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ABOUT THE MACROMECHANICAL CHARACTERISTICS OF COMPOSITE MATERIALS BY DYNAMIC IMPACT TESTS

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Abstract: *This paper focuses on the determination of the characteristics of composite materials reinforced with woven fabrics by using dynamic impact tests. The specimens used in our study were manufactured by reinforcing an epoxy resin with woven fabric EWR300 made of E-glass fibers. The hand lay-up technology is used to prepare the specimens with different pressures (low and high pressure) in the molding step. The composite specimens were subjected to the dynamic impact tests and the mechanical characteristics of the specimens were analyzed taking into account the different manufacturing methods used. The results obtained were compared taking into account the two kinds of reinforcements used.*
Keywords: *composite, manufacturing, mechanical tests, mechanical properties.*

1. INTRODUCTION

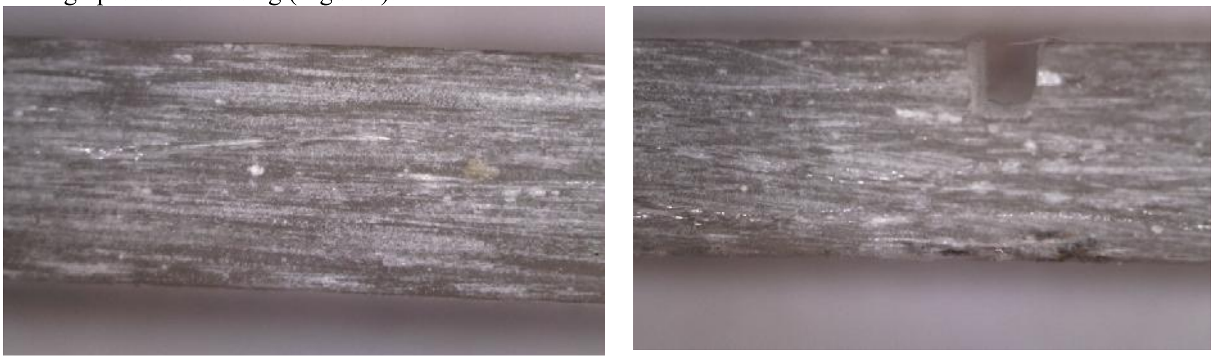
Composite materials reinforced with woven fabrics combine the strength and stiffness of reinforcing fibers with the load transferring and protective properties of a polymer matrix. With a combination of low weight and excellent mechanical performance, the fiber reinforced composites have found wide use in highly demanding structural applications. Currently composite materials are used increasingly in various industry branches such as aerospace, marine, defense, road transportation, construction, energy, domestic, consumer electronics, agricultural and automotive, railroad et., mostly due to the composite materials' behavior and performance (rigidity, resistance, thermal and phonic isolation etc). Textile / woven composite materials have recently received considerable attention due to their structural advantages of high specific-strength and high specific-stiffness as well as improved resistance to impact, crash and fatigue [6,8]. Three main methods are used currently to predict the mechanical properties of woven fabrics: analytical, numerical and experimental models [2,3,4,5,6,7,9,10,11,12]. The behavior of composite material reinforced with E-glass when impacted by solid objects is the subject of significant numerical, analytical and experimental research [1,6, 9]. To assess the behavior of composite plates to concentrated loads, two types of specimens reinforced with glass fiber fabric were studied, with concentrated loads application dynamically. Specimens were obtained by two different methods, casting by using a lower pressure and a higher pressure. The present paper presents the mechanical properties of composite materials as determined when they are subjected to impact with the Charpy hammer. The purpose of this study is to develop a new fabrication procedure for manufacturing composite materials reinforced with woven.

2. EXPERIMENTAL PART

2.1 Materials

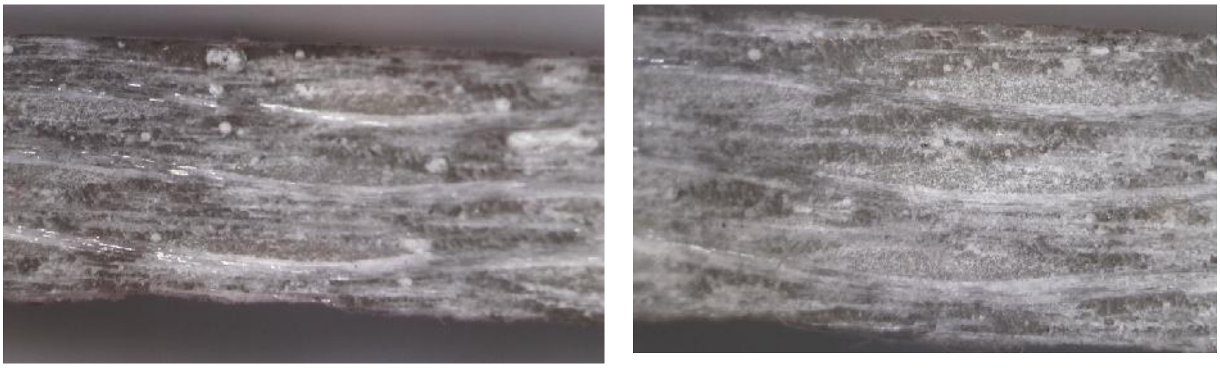
Some layers of the laminated composites are made of woven fabrics *EWR*300 / polyester *Copoly* 7233, while the others are reinforced with chopped *E*-glass fibres. A lower pressure was used to manufacture one of the specimens by using a hand lay-up technology, while higher pressure was used for the other one by using automated technology. After manufacturing the required number of specimens, a variety of tests were carried out to investigate the behavior of specimens when subjected to impact in various positions and under compression.
By using a digital microscope, sample sections photos were taken in order to analyze the structure of the composite material after loading with the Charpy hammer and to compare the two pressure manufacturing processes. Photos of the composite materials type Glass E / polyester Colpoly 7233 manufactured through

