Oberst beam measurement for Dedmas Elite 40 Black

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Introduction

The present study reports the tests made on composite beams made of a steel base plate and the DEDMAS ELITE 40 BLACK material.

Measurements have been carried out according to the Oberst beam experimental method (internal procedure ES18/CERT008-3).

Results are presented in *Part I* while the experimental method used here are described in *Part II*.

Contents

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Part I
Characterisation results

This section presents the results of the characterization of the elastic modulus and the damping loss factor for the Dedmas Elite 40 Black.

0.1 Results for the composite beam

Tab. 1 reports the elastic and damping properties of the four composite beams tested in this study.

Mode	Frequency	Real(Modulus)	η
2	193	4.50	0.16
2	186	4.10	0.15
2	190	4.46	0.14
2	186	4.27	0.15
Mean value (σ_X)	**189** (3)	**4.33** (0.18)	**0.15** (0.01)
Units	Hz	$\times 10^9$ N.m^{-2} or GPa	

Test conditions :

Temperature	= 20 °C
Relative humidity	= 45 %
Beams	= length $\approx$ 150 mm^2
	= width 10.1 mm^2
	= total thickness $\approx$ 3.5 $\pm$0.1 mm^2
	= metal thickness $\approx$ 0.95 $\pm$0.1 mm^2

Table 1: **Dedmas Elite 40 Black** : elastic and damping parameters of the composite beams. Values obtained for each sample, mean value and standard deviation (σ_X) for the entire set of samples.

Conclusion
The Dedmas Elite 40 Black material loss factor on a 1 mm steel bar at 200 Hz as per ASTM E756 is 0.15.

0.2 Results for the material only

Tab. 2 shows the results of the Young modulus E_1 and the loss factor η_1 estimated according to equations 4 and 5 of the ASTM E756[1]. Results are shown for the four samples tested in this study.

Mode	Frequency	$\mathbf{E}_1$	η_1
2	193	532.5	0.63
2	186	371.2	0.76
2	190	484.3	0.59
2	186	415.7	0.71
Mean value (σ_X)	**189** (3)	**450.9** (71.6)	**0.67** (0.08)
Units	Hz	$\times 10^6$ N.m^{-2} or MPa	

Table 2: **Dedmas Elite 40 Black** : elastic and damping parameters of the material only. Values obtained for each sample, mean value and standard deviation (σ_X) for the entire set of samples.

[1] ASTM E756-98. Standard test method for measuring vibration-damping properties of materials. *American Society for Testing and Materials*, 1998.

Part II
Presentation of the experimental characterization methods

This section presents the experimental characterization methods deployed in this study :

- the measure of the material thickness (see *Section 1*),
- the characterization of elastic and damping parameters using the Oberst beam method (see *Section 2*)

1 Measure of the sample thickness

The thickness of the samples are measured manually using an electronic caliper with an accuracy of 0.01 mm.

For sample having an irregular surface, the kept accuracy is 0.1 mm .

For materials having a thickness larger than 10 mm and for which the surface is not flat, the thickness may be rounded to the nearest millimeter.

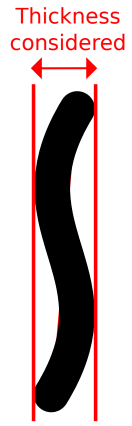

Figure 1: Material sample with a non planar surface.

2 Bending beam dynamic method

This method is based on the Oberst beam test as described in the standards ASTM E756 [2] and ISO 6721-3 [3] (see Fig. 2).

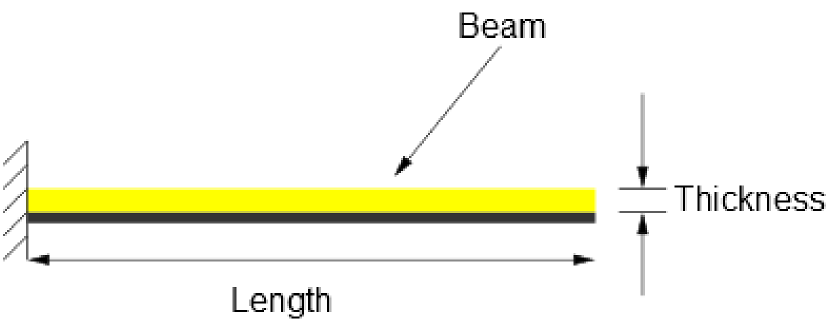

Figure 2: "Cantilever" beam oused for the standard Oberst beam test.

