COMPORTAMENTUL STATIC ŞI DINAMIC AL PLATBANDELOR DIN RĂŞINĂ POLIESTERICĂ RANFORSATE CU FIBRĂ DE STICLĂ DISPUSĂ ALEATOR

STATIC AND DYNAMIC BEHAVIOUR OF PLATBANDS MADE FROM POLYESTER RESIN REINFORCED WITH RANDOMLY DISPOSED GLASS FIBER

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The research presented in this paper consists in obtaining some composite platbands from polyester resin with randomly disposed fiber glass fabric as reinforcement. For the obtained samples, tensile loading on an universal testing machine was made and their elasticity modulus has been determined. Then, the experimental results have been compared with the ones obtained from some analytical methods. In the second part of the paper, the platbands were clamped at one end and the other was left free. By placing an accelerometer at the free end, free vibrations were recorded. By analyzing the free vibrations, the damping factors per unit mass and length, the eigenfrequency, the dynamic Young modulus and the loss factor have been determined. Very close results have been obtained between the static and dynamic Young moduli and, in the end, an overall elasticity modulus for samples with different glass fiber volume fractions has been defined.

Cercetarea prezentată în această lucrare, constă în obţinerea unor platbande compozite din răşină poliesterică ranforsate cu fibră de sticlă, dispusă aleatoriu. Pentru epruvetele obţinute, s-au făcut încercări de tracţiune pe o maşină universală de încercări şi s-a determinat modulul de elasticitate al acestora. Apoi, s-au comparat rezultatele experimentale, cu cele obţinute prin câteva metode analitice. În cea de-a doua parte a lucrării, s-au încastrat platbandele la un capăt şi au fost lăsate libere la celălalt. Prin amplasarea unui accelerometru la capătul liber, s-au înregistrat vibraţiile libere. Analizând vibraţiile libere, s-au determinat factorii de amortizare pe unitatea de masă şi lungime, frecvenţa proprie, modulul lui Young dinamic şi factorul de pierdere a energiei. S-au obţinut rezultate foarte apropiate între modulele Young statice şi dinamice, astfel încât, în final, s-a definit un modul de elasticitate unitar pentru epruvete cu diferite proporţii volumice ale fibrelor.

Keywords: *elasticity modulus, static loading, damping factor, eigenfrequency, loss factor, free vibrations .*

1. Introduction

The glass fiber is a material that has some high mechanical properties compared to steel products, such as tensile strength or small weight [1]. It is usually used to form a strong and light fiber reinforced polymer [1]. The glass fiber it is usually combined with a resin in order to obtain great binding properties between the fiber layers. In [1] there have been studied the tensile properties and bi axial impact hardness shear for epoxy and polyester resin composites using aluminum oxide and silicon carbide. There were obtained higher strength results for the composites reinforced with epoxy resin.

The polyester resin has also been combined with natural fibers. For example, in [2], the polyester and epoxy resin was combined with jute fiber and better mechanical properties were obtained for epoxy/jute fiber composite. Mechanical and water absorption properties of kenaf fiber reinforced polyester laminate manufactured by resin transfer molding were investigated in [3]. There were made tensile, flexural, impact and water absorption tests. Processing conditions were found to have little effect on properties except for pressurization which increased tensile and flexural strength, but decreased water absorption al low fiber volume fractions. Composites of unsaturated polyester resin and cellulose nanofibers obtained from dry cellulose waste of softwood and hardwood were developed in [4]. Nanocellulose is used in engineering for its high rigidity, low thermal expansion and high surface area [5,6]. There were determined, in [4], some mechanical characteristics like: density and water absorption values after 24, 168 and 672 hours, storage modulus in the rubbery and glassy regions, loss modulus and peak height. The tensile strength and tensile modulus for polyester resin reinforced sugarcane bagasse

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fibers modified by estherification, during 5 hours with acetic anhydride, toluene, acetic acid and perlocric acid, was investigated in [7]. There were obtained better mechanical strength results compared to the pure polymer.

In [8] a study regarding unsaturated polyester resin matrix composites processed by filament winding method is presented. It was obtained that the ultimate stress and stiffness increase with fiber volume fraction and is always higher for yarn with less mass irregularities. In [9] static tests were performed on four layers CSM600 glass fibers-reinforced Polylite 440-M888 polyester resin. There were determined some mechanical properties like: Young modulus, tensile strength or stress at break. The effect of glass fiber content on the thermal and mechanical properties of cross-linked composites based on unsaturated polyester resins have been investigated by many methods like: thermo-gravimetric analysis, differential scanning calorimetry, dynamic mechanical thermal analysis and by measuring the heat distortion temperature in [10]. It was obtained that the effect of the reinforcement on the composite performance was best determined with the heat distortion temperature method.

