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THE INFLUENCE OF REINFORCED DEGREE ON THE MECHANICAL CHARACTERISTICS IN CASE OF COMPOSITE MATERIALS PLATES REINFORCED WITH FIBER GLASS

Emilia SABĂU, Nicolae BÂLC, Paul BERE, Florica ŞERBAN

Abstract: *Reinforced materials have a significant influence on the quality, productivity and competitiveness of polymeric composite structures. The present study highlights the influence of the reinforced degree on the mechanical characteristics determined by compressive tests. Polymeric composite plates reinforced with glass fiber were obtained through hand lay-up process. It is important to know the compressive strength and its dependence on the reinforcement degree, because it gives information about the mechanical behavior of composite structure.*
Key words: *composite materials, glass fiber, hand lay-up, compressive tests.*

1. INTRODUCTION

Composite materials represent a category of engineering materials that present special scientific and technical interest [1], [3]. These are the first materials that have the internal structural disposal conceived by the human that confers them favorable resistance.

Composite materials represent a priority domain because nowadays the importance of pieces realized from these kinds of materials is growing, thanks to performances/cost characteristics and excellent mechanical and thermal properties reported at weight.

Mechanical strength of composite materials is influenced by the anisotropic and inhomogeneous material nature, mechanical incompatibility of the constituent phases, the effect of interfacial bonds, elastic and plastic behavior of the matrix and reinforcement materials, components volume fraction and mechanical strain directions [4], [5], [6] and [7].

Composite materials are obtained by the combination of two or more distinct materials, whose properties improve each other, resulting a new material with superior characteristics. Glass fibers are the most used reinforcing materials and have many characteristics: high tensile strength, high chemical resistance, low cost [2], [8], [9] and [11].

This paper studies the influence of the reinforced materials. It was also performed a study on the microstructure [10] of specimens required.

2. EXPERIMENTAL SECTION

In frame of these researches were elaborated polymeric composite plates reinforced with glass fiber.

The polymeric composite plates reinforced with fiber glass tissue were prepared by hand lay-up process.

The manual lay-up technology is the most used manufacturing process for the composite material parts.

In this research, the manufacturing process was achieved at ambient temperature of 20 °C and a manual impregnation of reinforced materials with polymeric matrices was used. In the hand lay-up process of composite plates were considered the following steps:

- Preparing the active surface of metallic mould by removing the resin deposits from the previous plate;
- Applying a uniform thin layer of release agent, type Formula Five, on the active surface of the mould with the use of a brush and polishing the layer after drying, ~ 15 - 20 min., without compression;
- Applying of first layer of resin, which was mixed before application with methyl-ethyl-ketone peroxide hardener at a ratio of 1% (the amount of prepared resin was 2 - 3 times higher than the weight of used reinforcing material);
- Applying the first layer of reinforcing (dry) material, then cut to desired sizes and impregnate with a metallic hand roller, to facilitate a uniform resin distribution among the fibers glass and remove the air bubbles from the composition;
- Repeating the application process of layers until the desired structure is reached;
- Polymerization of matrix to achieve an almost complete polymerization is accomplished on natural way, in ~16 - 24 hours at temperature t = 20 °C - 25 °C.
- Releasing the molded part, step-by-step from the edges to the center of the part;
- Finishing the part by trimming the edges using angle grinders with diamond blades; the cut is finished with sandpaper.

Advantages of this process can be mentioned: simple technology, great looking surfaces, the possibility of obtaining large parts, molds using cheap materials.

This study was performed in order to obtain materials with different reinforcement degrees.

Theoretical calculations were made regarding the mechanical characteristics of the elaborated plates and were made samples to determine the physical and mechanical characteristics at compressive tests.

The materials used in this study are glass fibers 250 g/m^2 normal tissue and polyester resin.

Polyester resin was used as matrix. The type and the characteristics of this material are: Polyester resin type Norpol 440-M750 (USA) is ortophtalic with low styrene emission, tixotropized and pre-accelerated.

Technical characteristics: Brookfield viscosity: 250-350 mPas, Colour: Transparent blue, Time for obtaining jelly with 2 % peroxide of MEEC: 8 - 15 min, Exothermic peak: 160 - 190 ºC, Exothermic peak time: 15 - 23 min.

Physical-Mechanical characteristics: Break strength: 62 MPa, Elongation at break: 2%, Bending strength: 126 MPa, Impact resistance: 6.1 mJ/mm2, Distortion temperature when exposed to heat: 72 ºC, Barcol hardness: 43 – 44.

Fiber glass is normal tissue of 250 g/m^2 from biaxial fabric.

3. COMPRESSIVE TESTS COMPOSITES

The samples were cut from the composite plates using a diamond disc, having rectangular form. Compressive specimens were required. The plates used during the experiments and the tests were performed in the Laboratory of the Technical University of Cluj-Napoca.

The testing machine used was Instron 1196, which has a 25 kN load capacity. Test speed was of 2 mm/min on compressive tests. The compressive tests were achieved at ambient temperature of 20°C.