[2] ASTM E756-98. Standard test method for measuring vibration-damping properties of materials. *American Society for Testing and Materials*, 1998.

[3] ISO 6721-3. Plastiques - détermination des propriétés mécaniques dynamiques - partie 3 : vibration en flexion - méthode en résonance. *Organisation Internationale de Normalisation*, 1996.

The results are analyzed according to the data of the frequency response transfer functions. These functions are calculated as the ratio of the normal velocity prescribed at one end of the beam to the normal velocity measured at an arbitrary position on the beam. The prescribed velocity is measured using an accelerometer placed at the clamped end of the beam. The resulting velocity is measured using a laser vibrometer to avoid any additional mass effect (see Fig. 3).

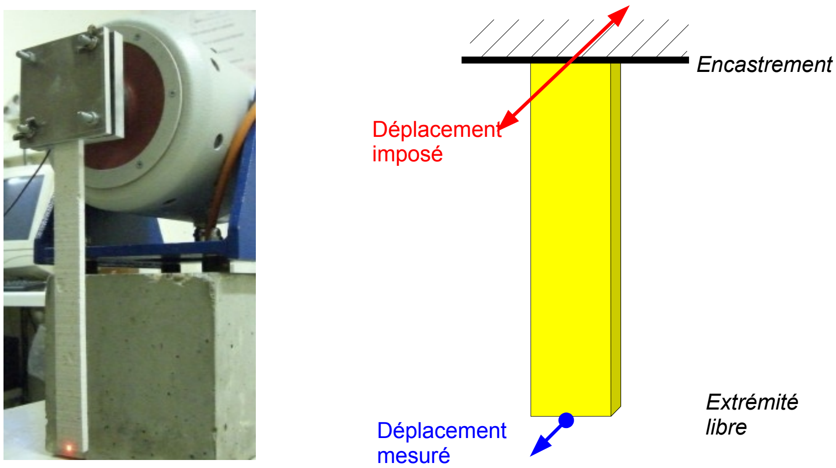

Figure 3: Example of the mounting of an Oberst beam and measurement using a laser vibrometer.

The Young's modulus and the damping loss factor, in the direction of the beam, are determined respectively from the position of the resonance frequency and from the width of the resonance peak at -3 dB.

However, this method does not allow the determination of the Poisson ratio of the material.

A schematic representation of the evolution of the Young modulus and the loss factor as functions of the frequency or of the temperature is given in Fig. 4. This graph illustrates the so-called time-temperature superposition principle (*TTS*).

This shows that the real part of the modulus increases with frequency. The evolution is faster around the transition between the glassy state and the rubber state. At this point, also called glassy transition, the loss factor reaches its maximum value. Before and after the transition point, the loss factor may increase or decrease.

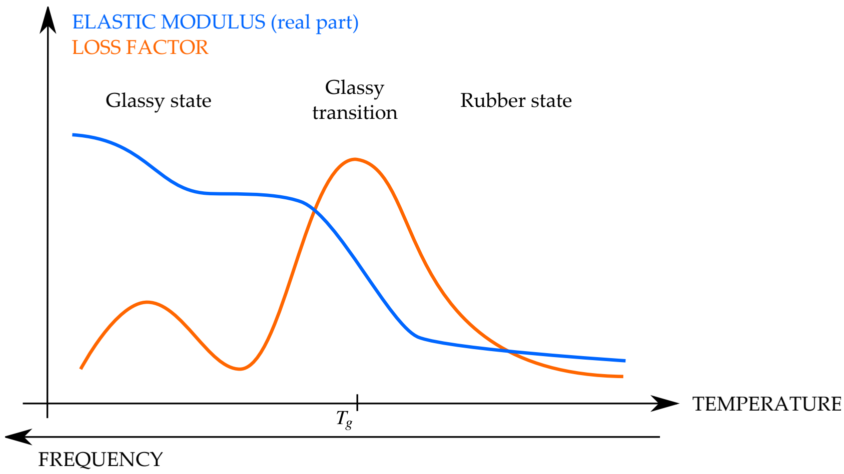

Figure 4: Schematic evolution of the real part of elasticity modulus and the corresponding loss factor η for a visco-elastic material. Evolution as a function of the temperature or as a function of the frequency.

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