M. Craciun, E. Soos, Mechanics of elastic composites, Chapman & Hall/CRC, (2003).

[2] A. Modrea, Ph.D. Thesis, TRANSILVANIA University of Brașov, 2005.

[3] H. Teodorescu-Drăghicescu, S. Vlase, Homogenization and Averaging Methods to Predict Elastic Properties of Pre-Impregnated Composite Materials, Computational Materials Science, **50**, 4, Feb. (2011).

[4] H. Teodorescu-Drăghicescu, S. Vlase, L. Scutaru, L. Serbina, M.R. Calin, Hysteresis Effect in a Three-Phase Polymer Matrix Composite Subjected to Static Cyclic Loadings, Optoelectronics and Advanced Materials – Rapid Communications (OAM-RC), **5**, 3, March (2011).

[5] S. Vlase, H. Teodorescu-Drăghicescu, D.L. Motoc, M.L. Scutaru, L. Serbina, M.R. Calin, Behavior of Multiphase Fiber-Reinforced Polymers Under Short Time Cyclic Loading, Optoelectronics and Advanced Materials – Rapid Communications (OAM-RC), **5**, 4, April (2011).

[6] H. Teodorescu-Drăghicescu, A. Stanciu, S. Vlase, L Scutaru, M.R. Calin, L. Serbina, Finite Element Method Analysis Of Some Fibre-Reinforced Composite Laminates, Optoelectronics and Advanced Materials – Rapid Communications (OAM-RC), **5**, 7, July (2011).