The addition effect of two new urethane prepolymers on the mechanical properties (elastic modulus, elongation at break and flexural strength) of unsaturated polyester resins and glass fiber reinforced plastics based on them was researched in [11]. There was obtained a flexural strength increase of the binders and glass fiber reinforced plastics based on them when there was added urethane prepolymers to the resins. The polyester resin is used in [12] to bind mortar aggregates. The resin is cured at room temperature and at 80^{0}C. Some mechanical parameters were investigated and it was found that thermal cured specimens exhibited improved compressive, flexural and split tensile strength compared to ambient cured specimens.

In this paper the authors studied some mechanical properties for composite platbands with polyester resin and randomly dispersed glass fibers, obtaining an original combination. This research is a continuation to the ones made in [13] and [14]. In future researches, this composite can be combined with polystyrene or polypropylene honeycomb cores in order to obtain new sandwich bars and study their mechanical properties.

2. The tested specimens

In the tests they were made a total of four samples from polyester resin with glass fabric. The plates are presented in Figure 1. A SEM representation with the longitudinal samples planar face is presented in Figure 2. The samples were divided in four categories depending on the fiber glass density: 1- the fiber glass quantity is 100g/m^2; 2- the fiber glass quantity is 200 g/m^2; 3- the fiber glass quantity is 300 g/m^2; 4- the fiber glass quantity is 450 g/m^2.

3. Static tests. Mechanical properties determination

From the plates presented in Figure 1, some samples for the tensile test were cut. The samples from the 3 and 4 category are presented in fig. 3. The tensile tests are made on a Walter Bai universal testing machine.

The stress-strain curves for all the samples are presented in Figure 4. All the experimental results are written in Table 1.

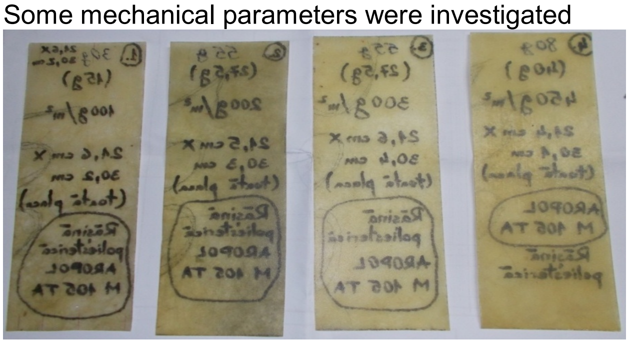

Fig. 1.- A general view with the composite materials / *O vedere generală cu materialele composite.*

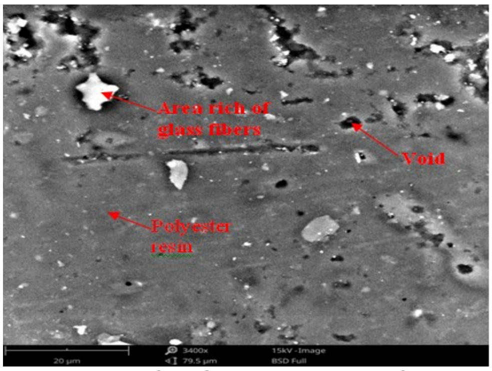

Fig. 2 - A surface SEM view with one of the samples *O vedere SEM a suprafeţei unei epruvete .*