- low pressure molding (Figure1);
- high pressure molding (Figure2).



a. b.

Figure 1. Photos of the structure of the materials in section, for the samples prepared for Charpy shock loading; composite material Glass E / polyester Colpoly 7233 (low pressure molding):



a. b.

Figure 2. Photos of the structure of the materials in section, for the samples prepared for Charpy shock loading; composite material Glass E / polyester Colpoly 7233 (high pressure molding):

By analyzing the figures 1 and 2, a few remarks can be made:
– high pressure molding manufacturing (Figure2), leads to reinforcement layers with glass weaving to be better consolidated, more pronounced and countured on the digital microscopy photos;
– low pressure molding manufacturing (Figure1) leads to glassfibers to be harder to detect, even with a zoom factor of 200 x (Figure1, e şi f).

2.2. Manufacturing technology effects by pressing on mechanical behaviour in an attempt to shock with the Charpy pendulum

The samples used for the Charpy test have rectangular shape, size 80mm x 10mm x 6mm (grosime) according to the European normatives EN ISO 179-1 (2001) for plastic reinforcement materials. The section size was recorded for eacg sample before the impact test. ; afterwards the samples were subjected to the Charpy loading. The impact is produced by raising the hammer at the height h.When the hammer is released, it follows a circular path, hitting the target sample; after impact the hammer reaches height *h'. The difference between the initial and after impact potential energy represents a measure of the energy necessary to break the sample. This energy is names the break energy and is noted U.*
The results obtained in the attempt to break the Charpy pendulum were systematized in Table 1, for the two types of samples that differ in table 1 (manufactured under low, respectively high pressure).

Table 1. Results: breaking Energy U values for the sample; resilience U/A as determined through the Charpy hammer breaking challenge

No.	Composite material / Molding pressure type used for manufacturing	Cod sample	Sample size		Width left at the notch	Transversal section area at the notch	Breaking energy	Resilience
			b (*mm*)	*h* (*mm*)	h_n (*mm*)	*A* (mm^2)	*U* (*J*)	*U / A* (kJ/m^2)
1.	Glass E / polyester Colpoly 7233 / Low pressure molding	P211	9.70	4.30	3.30	32.01	2.90	90.60
		P212	9.80	4.60	3.60	35.28	3.91	110.83
		P213	9.50	4.50	3.50	33.25	3.25	97.74
		P214	10.40	4.40	3.40	35.36	3.42	96.72
		P215	10.10	4.30	3.30	33.33	3.34	100.21
		P216	9.80	4.50	3.50	34.30	3.44	100.29
		P217	9.80	4.50	3.50	34.30	3.28	95.63
		P218	10.70	4.00	3.00	32.10	3.12	97.20
		P219	10.60	4.40	3.40	36.04	3.56	98.78
		P220	9.60	3.90	2.90	27.84	2.98	107.04
							Average value	99.50
2.	Glass E / polyester Colpoly 7233 / High pressure molding	N46	11.80	3.90	2.90	34.22	4.13	120.69
		N47	10.90	4.00	3.00	32.70	4.06	124.16
		N48	11.50	4.00	3.00	34.50	4.20	121.74
		N49	10.90	3.80	2.80	30.52	3.75	122.87
		N50	11.20	3.90	2.90	32.48	3.79	116.69
		N51	11.10	3.50	2.50	27.75	3.47	125.05
		N52	10.00	3.90	2.90	29.00	3.63	125.17
		N53	10.40	3.70	2.70	28.08	3.45	122.86
		N54	10.40	3.90	2.90	30.16	3.78	125.33
		N55	11.20	3.60	2.60	29.12	3.52	120.88
							Average value	122.54

