Characterization of Composite Plates "Sandwich"

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ABSTRACT

To determine the characteristics of a material one bases oneself on the method destruction; among the methods one finds the shearing, deflection test, tensile, torsion….etc. The evolution of current technology the researcher has to succeed has a method No destruction, among the methods, the method of vibration which one used this method to determine the characteristics mechanics of our materials composite. We used two relation one to calculate the Young modulus which one has to inject given test of vibration; and the other relation for the calculation of the modulus of rigidity of which one used given test of vibration; and as a comparison one has to recomputed modulated it of Young and shearing for alloy of aluminum.

Keywords: composite materials, characterization, method of vibration.

I. Introduction

The tests of vibratory nondestructive evaluation are based on the spectral analysis of the natural vibrations of an element of structure (beam, panel) subjected to an impulse excitation. This method, applicable to many materials, gives an instantaneous estimate of the mechanical properties of the products tested and can make it possible to establish a true mechanical identity card of each part (Hatreds and Leban, 1997; Zaveri and Phil, 1984)

The main advantage of this method, in addition to the fact that it is nondestructive, is simplicity. It adapts to all dimensions of parts, asks only very little handling and can be easily automated in the short turn.

The data resulting from these tests will make it possible to direct the matter choices upstream production, to optimize the production on criteria of mechanical properties, and of course to increase the effectiveness of the ranking in substituent with the visual ranking. In the vibratory analyses, one is always brought towards the measurement of the modes of vibration (natural frequencies of vibration) in order to compare them with the bibliographical references. It is estimated that the confirmation of the clean modes of vibration by tests can provide reinsurance for the validation of the results of the tests carried out (Ewins, 1984).

II- Composite material

A composite material is made up by the assembly of two materials of different nature, being supplemented and making it possible to lead to a material whose performances are higher than those of taken components the separately. A composite material is made up in the most general case of one or more discontinuous phases distributed in a continuous phase. The discontinuous phase, called reinforcement or reinforcing material, is usually harder with mechanical properties higher than those of the continuous phase, called matrix. Ranking of a composite material According to the form of the reinforcements, the composites are classified in two big classes: · composites with fibers: constituted by continuous or discontinuous fibers (cut or short fibers). Their orientation makes it possible to modulate the mechanical properties of material and to obtain isotropic or anisotropic materials. Composites with particles: the particles are generally used to improve certain properties of materials. These materials are normally assembled to constitute composite macro-materials.

III. The Material Sandwich

The sandwiches are materials made up of two different parts, one is called:

- "coating (soles or skins)", the other:
- "Heart (or heart)".

The sole is part of great rigidity and low thickness wrapping the heart which has a strong thickness and a low resistance

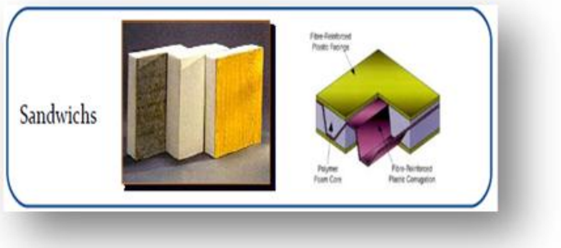

Figure1. Plate Sandwich

Laminates: obtained by stacking of layers in composite directed in a different way; the macroscopic mechanical behavior must be conceived;

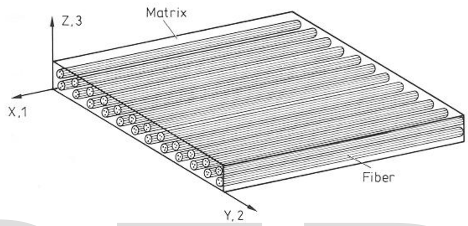

Figure2. Plate laminated

IV. Definition Of the Vibratory Method of analysis

IV.1 Mechanism of excitation of structures and data acquisition

The vibratory method of analysis most usually used in the experimental field consists of the excitation of the structure and the recording of its answer. The measurement techniques of the requests exerted on the structures and the answers of these last for the dynamic analysis understand three fundamental aspects (D' ssing, 1987a; D' ssing, 1988b; Dumas and Bennevault, 2001): The mechanism allowing exciting the structure correctly.That allowing to measure the desired signals (forces, accelerations, displacement… etc) and finally that which ensures the extraction of information that one wishes to acquire. The dischargers can be classified in two categories: those directly in contact with the structure studied during all those and duration of test which acts remotely or which is in contact only during one certain period of time (case of the hammers of impulse in the case of transitory test of excitation)

