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INTERNATIONAL POST DOCTORAL RESEARCH FELLOWSHIP PROGRAMME

FINAL REPORT

TITLE OF THE RESEARCH: The Study of Acoustic and Vibration Properties of Nano-Polymer and Bio - Composite Materials

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GENERAL INFORMATION

RESEARCH TITLE	The Study Of Acoustic And Vibration Properties Of Nano-Polymer And Bio - Composite Materials
RESEARCHER NAME	Dr. Sezgin Ersoy
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1. Introduction

The polymeric materials are used in a wide variety of fields for their several surpassing properties. The mechanical properties of polymers are, however, strongly influenced by various environmental factors. One of the principles for estimating the long-term behaviour of polymers may be a time–temperature superposition (equivalence), based on the viscoelastic properties of polymers varying with time and temperature. This is accepted that viscoelastic properties of flax in the epoxy materials related to some modes in the time/temperature domain. This relations are presented some formulas as WLF, Arrhenius and etc. In this work these theoretical attempt to understand the nature vibration behaviour depend to frequency-temperature relationship.

The damped vibration responses of complex structural dynamics such as sandwich beam structures with viscoelastic layers [1, 2] are usually analysed in either frequency or time domain. In the frequency domain analysis, the external excitation force is expressed as harmonic force so that the imaginary part is automatically defined [3]. But, in the time domain analysis, the external excitation force is real contrary to the complex-valued dynamic equation system. In order to maintain the consistency in the complex-valued dynamic equation system, the real-valued external impulse force can be converted into an analytic force signal by defining the imaginary force signal using Hilbert transform. Meanwhile, a state-space formulation in the modal superposition approach to solve the time response of the damped dynamic system leads to two poles which are radial symmetry in the complex plane [4-6].

Scott and others work on effect of the degree of cure on the viscoelastic properties of vinyl ester resin. When they were characterized in the temperature and frequency domains (obtained by time – temperature superposition) [7]. In the other works the thermal expansion behaviour was investigated by dynamic mechanical analysis at a fixed of 1 Hz where was accomplished by conducting the time-temperature superposition experiments using [8]. The other works can be resolved by conducting a range of short-term creep tests and applying accurate prediction methods to the results. Short-term creep testing was conducted on viscoelastic polyurethane foam, a material commonly used in seating and bedding systems. Tests were conducted over a range of temperatures, providing the necessary results of allow for the generation of predictions of long-term creep behaviour using time – temperature superpositions [9]. Borg and Paakkönen work on Temperature effect on the linear viscoelastic models with time – temperature superposition. [10].

The analysis of the viscoelastic properties of polymeric surfaces has attracted considerable attention in recent years, due to the applications on adhesives, lubricants, biosensors and protective coatings. An alternative approach to explore viscoelastic behaviour regards the study of changes in adhesion with temperature. The authors have recently shown that the effects of viscoelasticity, plasticity and viscoelasticity can be minimized by a proper choice of the experimental conditions. For instance, it was shown that performing nanoindentationsat high loading rates allows to get residual imprints that are much smaller than the penetration at full load, thus suggesting that under these conditions indentations are dominated by elastic behaviour with negligible irreversible deformation [11]. In a recent work which performed a viscoelastic characterization in both the time and temperature domains, studying the variation of the elastic modulus with experimental time and temperature. These pioneer works, however, have made some simplifications such as using the 'frequency' to characterize the time-dependent behaviour [12].

It is well known that the mechanical behaviour of polymers arising from indentations becomes significantly different when using different loading rates [13], a fact that could apparently be related to the viscoelastic response of the material. However, when using low loading rates, the residual imprint may increase and become comparable to the penetration depth at full load [14].

Under such conditions, it is hard to state that neither plasticity nor viscoplasticity is present when indenting complex polymeric materials, even though it was shown [15] for some samples (PS with very low molecular weight, lower than the critical one to develop entanglements) that the residual imprint is completely recovered, above the glass transition temperature, after at most 2 h. Hence, it becomes difficult to claim that the apparent differences in the force curves collected at various frequencies, i.e. loading rates, are fully viscoelastic.