Specimen was embedded in two metal blocks and from total length of the specimen remaining 10 mm portion of the test. At the ends of the test-part aluminum protection were mounted. This prevents the damage of the composite material during compression. They were fixed by sticking with a structural epoxy glue of type Bison Epoxy Universal.

For compression tests were taken 5 samples from each plate.

Table 1

Compressive tests results.

Reinforcement degree [%]	Force [KN]	Average force [KN]	Average compressive breaking strength [MPa]
60%	114,4	110,88	265,4
	108,4		
	106,2		
	109,8		
	115.6		
70%	142.3	147,34	280,6
	151.3		
	145,6		

	149,4		
	148,1		

For determining the compressive breaking strength (σ_{rc}) has been reported the maximum force at sectional aria required, using the relation:

$$\sigma_{rc} = \frac{F_{\max}}{A} \text{ [MPa].} \quad (1)$$

where: $F_{\max}$ - maximum compressive load to the specimen fracture, [N]; A - initial cross-sectional area of the specimen, [mm^2].

The obtained results are presented in Table 1. We can observe that composite with 70 % reinforced degree have higher mechanical characteristics then composite with 60 % reinforced degree. Following the compressive stress of specimens, the constituent composite material remains bonded through filaments of reinforcement material.

4. MICROSCOPY STUDY

The microstructure of fracture samples composites was investigated using a metallographic microscope type Optika XDS-3 MET.

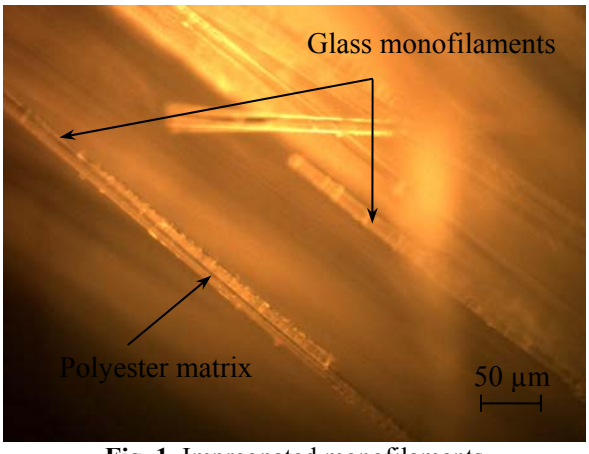

Fig. 1. Impregnated monofilaments

Figure 1 shows impregnated monofilaments, where the particles of polyester resin are glued on the glass monofilaments.

It appears a good impregnation of the matrix and a good compatibility between filaments and matrix.

The particles of polyester resin glued on the glass monofilament indicate that connection between glass fibers and polyester matrix was correct.

5. CONCLUSIONS

This paper shows results obtained by experimental researches at compressive tests. The manufacturing technology was hand lay-up.

The experimental research made in this study is leading us to the following opinions and conclusions:

- the mechanical behavior of the polymer-composite materials depends by the nature and by the reinforcing material and by the technological procedure.
- the structure of the reinforcing material will influence the mechanical characteristics.
- the greater the reinforcing degree is, the mechanical characteristics of the composite are higher.

The microstructure of fracture samples was microscopic analyzed. We can conclude that appears a good impregnation of the matrix and a good compatibility between filaments and matrix.

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INFLUENȚA GRADULUI DE ARMARE ASUPRA CARACTERISTICILOR MECANICE ÎN CAZUL PLĂCILOR DIN MATERIALE COMPOZITE ARMATE CU FIBRE DE STICLĂ

Materialele de armare au o influență semnificativă asupra calității, productivității şi competitivității structurilor compozite polimerice. Studiul de față evidențiază influența gradului de armare privind caracteristicile mecanice rezultate în urma încercărilor la compresiune. Plăcile compozite polimerice armate cu fibre de sticlă s-au obținut prin procesul de formare manuală. Este important să se cunoască rezistența la compresiune şi dependența acesteia față de gradul de armare, deoarece ne dă informații despre caracteristicile mecanice ale structurii compozite.

Emilia SABĂU, PhD. Eng., Teaching Assistant, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 103-105, Muncii Bvd., 400641, Cluj-Napoca, e-mail: Emilia.Sabau@tcm.utcluj.ro
Nicolae BÂLC, PhD. Eng., Professor, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 103-105, Muncii Bvd., 400641, Cluj-Napoca, e-mail: Nicolae.Balc@tcm.utcluj.ro, Office Phone: +40 (0)264 401614
Paul BERE, PhD. Eng., Postdoctoral Researcher, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 103-105, Muncii Bvd., 400641, Cluj-Napoca, e-mail: Paul.BERE@tcm.utcluj.ro
Florica ŞERBAN, PhD. Eng., Postdoctoral Researcher, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 103-105, Muncii Bvd., 400641, Cluj-Napoca, e-mail: florica.groze@tcm.utcluj.ro