IV.2 Transform of Fourier Discrete of a real function:

The calculation and the representation of the functions in frequential field require the knowledge of the signals in the frequential field. In practice, one has only access to the signals in the temporal field (answer of an accelerometer for example). The passage of the temporal field to the frequential field is carried out using the Transform of Fourier Rapid (Fast Fourier Transformed - FFT). The expression of the transform of Fourier of a real function there (T) definite for 0 < t > the form (Lemay,2001).

$$y(t) = \int_0^\infty y(t) \exp\left(-j2\pi ft\right) dt \qquad (1)$$

For a continuous signal defined by his transform of Fourier given by the equation (1), by taking a sampling rate fs and a time of observation T there will be then a sample there (t_n) of size N. That amounts observing there (T) at spaced discrete times of a step one $\Delta t = \frac{1}{f_s}$ thus observes a signal at

the moments tn =T Δt with
0 < N < N - 1. Thus, the discrete transform of Fourier of a given signal is expressed in the following form:

$$y(t) = \Delta t \sum_{n=0}^{N-1} y_n \exp\left[-\frac{f\,2\pi n}{N}\right] \quad (2)$$

With : K = 0.1.2 ……..N/2

Figure3. Procedure of test of vibration and data acquisition in the case of a free bar at the ends

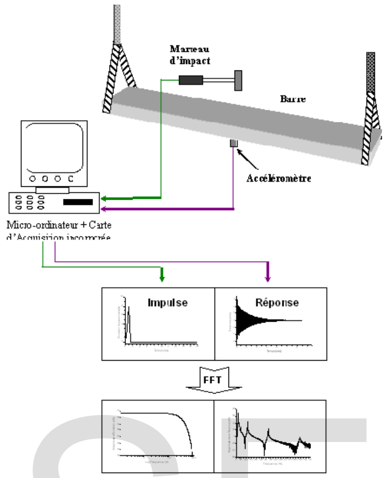

Figure3. Procedure of test of vibration and acquisition

V. Experimental procedure

The micro-computer manages, under the control of a map of acquisition, the totality of the parameter setting of the case of acquisition and information processing collected following the percussion applied. The emitted wave is transformed into electrical signal by a sensor of answer (accelerometer). This one amplifies filter then samples via the case of acquisition. Then, after conversion of the analog signal into numerical information, the recording is transferred directly via the parallel port in a memory user from the PC. The composition spectral from the recording is obtained by (FFT) transform of Fourier Rapid (fig.4).

Figure4. Procedure of test of vibration and acquisition

And materials subjected to the experimental tests are composite material beams laid out according to a system embedded on one of the ends (fig5).

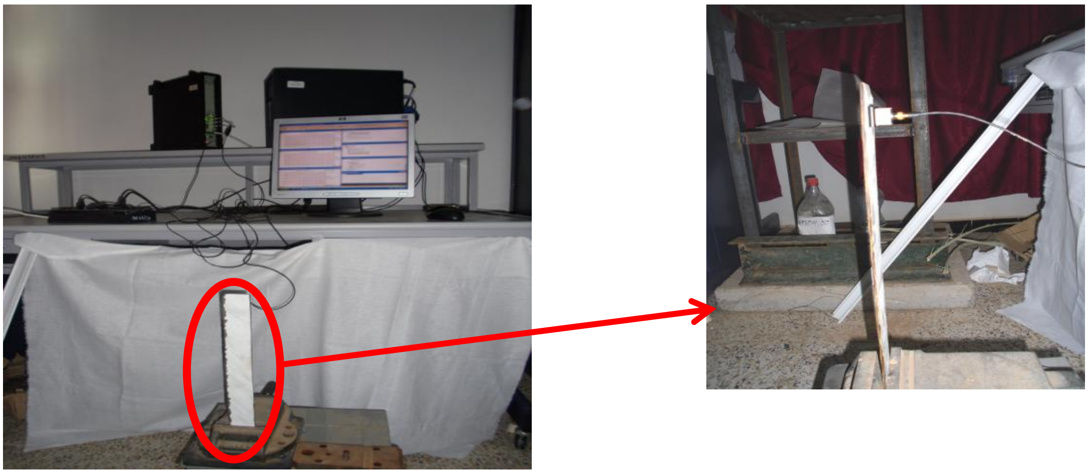

Figure5. Installation of equipment in the case of composite material beam laminated embedded by one of its ends.