Previously investigated the effects of moisture on the dynamic viscoelastic behaviour of epoxy resin, a typical thermosetting polymer, and examined the time–water content superposition for the saturated samples at various humidity's. Because the viscoelastic factor (storage modulus) showed only a small change with the water content, the examination of this superposition was in adequate.

We generated to two kind materials. Firstly, we investigate to Acoustic properties of Polymer Composites. The materials product with HDPE and SBR polymers. Secondly, flex/epoxy composite materials. The flax are arranged in different angles (0-45-90) and applied vibration laser test. All results obtained that include different temperature apply re-organized with superposition approaching. The outcome are evaluated with Abaqus Finite Element Programme and their results was combined with Matlab Programme.

1.1. Test samples of materials for experimental process

Composite Constituents

The constituents in a composite retain their identity such that they can be physically identified and they exhibit an interface between one another. This concept is graphically summarized in Figure 1 the body constituent gives the composite its bulk form, and it is called the matrix. The other component is a structural constituent, sometimes called the reinforcement, which determines the internal structure of the composite. Though the structural component in Figure 1 is a fiber, there are other geometries that the structural component can take on, as we will discuss in a subsequent section. The region between the body and structural constituents is called the interphase. It is quite common (even in the technical literature), but incorrect, to use the term interface to describe this region. An interface is a two-dimensional construction - an area having a common boundary between the constituents - whereas an interphase is a three-dimensional phase between the constituents and, as such, has its own properties. It turns out that these interphase properties play a very important role in determining the ultimate properties of the bulk composite.

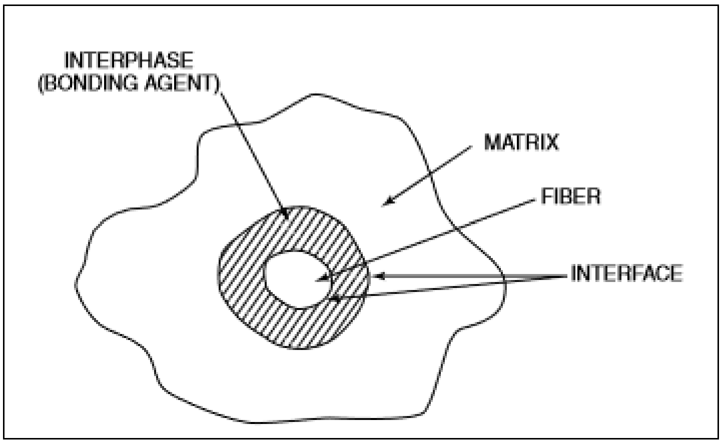


Figure 1. Schematic illustration of composite constituents.

Mechanical stresses are transferred between the matrix and the reinforcement. The interphase is also critical to the long-term stability of a composite. It will be assumed that there is always an interphase present in a composite, even though it may have a thickness of only an atomic dimension. The chemical composition of the composite constituents and the interphase is not limited to any particular material class. There are metal–matrix, ceramic–matrix, and polymer–matrix composites, all of which find industrially relevant applications. Similarly, reinforcements in important commercial composites are made of such materials as steel, E-glass, and Kevlar. Many times a bonding agent is added to the fibers prior to compounding to create an interphase of a specified chemistry. We will describe specific component chemistries in subsequent sections [17].

Composite Classification

There are many ways to classify composites, including schemes based upon materials combinations, such as metal–matrix, or glass-fiber-reinforced composites; bulk form characteristics, such as laminar composites or matrix composites distribution of constituents, such as continuous or discontinuous; or function, like structural or electrical composites. Scheme is the most general, so we will utilize it here. We will see that other classification schemes will be useful in later sections of this chapter. As shown in Figure 2, there are five general types of composites when categorized by bulk form. Fiber composites consist of fibers; with or without a matrix. By definition, a fiber is a particle longer than 100 μm with a length-to-diameter ratio (aspect ratio) greater than 10:1. Flake composites consist of flakes, with or without a matrix. A flake is a flat, plate-like material. Particulate composites can also have either a matrix or no matrix along with the particulate reinforcement.