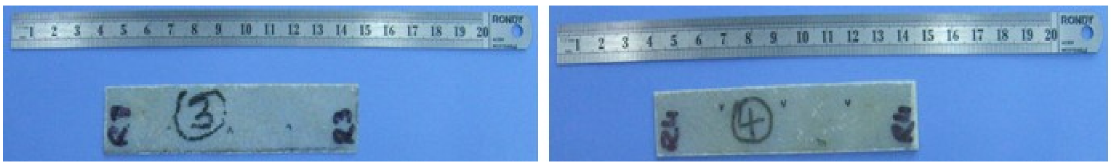

Fig. 3 - Tesile test samples / *Epruvetele supuse la tracţiune.*

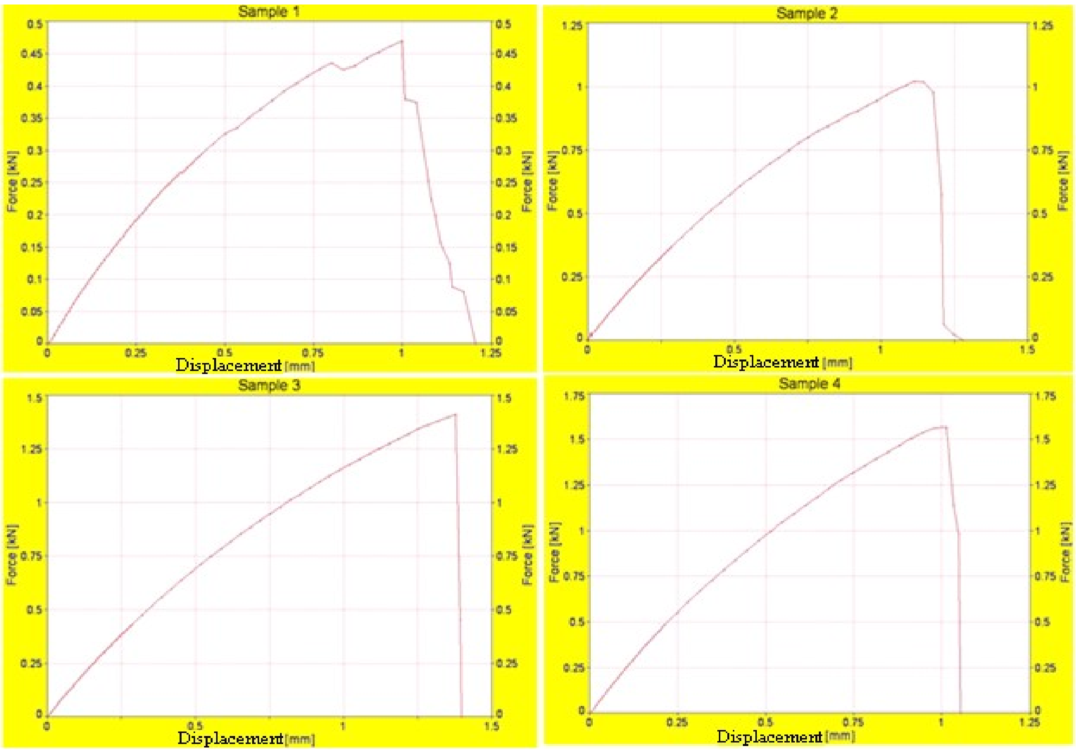

Fig. 4 - The stress-strain curves for all the samples / *Curbele tensiune-deformaţie specifică pentru toate epruvetele.*

According to [15], for a composite material with known fibers direction, the elasticity modulus along the fibers direction can be determined with (1) and across the fibers direction with (2).

$$E_l = V_f \cdot E_f + V_m \cdot E_m \quad (1)$$

$$E_t = \frac{E_f \cdot E_m}{V_f \cdot E_m + V_m \cdot E_f} \quad (2)$$

In (1) and (2) there has been marked with: E_m the elasticity modulus of the matrix, V_m the matrix volume fraction, E_f the fibers elasticity modulus, V_f the fibers volume fraction, E_l the elasticity modulus along the fibers direction and E_t the elasticity modulus across the fibers direction.

For composites with randomly disposed fibers, according to the methodology used in [16], where a breaking strength formula was obtained for a composite material with randomly disposed fibers, the formula (3) can be used for the elasticity modulus determination. According to [16], the formula (3) was obtained for the elasticity modulus after a linearization of the $\sqrt{E_l \cdot E_t}$ parameter. The theoretical results for the elasticity modulus are written in table 2. The elasticity modulus of the polyester resin and the fiber glass are 1,8 GPa and respectively 72 GPa.

If the elasticity moduli along and across the fibers direction are determined using the Halpin-Tsai model [17], the relations (4) are obtained. For the elasticity modulus, the formula (5) is obtained after inserting (4) in (3).

$$E = E_m \cdot V_m + V_f \cdot \sqrt{E_t \cdot E_l} = E_m \cdot V_m + V_f \cdot \sqrt{E_m \cdot E_f \cdot \frac{E_m \cdot V_m + E_f \cdot V_f}{E_m \cdot V_f + E_f \cdot V_m}} \quad (3)$$

$$E_l = E_m \cdot \frac{1 + \frac{2 \cdot l \cdot V_f}{d} \cdot \frac{-1 + \frac{E_f}{E_m}}{\frac{E_f}{E_m} + \frac{2 \cdot l}{d}}}{1 - \frac{-1 + \frac{E_f}{E_m}}{\frac{E_f}{E_m} + \frac{2 \cdot l}{d}} \cdot V_f}, \quad E_t = E_m \cdot \frac{1 + 2 \cdot V_f \cdot \frac{-1 + \frac{E_f}{E_m}}{\frac{E_f}{E_m} + 2}}{1 - \frac{-1 + \frac{E_f}{E_m}}{\frac{E_f}{E_m} + 2} \cdot V_f} \quad (4)$$