VI. Composite characterization of Materials

VI.1 Composite Material Sandwich:

The material used it is a composite sandwich called also composite panel aluminum, the skins are out of aluminum thickness 0.5mm and the heart is in fluorite carbon thickness 3mm what forms the sandwich panel thickness 4mm

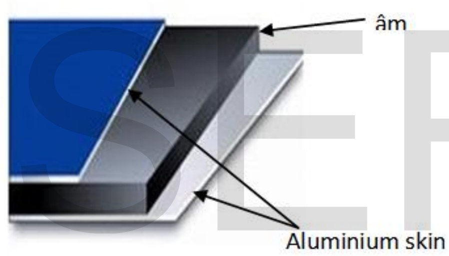

Figure6. Composite panel aluminum

One given the mechanical characteristics by a method of vibration which one used the software PULSATES is the following relation:

$$f_n = \frac{X_n^2}{2\pi L^2}\sqrt{\frac{EI}{\rho S}} \quad (3)$$

With:

*f*n: Eigen frequency (Hz)

X_n^2: give [Lalanne.83].

L: the length of embedding (mm)

E: YOUNG modulus (MPa)

I: quadratic moment (m4)

ρ: density (kg/m3)

S: section of the test-tube (m2)

According to the formula one draws the YOUNG Modulus "E" is one obtains:

$$E = \frac{\rho S}{I}\left(\frac{f_n 2\pi L^2}{X_n^2}\right)^2 = 48\pi^2\rho\left(\frac{L^2 f_n}{hX_n^2}\right)^2 \quad (4)$$

For the calculation of the Modulus of rigidity one used the following formula:

$$w = \sqrt{\frac{\pi G d^4}{32 L I}} \quad (5)$$

With:
From where:
: Own pulsation (Hz)
F: Eigen frequency (Hz)
G: Modulus of rigidity (GPa)
L: length of embedding (m)
I: quadratic moment (m4)
D: torsion arm (m)
According to the formula one draws the Modulus of rigidity "G" is one obtains:

$$G = \frac{32 f_n \pi L^4}{3h^3} \quad (6)$$

a) Results:
The results of calculation are given by curves obtained by PULSATES in the following tables:

- Test of Inflection:

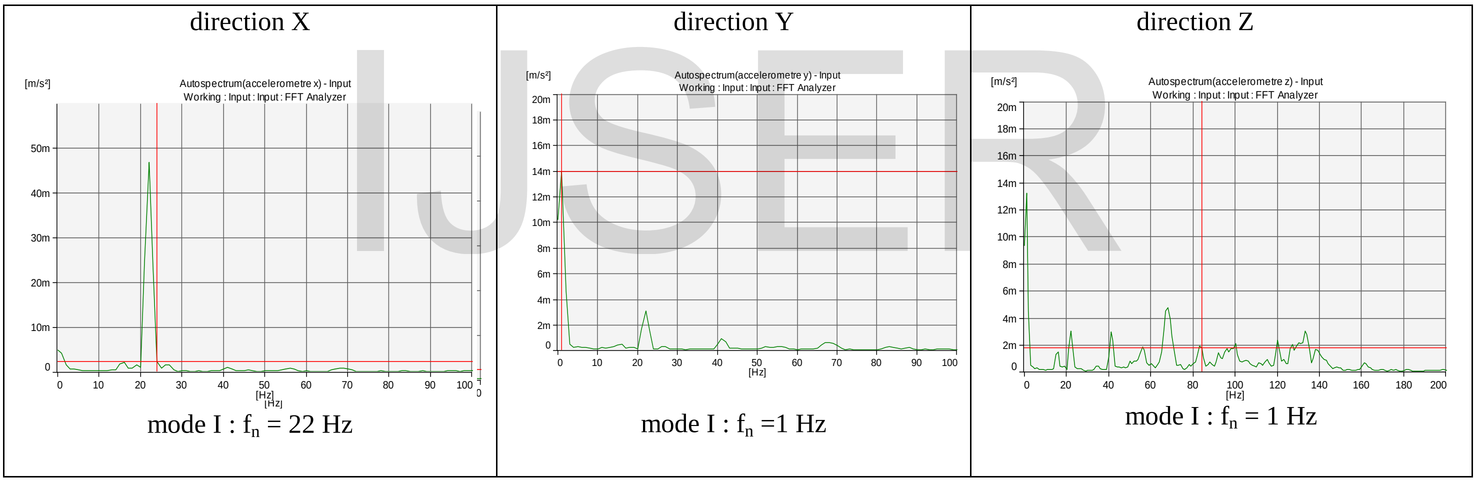

Figure7. Modes of the Deflection test

- Test of Torsion:

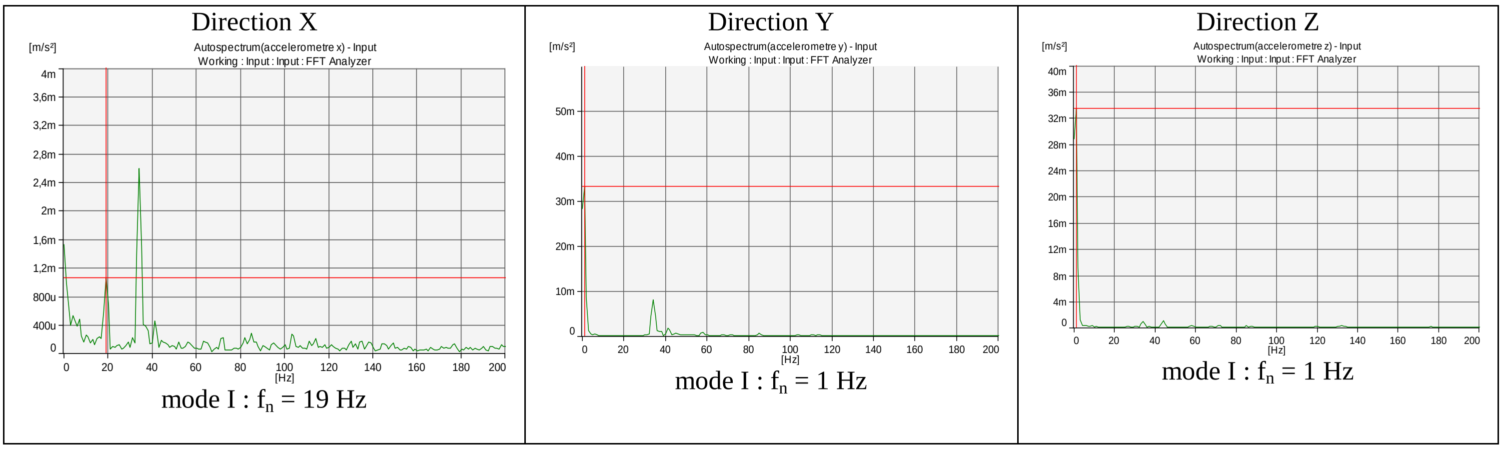

Figure8. Modes of the test of Torsion

After the calculation of YOUNG and the Modulus of rigidity one gives the results in the following table:

Table 1: results of the YOUNG Modulus and the Modulus of rigidity

Composite material sandwich	YOUNG modulus «E» (Gpa)	Modulus of rigidity "G" (GPa)	Poisson's ratio "υ"
Direction X	8.085	3.48	0.16
Direction Y	1.67	1.23	-0.32
Direction Z	1.67	1.23	-0.32

VII. Comparison

One used these formulas for checked the mechanical characteristics of aluminum by the method of vibration. (It is known that E = 70000MPa,
G = 27000MPa,
ν = 0.30)
One gives given aluminum test-tube following for calculates:

The length: L = 0.895m

The width: L = 0,025

The thickness: E = 2mm

ρ = 2800 Kg/m^3

Table2: According to the deflection test one gives the table of the results according to:

	The axis X	The axis Y	The axis Z
Mode I	16	16	16
Mode II	27	27	27
Mode III	46	46	46
Values of Lalanne 83 X_n^2	Mode I	Mode II	Mode III
	22.37	61.67	120.9

For relation 7 we are: G = 61618MPa

$$G = \frac{E}{2(1+v)} \ de\ la\ on\ tire\ v = \frac{E}{2G} - 1 \quad (7)$$

Digital application:

$$v = \frac{69595}{2x61618} - 1 = -0.42 \quad (8)$$

Note: after calculation one notes that the value of G is larger than the standardized value i.e. it remains with checked the equation of the Modulus of rigidity.

VIII. Conclusion

The use of this method of vibration confirms results obtained for the calculation of Young's modulus because we find the same value of the Young's aluminum module; but remains to verify the relationship of the shear modulus.
After calculation one notes that the value of G is larger than the standardized value i.e. it remains with checked the equation of the Modulus of rigidity

The authors declare that they have no conflict of interest.

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