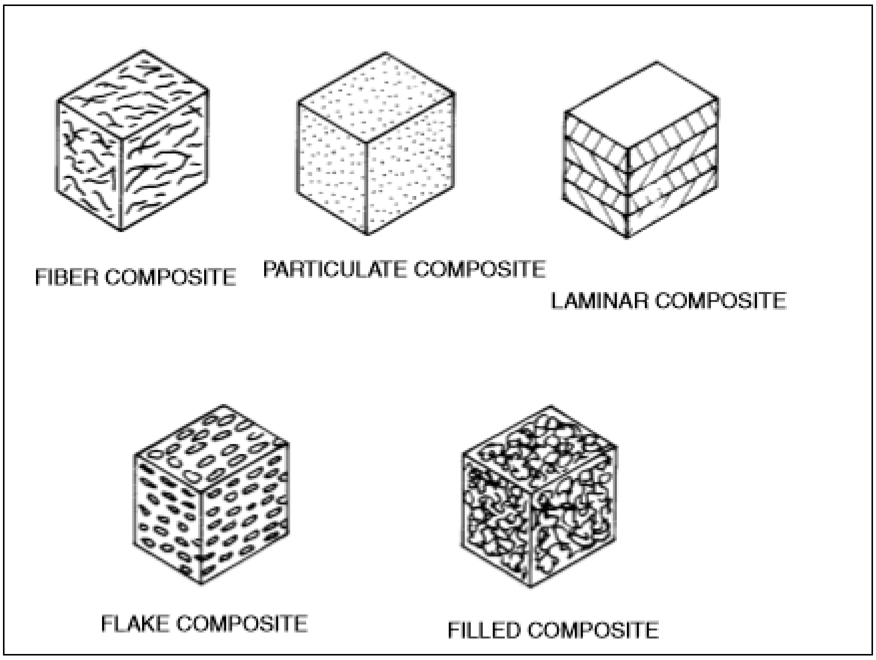


Figure 2 Classes of composites.

Particulates are roughly spherical in shape in comparison to fibers or flakes. In a filled composite, the reinforcement, which may be a three-dimensional fibrous or porous structure, is continuous and often considered the primary phase, with a second material added through such processes as chemical vapour infiltration (CVI). Finally, laminar composites are composed of distinct layers. The layers may be of different materials, or the same material with different orientation. There are many variations on these classifications, of course, and we will see that the components in fiber, flake, and particulate composites need not be distributed uniformly and may even be arranged with specific orientations [17].

Fiber-Matrix Composites

As shown in Figure 3, there are two main classifications of FMCs: those with continuous fiber reinforcement and those with discontinuous fiber reinforcement. Continuous-fiber-reinforced composites are made from fiber roving's (bundles of twisted filaments) that have been woven into two dimensional sheets resembling a cloth fabric. These sheets can be cut and formed to a desired shape, or preform, that is then incorporated into a composite matrix, typically a thermosetting resin such as epoxy. Metallic, ceramic, and polymeric fibers of specific compositions can all be produced in continuous fashions, and the properties of the resulting composite are highly dependent not only on the type of fiber and matrix used, but also on the processing techniques with which they are formed [17].

