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FLEXURAL RIGIDITY EVALUATION OF COMPOSITE SANDWICH PANEL OF CARBON-HEMP

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Abstract: *The paper presents the most important mechanical properties determined in a simple tensile test on a 0.4 mm thickness compozit of carbon-hemp impregnated with epoxy resin, used as skins for an advanced ultralight sandwich composite structure with expanded polystyrene as core. The sandwich panel is subjected to flexural load-unload tests. This kind of fabric presents very good mechanical properties and is suitable to reinforce a quite large range of epoxy resins. The aim of using this fabric is to obtain thin structures with complex shapes and high stiffness for the automotive industry. The flexural load-unload tests show an outstanding stiffness of the whole sandwich panel. Various specimens' thickness have been used.*

Keywords: *Composite material, Hemp fibers, Hybrid composite, epoxy-resins, flexural-rigidity, sandwich*

1. INTRODUCTION

Carbon fibre-reinforced epoxy resins are used extensively to build composite structures with an outstanding specific weight/strength ratio. Such structures, usually called laminates, present a relative poor tensile stiffness and the flexural stiffness remains at a low level due to low sensitivity at flexural loads of the carbon fibres, especially of the unidirectional reinforced ones [1]-[3]. In general, composite laminates are manufactured from thin layers called laminae. These laminates present a quite low stiffness and flexural rigidity. A solution could be the increase of the layers but this leads to the disadvantage of increasing the overall weight as well as the resin and reinforcement consumption. For pre-impregnated composites, to predict their elastic properties, homogenizations and averaging methods can be used [4]-[5]. A better solution to increase the overall stiffness of a composite laminate is to use a biocomposite in the structure. This kind of composite can be a hemp-composite and presents the advantage to absorb the excessive resin. A composite laminate with this kind of embedded core material presents following main advantages: weight saving, stiffness increase, quick build of the structure's thickness, saving of resin and reinforcement as well as an increased possibility to obtain a better surface finish.

2. METHOD

The research has been carried out on eight composite panels presenting a rectangular shape and being underpinned on two edges. All specimen have the same material's structure:

- a layer of thermosetting resin reinforced with carbon fabric;
- a layer of thermosetting resin reinforced with hemp fabric;
- a layer of thermosetting resin reinforced with carbon fabric;
- a layer of thermosetting resin reinforced with hemp fabric.

The plies sequence has been carried out in the hand lay-up process using a roll for resin impregnation of carbon and hemp fibers. Finally, the structure's thickness has been 4 mm. The laminate panel has been maintained at room temperature for two weeks from which eight specimen have been cut. Composite specimen were made using the Romanian standard SR EN ISO 14125 since 1998, materials-plastic composites reinforced with fibers Determination of bending. This part of ISO 14125 is based on ISO 178 and handles fiber reinforced plastics. Keep the test conditions relevant to the system of carbon fiber reinforced and extended in the ISO 178 test conditions includes both the three-point test method (method A) and four-point test (Method B), and conditions for composites based on carbon fibers.

3. EXPERIMENTAL RESULTS

The equipment used is a testing machine at constant speed. Testing machine three-point bending test is produced by Lloyd's Instruments, UK, being a car guy LR5K Plus, which provides a maximum force Fmax = 5 kN. The testing machine presents the following characteristics:

- Force range: 5 kN;
- Speed accuracy: <0.2%;
- Load resolution: <0.01% from the load cell used;
- Analysis software: NEXYGEN Plus.

The samples were subjected to bending with a constant speed of 5 mm / min until fracture or until the tension (load) and deformation (elongation) has reached a predetermined value (fig.1)

Figure 1: Specimen before, after and during application to the three-point flexural

During the test, the load measured by the specimen and its elongation. Also have accurately measured the size of each specimen: specimen cross section and width. These dimensions were introduced as input data in the computer connected to the test machine having NEXYGEN software that retrieves data from experimental testing machine and process statistics.