$$E = E_m \cdot V_m + V_f \cdot \left[\frac{\left(-E_f d - 2lE_m + 2lV_f E_m - 2lV_f E_f\right)\cdot\left(-E_f - 2E_m + 2E_m V_f - 2E_f V_f\right)\cdot E_m^2}{\left(E_f d + 2lE_m + dV_f E_m - dV_f E_f\right)\cdot\left(E_f + 2E_m + E_m V_f - E_f V_f\right)} \right] \quad (5)$$

$$E = \chi \cdot V_f \cdot E_f + V_m \cdot E_m \quad (6)$$

In (4), *d* is the glass fiber diameter and *l* is the glass fiber length. If the rule of mixtures theory is used, it can predict the longitudinal elastic constants reasonably well for long fiber reinforced unidirectional aligned and uniformly distributed composites [18]. But for specimens that have randomly short oriented glass fibers, the longitudinal elastic constants are not accurately predicted. That is why an efficiency factor χ must be inserted into the rule of mixtures equation to account the random orientation of the glass fibers distributed throughout the composite [19]. The calculus relation (6) is obtained. Four our case, the χ factor was chosen to be *1/14*.

In Table 2, in the last column, the errors between the elasticity modulus values obtained from theoretical and experimental results are written.

Images with the fracture section macroscopic shape are presented in Figure 5.

By using the same methodology from [20], from the load – extension experimental data written in Table 3, in the plastic domain, a direct calculus relation between the stress and the strain expressed by (7), was determined. The relation (7) can only be used for the composite platbands studied in this paper. In order to simplify the calculus, the last 23 results until the breakage of the sample were taken into account.

$$\sigma(\varepsilon) = a + b\cdot\varepsilon^{0,5} + c\cdot\varepsilon + d\cdot\varepsilon^{1,5} + e\cdot\varepsilon^{2} + f\cdot\varepsilon^{2,5} + g\cdot\varepsilon^{3} + h\cdot\varepsilon^{3,5} + i\cdot\varepsilon^{4} + j\cdot\varepsilon^{4,5} + k\cdot\varepsilon^{5} \quad (7)$$

Table 1

Experimental results from tensile test/ *Rezultate experimentale din încercarea la tracţiune*

Sample *Epruvetă*	Tensile rate *Viteza de testare* [mm/min]	Maximum Force *Forţa maximă* [kN]	Displacement at maximum force *Alungirea la forţa maximă* [mm]	Tensile elasticity modulus *Modulul de elasticitate la tracţiune* $E_{tensile}$[MPa]
1	2	0.469977 kN	0.9998	2048
2	2	1.020592	1.11334	2160
3	2	1.410669	1.380001	2376
4	2	1.56508	1.013312	3472

Table 2

Theoretical results for the elasticity modulus / *Rezultate teoretice pentru modulul de elasticitate*

Sample *Epruvetă*	Reinforcement volume fraction *Proporţia volumică a ranforsantului*	Theoretical tensile elasticity modulus *Modulul de elasticitate la tracţiune teoretic* [MPa]			Error *Eroare* [%]		
		Model from [19] *Modelul din [19]*	Model from [17] *Modelul din [17]*	Model from [15] *Modelul din [15]*	Experimental vs. model from [19] *Experimental vs. modelul din [19]*	Experimental vs. model from [17] *Experimental vs. modelul din [17]*	Experimental vs. model from [15] *Experimental vs. modelul din [15]*
1	0.1	2134	2075	2039	4.199	1.318	0.439
2	0.13	2235	2250	2182	3,357	4	1.019
3	0.19	2435	2957	2486	2,423	19.648	4.63
4	0.29	2769	3933	3440	20.248	11.721	0.922