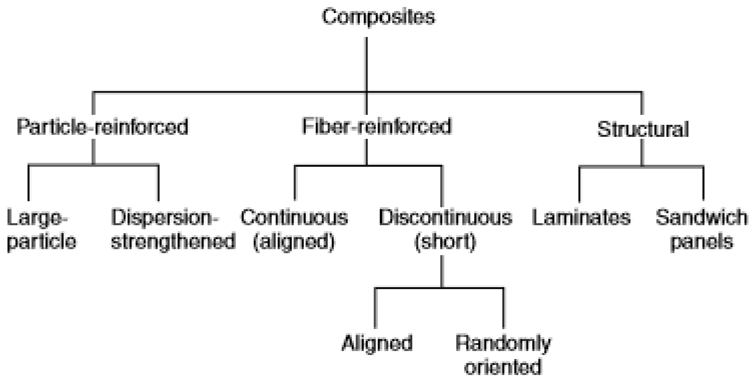


Figure 3 Types of reinforced composites.

Particulate Composites.

Particulate composites encompass a wide range of materials, from cement reinforced with rock aggregates (concrete) to mixtures of ceramic particles in metals, called cermet. In all cases, however, the particulate composite consists of a reinforcement that has similar dimensions in all directions (roughly spherical), and all phases in the composite bear a proportion of an applied load. The percentage of particulates in this class of composites range from a few percent to 70%.

The particle constituent seldom exceeds 3% by volume, and the particles are very small, below micro meter sizes. The characteristics of the particles largely control the property of the alloy, and a spacing of 0.2–0.3 μm between particles usually helps optimize properties [17].

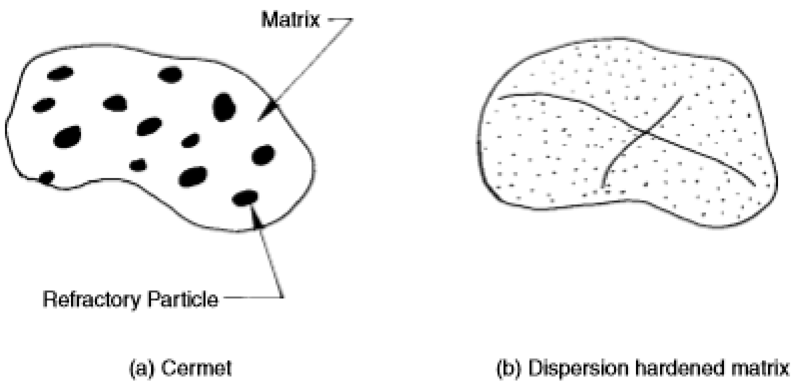


Figure 4 Comparison of (a) cermet and (b) dispersion-hardened alloy

Rubber-Reinforced Polymer Composites:

One of the major developments leading to plastics with outstanding toughness has been the production of rubber-modified glassy polymers such as the acrylonitrile butadiene–styrene (ABS) resins made by polymerizing a continuous glassy matrix in the presence of small rubber particles. Only a small amount (5–15%) of rubber is needed to effect this improvement, and the optimum size of the rubber particles is 1–10 μm. The mechanism by which toughness is developed in these materials can be explained in terms of the crack propagation mechanism. Most glassy thermoplastics undergo a specific type of crack formation and propagation called crazing, in which a network of fibrils connect the two bulk surfaces in a polymeric crack.

The incorporation of rubber particles into the glassy matrix serves to bridge the micro voids and arrest crazing and crack propagation, resulting in increased toughness. The ductility is improved in polystyrene (PS) through the addition of small rubber particles to produce high-impact polystyrene (HIPS) [17].

Fiber-Reinforced Composites

There are a number of ways of further classifying fiber–matrix composites, such as according to the fiber and matrix type—for example, glass-fiber-reinforced polymer composites (GFRP) or by fiber orientation. In this section, we utilize all of these combinations to describe the mechanical properties of some important fiber-reinforced composites. Again, not all possible combinations are covered, but the principals involved are applicable to most fiber-reinforced composites. We begin with some theoretical aspects of strength and modulus in composites that the fiber reinforcement can be classified as either continuous or discontinuous. In the next two sections. It describe the mechanical properties of these two classes of fiber reinforcement in composites, with the emphasis on reinforcement of polymer–matrix composites. Generally, the highest strength and stiffness are obtained with continuous reinforcement. Discontinuous fibers are used only when manufacturing economics dictate the use of a process where the fibers must be in this form—for example, injection molding. We begin our description of discontinuous fiber-reinforced composites with some concepts related to the distribution of stresses that are independent of fiber composition. These developments will be limited to unidirectional aligned fibers that is, fibers with their axes aligned. First, we will concentrate on continuous, unidirectional fibers, and then the strength and modulus of discontinuous, unidirectional fiber-reinforced composites will be analysed [17].