Bending test results for carbon-hemp hybrid composite C-Cnp figure2-4 are presented based on centralized processing tab.1

Tab.1 The mechanical properties of the composite hybrid C-Cnp following applications flexural

Samples No.	Load at Max. Load	Max. Bending Stress at Max. Load	Flexural Rigidity	Young's Modulus of Bending
	[kN]	[MPa]	[Nm^2]	[MPa]
Specimen No. 1	0,403687	161,474802	0,29297599	3662,19989
Specimen No. 2	0,43507311	174,029243	0,35647281	4455,91017
Specimen No. 3	0,34740662	138,96265	0,35821571	4477,69641
Specimen No. 4	0,35514589	142,058355	0,33281249	4160,15614
Specimen No. 5	0,3507151	140,286038	0,35060906	4382,61321
Specimen No. 6	0,74215661	296,862645	0,4029541	5036,92621

Specimen No. 7	0,54645625	218,5825	0,22014731	2751,84138
Specimen No. 8	0,61859262	247,437048	0,26177819	3272,22742

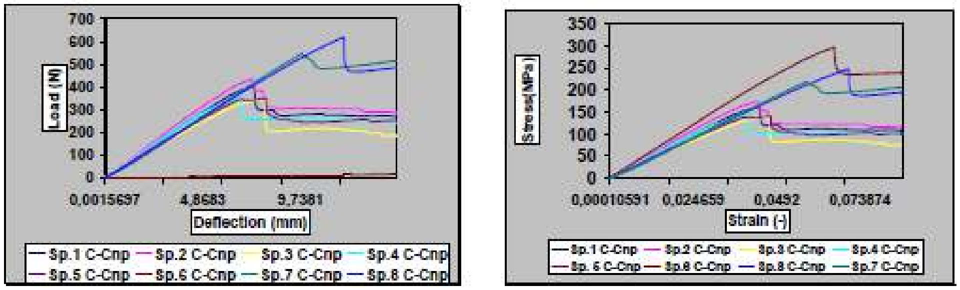

Figure 2. Load-deflection distribution and Stress-strain distribution of the composite hybrid C-Cnp

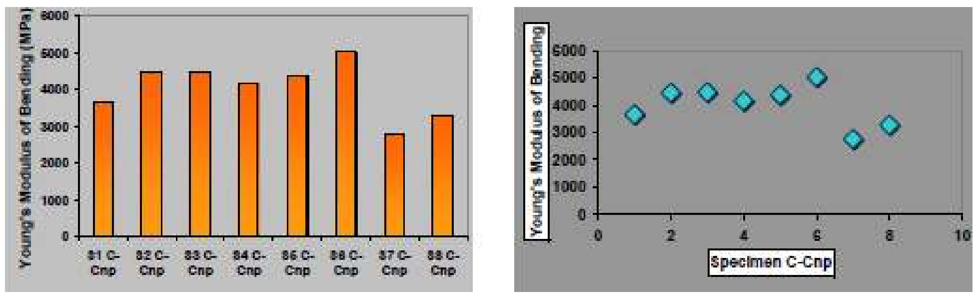

Figure 3. Young's modulus of bending distributions of the composite hybrid C-Cnp

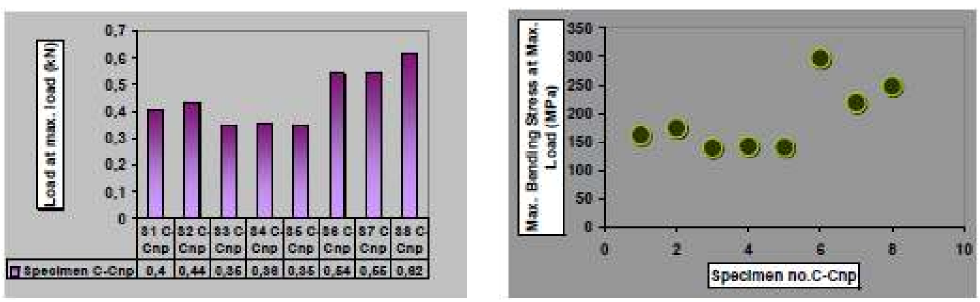

Figure 4. Maximum load distribution and maximum stress of the composite hybrid C-Cnp

4. CONCLUSION

Carbon fibres are suitable to fit special structures and devices for the future car due to their excellent thermal and electric conductivity. Also composites based on carbon and hemp fit special structures and devices for auto industry due to their excellent thermal and electric conductivity as well for their good force at break distribution as a function of Young's modulus.

The comparison between the flexural rigidity of the structure obtained experimentally and that obtained through the theoretical approach shows a good agreement between the experimental data and the theoretical approach. The following conclusions can be drawn:

- in a first analysis of composite hybrid graphics when C-Cnp can easily see that if this modulus dispersion is situated in a range of values in the range 2500-5500 MPa corresponding to a range between 0.2 - 0.5 nm2 stiffness. If disptribuției recorded force max. it is between 0.4-0.6 kN;
- the stress-strain distributions in all types of compozit hemp-carbon present a non-linear tendency. Almost all of these prepregs subjected to three-point bend tests have presented a fall of their stiffness at certain strain values For instance, in case of, specimen no. 1-6 this decrease is in the range 4,8683-9,7381

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