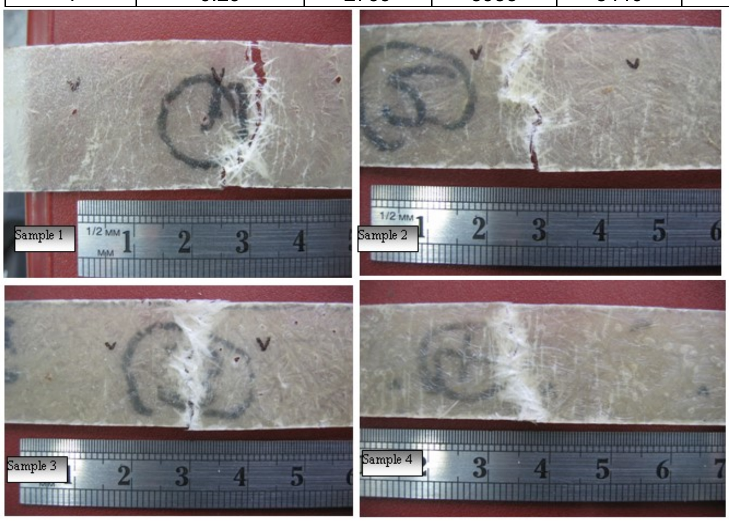

Fig. 5 - Macroscopic fracture section shape of the samples from the tensile test / *Forma secţiunii de rupere la nivel macroscopic din solicitarea la tracţiune.*

Table 3. Load – extension experimental data / *Date experimentale cu privire la încărcare – deformaţie*

Displacement *Deformaţie* [mm]	Force *Forţă* [kN]	Sample *Epruvetă*	Displacement *Deformaţie* [mm]	Force *Forţă* [kN]	Sample *Epruvetă*
0.246632	0.548023	4	0.620077	0.817695	3
0.279815	0.610491		0.653559	0.853231	
0.313237	0.669551		0.686742	0.885107	
0.346659	0.728048		0.719985	0.917708	
0.380082	0.784103		0.753288	0.948351	
0.413325	0.838731		0.78677	0.979005	
0.446508	0.892233		0.820252	1.011296	
0.47987	0.943916		0.853435	1.038838	
0.513353	0.995499		0.886618	1.068547	
0.546775	1.047428		0.919921	1.09674	
0.579958	1.091127		0.953403	1.124005	
0.613201	1.138416		0.986885	1.151035	
0.646504	1.183839		1.020128	1.176621	
0.679926	1.230881		1.053371	1.202918	
0.713408	1.275983		1.086614	1.226911	
0.746651	1.315448		1.120036	1.250021	
0.779894	1.355688		1.153519	1.274388	
0.813077	1.393246		1.186821	1.297761	
0.846619	1.429738		1.220005	1.320792	
0.880101	1.468159		1.253247	1.34387	
0.913344	1.505264		1.28673	1.362351	
0.946587	1.535132		1.320152	1.381947	
0.97983	1.562551		1.353574	1.399682	
1.013312	1.565077		1.380001	1.410669	
Displacement *Deformaţie* [mm]	Force *Forţă* [kN]	Sample *Epruvetă*	Displacement *Deformaţie* [mm]	Force *Forţă* [kN]	Sample *Epruvetă*
0.353535	0.443202	2	0.393176	0.273262	1
0.386778	0.47805		0.400052	0.276832	
0.420021	0.512363		0.406688	0.279812	
0.453204	0.543314		0.413325	0.283361	
0.486627	0.575678		0.420141	0.287712	
0.520169	0.608171		0.426538	0.290162	
0.553531	0.638966		0.433294	0.294368	
0.586654	0.66573		0.466478	0.310363	
0.619897	0.69552		0.49996	0.326438	
0.65326	0.720895		0.533502	0.334986	
0.686802	0.749576		0.566685	0.350653	
0.720224	0.776979		0.599988	0.363804	
0.753348	0.800648		0.633171	0.37798	
0.78659	0.82422		0.666593	0.392359	
0.819834	0.84356		0.700135	0.403837	
0.853435	0.864722		0.733438	0.414925	
0.886857	0.888781		0.766621	0.426523	
0.919981	0.902893		0.799924	0.435458	
0.953284	0.924467		0.833167	0.425481	
0.986527	0.944189		0.866768	0.431035	
1.020069	0.967122		0.900131	0.442836	
1.053491	0.988175		0.933374	0.452364	
1.086734	1.005863		0.966557	0.461918	
1.11334	1.020592		0.9998	0.469977	

Table 4

The coefficients for the stress calculus formula in the plastic domain / *Coeficienţii pentru formula de calcul a tensiunii în domeniul plastic*