Injection Molding.

Injection molding is the process of producing identical articles from a hollow mold. Because of their high viscosity, polymers cannot be poured into a mold, or cast, in the same way that metals are, because gravitational forces are not sufficient to produce appreciable flow rates. Thus, the melt must be injected into the mold cavity by the application of large forces from a plunger. Moreover, once the mold is filled with melt and solidification starts, an additional amount of melt must be packed into the mold to offset polymer shrinkage during solidification. Injection molding involves two distinct processes. The first is melt generation, mixing, and pressurization and flow, which is carried out in the injection unit of the molding machine. The second is product shaping, which takes place in the mold cavity. Injection molders, therefore, have two distinct parts: the injection unit and the mold/clamping unit. The function of the injection unit is to melt the polymer and inject it into the mold; the function of the clamping unit is to hold the mold, open and close the mold, and eject the finished product Two systems have been used in injection molding machines to melt and inject the polymer. The most commonly used types use a reciprocating screw, which has many similarities to an extruder screw, but with a unique reciprocating (back and forth) action. The other type of injector system is the ram injector [17].

1.2. Defined of Materials vibro - acoustic properties

Every materials has a performance on acoustics and vibration effects. These performance related with structural and compose about materials. When the properties specification we have to take into account two part: test results and physical models.

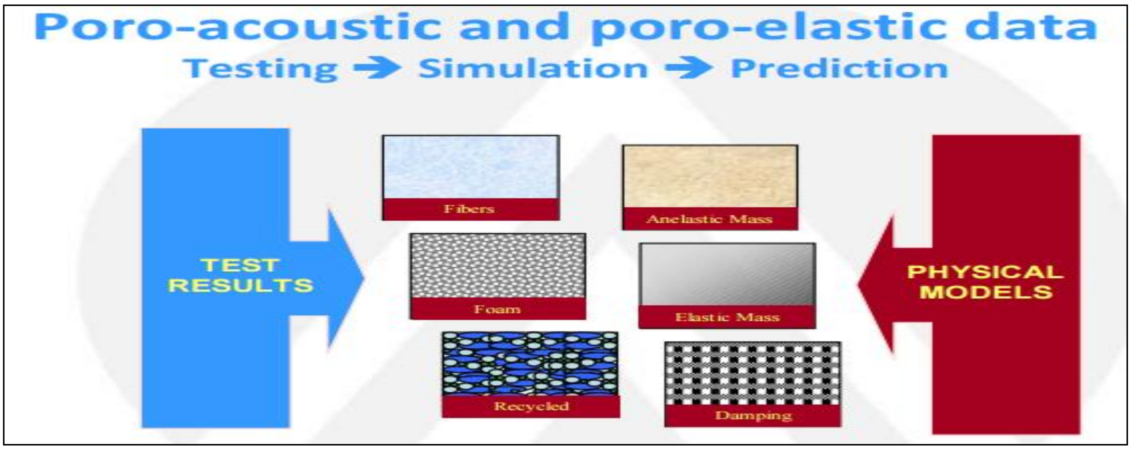


Figure 5. Poro-acoustic / elastic data process schema [18]

These analysis are formed some physical parameters which are considered at modelling and optimisation process.