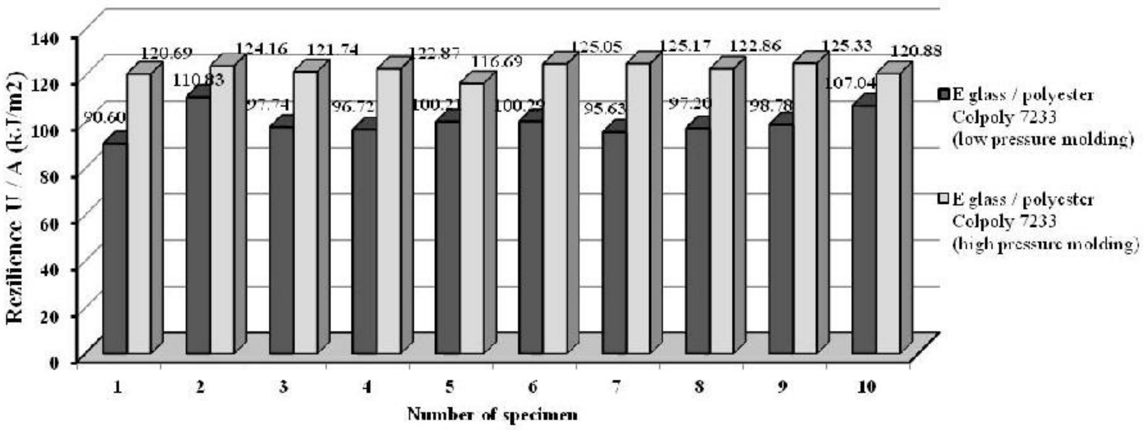


Figure 3. – Effect of the manufacturing pressure type on the resilience U / A (resistance to impact) for Glass E / polyester Colpoly 7233

3. CONCLUSION

Figure 3 presents graphically the comparative results in the last column of table 1. This figure presents the K resilience, the ratio of the rupture energy U and the transversal sectional aria A [at the notch]. This ration is higher for composite materials manufactured by using high pressure. In this case, the medial value of the K impact resistance is 122,54 kJ/m^2 (Table 1), 23,16% higher than the median value 99,50 kJ/m^2 (Table 1), value that was recorded in the case of composite materials samples manufactured under low pressure.

4. REFERENCES

[1]. Abrate,S.: Impact on composite structures, Cambrige University Press, 2001.
[2]. Cerbu A., Ciofoaia, V., Curtu I., Visan A.,The Effects of the Immersion Time on the Mechanical Behaviour in Case of he Composite Materials Reinforced with *E*-glass Woven Fabrics. Materiale Plastice, 46, nr.2, p.201-205, 2009.
[3]. Cerbu, C., Ciofoaia, V., Teodorescu-Draghicescu, H., Rosca, I.C., Water effects on the composites made of E-gass woven fabrics. Proceeding of International Conference Advanced Composite Materials Engineering, COMAT 2008, Brasov, 0-11 octombrie 2008, p.310-313.
[4]. Cerbu Camelia, V. Ciofoaia, Curtu I. – The effects of the manufacturing on the mechanical characteristics of the E-glass / epoxy composites, Proceedings of The 12th International Research / Expert Conference "Trends in the development of machinery and associated technology"- TMT2008, Istanbul (Turkey), 26-30 august, 2008, p.229-232.
[5]. Cerbu Camelia, Ciofoaia, V., Curtu I., Visan, A. The Effects of the Immersion Time on the Mechanical Behaviour in Case of the Composite Materials Reinforced with E-glass Woven Fabrics. Materiale Plastice ISSN 0025 / 5289, vol. 46, nr.2, iunie 2009, pag.201-205.
[6]. Ciofoaia, V., Modelarea şi simularea comportării la factori mecanici şi de mediu agresiuv a materialelor compozite întărite cu textile. Project ID_191, no. UEFISCU 225 / 2007
[7]. Ciofoaia, V., Cerbu, Camelia Dogaru, Fl., On the determination of the mechanical elastic constants of textile composites.COMAT 2010.
[8]. Choo V.K.S Fundamntals of composite materials. Knowen Academic Press, Inc., Dover, Delaware USA, 1990.
[9]. Gay D., Hoa S.V., Tsai S.W., Composite Materials. Design and applications. CRC Press Washington D.C. 2003.
[10]. Dogaru, Fl. Baba, M.N. – Analytical study of the CFRP laminated plates subjected to low velocity impact, Proceedings of International Conference Advanced Composite Materials Engineering „COMAT 2008", Braşov, 9-11 octombrie, 2008, p. 126-129
[11]. Morozov E. V. Mechanics and analysis of fabric composites and structures AUTEX Research Journal, Vol. 4, No2, June 2004
[12]. Sherburn M. Geometric and Mechanical Modelling of Textiles. The University of Nottingham. 2007.
[13]. Vasiliev V.V. and Morozov E.V.. Mechanics and Analysis of Composite Materials. Elsevier Science, (2001).