Sample *Epruveta*	a	b	c	d	e	f
1	126467.08	-928311 3.3	$2.8625821\cdot10^{8}$	$-4.7125744\cdot10^{9}$	$4.1682114\cdot10^{10}$	$-1.2753961\cdot10^{11}$
2	-1,33349.81	7883054.9	$-1.9586884\cdot10^{8}$	$2.5658154\cdot10^{9}$	$-1.6936651\cdot10^{10}$	$1.3325348\cdot10^{10}$
3	25307.14	-1100387.7	17730411	$-1.042949\cdot10^{8}$	$-3.8636477\cdot10^{8}$	$8.4940892\cdot10^{9}$
4	110927.41	-83411815.5	$2.7131931\cdot10^{8}$	$-4.9469895\cdot10^{9}$	$5.4262385\cdot10^{10}$	$-3.4589377\cdot10^{11}$

g	h	i	j	k	Sample *Epruveta*
$-1.1742103\cdot10^{12}$	$1.5274822\cdot10^{13}$	$-7.6550084\cdot10^{13}$	$1.9077745\cdot10^{14}$	$-1.9509672\cdot10^{14}$	1
$7.0035452\cdot10^{11}$	$-5.59463711\cdot10^{12}$	$2.3751402\cdot10^{13}$	$-4.9118423\cdot10^{13}$	$4.2337985\cdot10^{13}$	2
$-3.5827371\cdot10^{10}$	$-5.5364857\cdot10^{10}$	$9.4742667\cdot10^{11}$	$-3.0064719\cdot10^{12}$	$3.2772033\cdot10^{12}$	3
$9.3694975\cdot10^{11}$	$2.8487192\cdot10^{12}$	$-3.2329143\cdot10^{11}$	$1.0344931\cdot10^{14}$	$-1.2196172\cdot10^{14}$	4

The coefficients from relation (7) are presented in Table 4. The correlation factor is 0,998 for sample 1 and 0,999 for the other samples. The samples section area is: 14,5116 mm^2; 24,79 mm^2; 19,383 mm^2; 23,15 mm^2. The samples calibrated length is: 33,35 mm; 35,43 mm; 37,03 mm; 37,72 mm.

4. Dynamic tests. Mechanical properties determination

In this part of the paper, some composite platbands with the fiber glass quantity of 200, 300 and 450 g/m^2 were built, like the ones presented in the section 2 of the paper and in Figure 6. The platbands width is 40 mm. The bars were clamped at one end and the next free lengths were considered: 100, 120, 140, 160 and 180 like in the scheme from Figure 7. The same experimental setup described in [13] and [14] was used in this paper, where there have been obtained some mechanical properties for various composite platbands: the platbands were clamped at one end and at the free end a Bruel&Kjaer accelerometer with the sensitivity of 0,04 pC/ms^{-2} was placed, at a 10 mm distance from the edge. An initial force which deformed the platband was applied, the force was removed and bar was left to freely vibrate. The damping factor and the frequency of the first eigenmode was recorded. For the data acquisition both the SPIDER 8 and NEXUS 2692-A-0I4 apparatus were used. The experiment was repetead 10 times in order to avoid wrong data acquisition and the mean value of the damping factor and eigenfrequency was made for all the experimental data.

In Figures 8 and 9 there are presented the experimental recordings representative values and the damping factor with eigenfrequency determination for the sample 4 corresponding to 140 mm platband free length. The damping factor per unit mass, per unit length, the loss factor and the dynamic Young modulus are determined according to [14].

All the experimental results and calculated mechanical properties are written in Tables 5 and 6. Because of its small value, only for the loss factor there were chosen numbers with three decimals. Also the damping factor per unit mass variation with the bars free length is given in Figure 10.

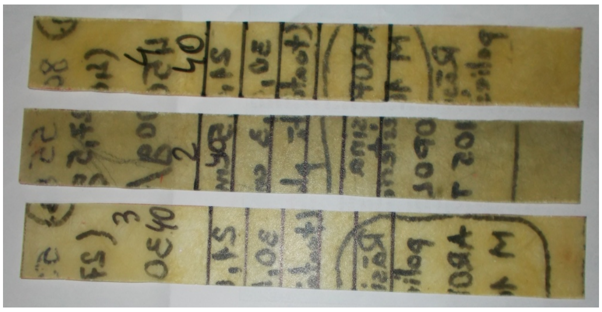

Fig. 6- A general presentation with the samples dynamically tested / *O prezentare generală cu epruvetele încercate dynamic.*

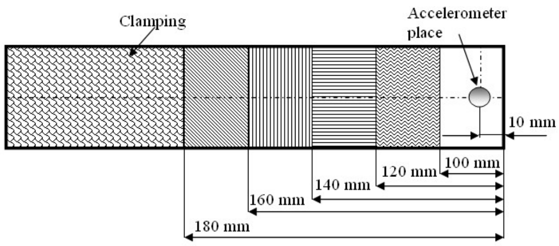

Fig. 7 - Experimental setup / *Montaj experimental.*

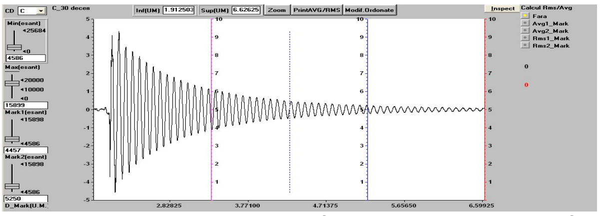

Fig. 8 - Experimental recordings for the sample 4, with the free length of 140 mm / *Înregistrare experimentală pentru epruveta 4, având lungimea liberă de 140 mm.*