Sound Absorption: Sound waves striking an arbitrary surface are either reflected, transmitted or absorbed; the amount of energy going into reflection, transmission or absorption depends on acoustic properties of the surface. The reflected sound may be almost completely redirected by large flat surfaces or scattered by a diffused surface. When a considerable amount of the reflected sound is spatially and temporally scattered, this status is called a diffuse reflection, and the surface involved is often termed a diffuser. The absorbed sound may either be transmitted or dissipated. A simple schematic of surface-wave interactions is shown in figure. [19]

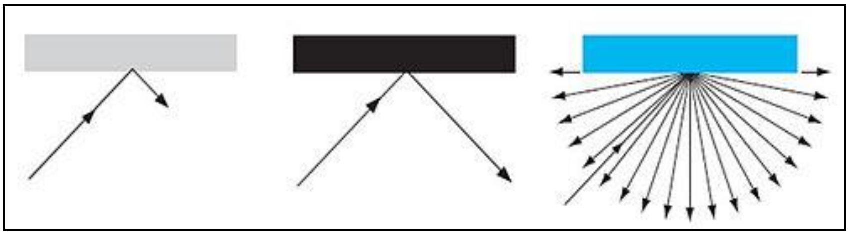


Figure 6. Sound motion on material

Vibration: The most common damping mechanism used to address vibration (and noise) problems is viscoelastic damping. Viscoelastic means that the material exhibits both elastic and viscous behaviour. An elastic material is one that stores energy during a load and all energy is returned when that load is removed. A viscous material doesn't return any energy. All energy is lost as "pure damping" once the load is removed. A viscoelastic material therefore stores some of the energy during a load and then the remainder is released as heat.

Frequency–temperature superposition

When temperature and frequency are variable, there is a requirement for a shifting rule that predicts the viscosity function at arbitrary T and Hz. This shifting rule allows the comparison of results from experiments under different temperature conditions and is the means by which the viscosity function can be applied to practical problems. The Arrhenius shifting rule was validated for shifting with respect to T and Hz.

1.3. The finite element method and structural reliability

Finite element methods have been developed by several researchers for use on complex structures. The algebra involved is cumbersome and obtaining solutions is time-consuming in view of the large number of nodal displacements and number of elements needed, especially for analysis at high frequencies.

Solving complex mechanical problems increasingly demands the use of the finite elements method, which has, in recent years, become the key tool in structural design. The recent development of mechano-reliable couplings and stochastic or probabilistic finite element methods is a response to the limitations of deterministic numerical analysis.

The structure's response is studied using a probabilistic approach that accounts for variation in the problem's parameters. Two major families of numerical methods currently exist:

– Mechano-reliable couplings that enable the analysis of reliability in a complex structure by combining the finite elements method with the reliability method described previously.

– The first two moment's methods enable analysis of a structure's sensitivity when subject to hazards coupling the finite element method and probability theory.

Steps;

a. A structure reliability problem: A structure is made to respond to a series of clearly identified needs. Structure reliability aims to evaluate the probability that a structure, subject to risk (vibrations, temperature, shock, fatigue, etc.), is capable of satisfying all its requirements for a given duration. However, calculating this probability requires a thorough research methodology that comprises four stages: – defining a deterministic mechanical model adapted to the problem in question; – identifying the random parameters of this model and modelling them using an appropriate probabilistic tool; – defining the types and scenarios of failure in the problem; – evaluating the probability of these types of failure occurring. The precision of the result and the probability of the structure's failure are also governed by a series of expert, experimental, mathematical, numerical and practical factors that affect each stage of the reliability study.

b. Modelling a structure reliability problem: The first stage in a reliability study is to identify the mechanical problem being examined. An adapted deterministic mechanical model is therefore identified. This integrates the structure's geometry, the materials' mechanical properties and its boundary conditions. [16]

c. Calculating the probability of failure in a structure: There are currently two main categories of method for evaluating the probability of failure in an existing structure. The first aims to evaluate Pf over the whole of the failing area Df and uses simulations based on the Monte-Carlo technique. The second entails using a simulation of area Df enabling the calculation of a value approaching Pf from a reliability index β.

d. Reliability indices

e. Over view of the resistance – solicitation problem: The majority of mechanical systems can be schematized.
f. System reliability in mechanics: Failure in a structure is rarely only due to a single event. In general, thermal function of a mechanical system is the result of a series or combination of core events of failure. In such complex cases, rigorous methodology must be followed. First, each potential type of failure in the problem must be identified. Second, a failure scenario, precisely describing the series of key elements resulting in failure, is then constructed. [16]
g. The finite element method and structural reliability

1.4. Optimization

In view of the large number of parameters involved in viscoelastically damped systems, it is desirable to carry out multi-parameter optimisation, with specified geometrical and physical constraints and to arrive at a dynamically optimum configuration.