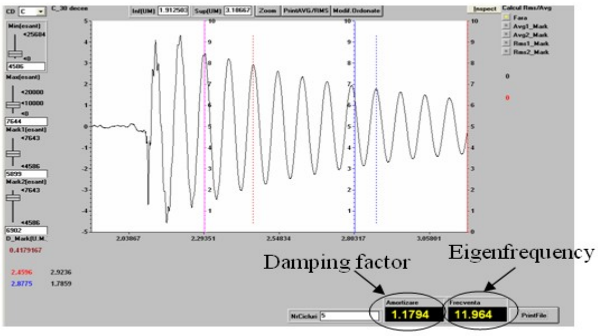

Fig. 9 - Experimental determinations for the sample 4 damping factor and eigenfrequency / *Determinări experimentale ale factorului de amortizare şi frecvenţei proprii pentru epruveta 4.*

Table 5

Experimental data / *Date experimentale*

Width (mm)	Thickness (mm)	Free length (mm)	Eigen frequency [1/s]	Damping Factor [(Ns/m)/kg]	Samples set
40	0.98	100	24.01	1.70	4
40	0.98	120	16.75	1.44	4
40	0.98	140	11.96	1.18	4
40	0.98	160	9.42	0.94	4
40	0.980	180	7.18	0.76	4
40	0.66	100	13.62	1.30	3
40	0.66	120	9.15	1.06	3
40	0.66	140	6.80	0.78	3
40	0.66	160	5.27	0.63	3
40	0.66	180	4.07	0.48	3
40	0.66	100	12.28	1.29	2
40	0.66	120	8.61	0.96	2
40	0.66	140	6.25	0.62	2
40	0.66	160	4.88	0.49	2
40	0.66	180	3.79	0.33	2

Table 6

Samples mechanical properties / *Proprietăţi mecanice ale epruvetelor*

Density [kg/m^3] *Densitate*	Specific mass [kg/m] *Masa specifică*	Damping factor per unit length [(Ns/m)/m] *Factor de amortizare pe unitatea de lungime*	Lossfactor *Factor de pierdere a energiei*	Samples set	Dynamic elasticity modulus [MPa] *Modul de elasticitate dianmic*
1531	0.06	0.20	0.023	4	3522
1531	0.06	0.17	0.027	4	3554
1531	0.06	0.14	0.031	4	3359
1531	0.06	0.11	0.032	4	3552
1531	0.06	0.09	0.034	4	3311
1515	0.04	0.10	0.03	3	2472
1515	0.04	0.08	0.037	3	2312
1515	0.04	0.06	0.037	3	2369
1515	0.04	0.05	0.038	3	2424
1515	0.04	0.04	0.038	3	2320
1515	0.04	0.10	0.04	2	2010
1515	0.04	0.07	0.035	2	2047
1515	0.04	0.05	0.031	2	1998
1515	0.04	0.04	0.029	2	2079
1515	0.04	0.03	0.028	2	2007

Table 7

Coefficients from the damping factor calculus formula and the correlation factor R^2 / *Coeficienţii din formula de calcul a factorului de amortizare şi factorul de corelaţie R^2*

Sample number *Număr epruvetă*	α	β	χ	δ	R^2
2	-1.2130969	0.02471453	22330.704	$-7.0063794\cdot10^{42}$	0.99967733
3	0.21924076	-0.0043525362	13700.776	$-5.2285029\cdot10^{42}$	0.99908805
4	1.9279209	-0.040703017	7750.97	$-3.0769032\cdot10^{42}$	0.99960193

Using the same methodology from [20], with the damping factor experimental data, a direct calculus formula for the damping factor was determined, presented in (8).

$$\mu(L)=\alpha+\frac{\beta\cdot L}{\ln L}+\frac{\chi}{L^2}+\frac{\delta}{e^L} \qquad (8)$$

In (8), L is the platband free length. The coefficients from the formula (8) are presented in Table 7 with the value of the correlation factor R^2.

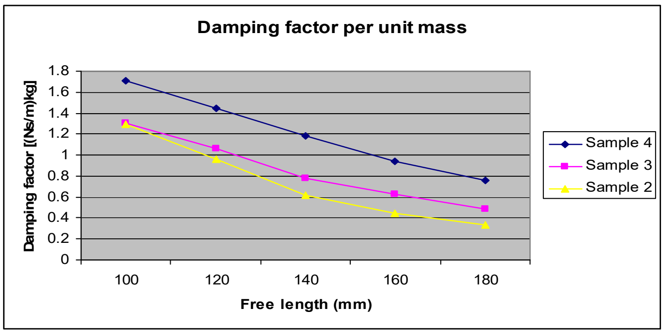

Fig. 10 - Damping factor per unit mass variation with the free length / *Variaţia factorului de amortizare pe unitatea de masă cu lungimea liberă a epruvetelor.*

The studied composites from this paper can be used as reinforcements for the samples studied in [21] and [22].

5. Conclusions

The research in this paper consists in building some composite platbands from polyester resin and fiber glass. The samples are thin bars that can be used, for example, as reinforcement for other complex composite structures, like sandwich structures with honeycomb or polystyrene cores, or to strengthen the reinforced concrete slabs. The bars were subjected to tensile test and the elasticity modulus was experimentally determined. Then, by using the regression analysis, a direct calculus formula for the stress was found. From the Figure 3, Tables 1 and 2 the following conclusions can be highlighted:

- the elasticity modulus of the samples increases with the fiber glass volume fraction increase; this can be explained by the fact that the glass fiber has a much higher elasticity modulus than the polyester resin and with its increase as volume fraction, the overall elasticity modulus will increase;

- the highest errors between the experimental results and the analytical ones using the Halpin-Tsai and rule of mixtures with efficiency factor methods are around 19% and 20%; this result can be explained by the fact that the analytical models are usually applied to micromechanics studies, where the fiber diameter and length are measured in μm; in our case the diameter is 10^{-2}mm and the length is 70 mm;

- the errors between the analytical method based on a linearization of the $\sqrt{E_l \cdot E_t}$ parameter and the experimental one, are very small, under 5%, so it fits best the experimental results.

Then, the specimens were dynamically tested. The bars were clamped at one end and free lengths between 100 and 180 mm were considered. For these, the first eigenmode frequency, the damping factors per unit mass and length, the dynamic elasticity modulus and the loss factor were determined. All the experimental data have been written in Tables 3 and 4. From these results, the following conclusions can be extracted:

- the damping factor per unit mass and per unit length decreases with the platbands free length;

- the elasticity modulus is almost the same, no matter how the bars free length is; the highest error is bellow 7% and it is obtained for the sample 2;

- the values of damping factors per unit mass and length depend on several features such as: sample dimensions, specific mass or the quantity of material from sample, elastic and damping properties of component materials;

- the sample mass or specific linear mass influence the damping factor by the fact that the samples with higher mass and width, the deformation energy which is stored in sample through the initial deformation, is dissipated in a larger quantity of material.

If the results from Tables 1 and 4 are analyzed, it can be seen that the static elasticity modulus obtained from the tensile test has almost the same values with the dynamic elasticity modulus obtained from the clamped-free platbands vibrations. Therefore a unitary elasticity modulus can be defined, no matter how the loading is (static or dynamic). From the dynamic test results, the elasticity modulus values by making the arithmetic mean of the free length sample results, are: 3459,6 MPa (sample 4), 2379,4 MPa (sample 3) and 2028,2 MPa (sample 2). The errors between the static and dynamic results are, at most, 6,111%. This value is accepted in practical engineering. So, for the final results, if a further arithmetic mean between the static and dynamic results for the elasticity modulus is made, in order to determine an universal value, no matter how the loadings are, the next results are obtained: 3466 MPa (sample 4), 2378 MPa (sample 3) and 2121 MPa (sample 2).

The added values for the composite domain extracted from this study can be:

- building some composite platband with random distribution of reinforcement;

- determining the static elasticity modulus for composite bars with random distribution of reinforcement with small errors by two methods: experimental by tensile test and analytically;

- obtaining the dynamic elasticity modulus for composite bars with random distribution of reinforcement from the platbands free vibration;

- determining an universal value of the elasticity modulus, no matter if the tests are static or dynamic;

- obtaining a direct calculus formula for the stress in the plastic domain, depending on the strain value; the formula can only be applied for the studied composites in this paper;

- the damping factor per unit mass direct calculus formula, depending on the platbands free length;

- the experimental montage for the vibration tests, by clamping the bar at one end and leaving it free at the other;
- the eigenfrequency, damping factor per unit mass and length values depending on the bars free length.

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