Numerical simulation in the calculation of mechanical structures has seen a number of developments over recent decades due to advances in scientific calculation and the development and growth of computers, both in terms of their processing speed and the quality of data produced. Engineers therefore have a wide choice of methods supported by computer devices, notably the finite element method and optimization methods that constitute valuable tools in the optimal design of structures with respect to specific rules or norms. [16]

The finite element method appeared in response to the need to solve complex and general calculation problems in a context where the vast development of informatics has automated processing in large systems of equations. Most of the industrial computer-aided design (CAD) software based on the finite element method has been developed, notably ANSYS, ABAQUS, NASTRAN, ACTRAN and etc.

Numerical partial differential equations (PDE) resolution methods have today reached a level of maturity that means they can be used to aid engineering design. In addition, the field of optimization has developed considerably with calculation infrastructures. There are currently a number of algorithms for solving nonlinear, deterministic (descent and simplex methods) or even stochastic programming problems (simulated annealing, evolutionary algorithms, particle swarm algorithms, etc.), as we saw in the first chapter. It therefore seems natural to combine these two fields to propose automatic strategies to aid optimization-based design. [16]

In mechanical engineering, these uncertainties are inherent to modelling faults, materials' mechanical properties (Young's modulus, volume mass, etc.), manufacturing and assembly processes (sheet thickness, junction, etc.). In the pre-project design phase, these uncertainties are introduced to account for a lack of knowledge about specific design variables. This raises the following concepts:
– Uncertain parameter: an uncertain parameter relates to a non-deterministic parameter characterized by a nominal value and an uncertainty.
– Nominal model: a model in which all the uncertain parameters are fixed at nominal values.
– Random model: a model where parameters' values are selected at random. [16]

2. Studies in report terms

I. **Term:** In this work include vibro-acoustic properties of bio-nano composites. Nowadays we need to special materials for many industrial product. On these topic work has increased by science and researcher. We are analyse on studies constantly in scientific database. In these studies, placed in many studies were reviewed as part of our research development and change. Planning of future studies will be prepared in the light of this information.

II. **Term:** The project plan has include manufactured test samples at second step. Both bio materials and nano materials produced fabricate steps with standards. Materials selected for product condition and using. Mixing and composing ratio prepared. Process steps, measured and control devices defined and calibrated also were lost and error parameters. When these materials produced all condition, standards, process and measures was recorded. After these process, we had test samples formally. The test samples was applied to vibro-acoustic tests.

Acoustic Experimental Method

The test was performed by the DRIVE laboratory (Département de Recherche en Ingénierie des Véhicules pour l'Environnement) of the ISAT (Institut Supérieur de l'Automobile et des Transports) in Nevers, France. Sound properties measurement was based on the two microphone transfer-function method. These operations are applied according to ISO 10534-2 and ASTM E1050-98 international standards. These test devices were part of a complete acoustic material testing system. Small-tube setup was used to measure different acoustical parameters for the frequency range of 100-6400 Hz.

Small impedance tube kit from Brüel & Kjaer Type 4206 consisting of a 29 mm diameter tube (small tube), sample holder and an extension tube at the same diameter was used. A frequency-weighting unit is also provided within the tube, in which different types of frequency weighting are available; high-pass, for high frequency measurements in the small tube, linear for measurements in the large tube, and low-pass for additional measurement accuracy below 100 Hz. At one end of the tube, a loudspeaker is situated to act as a sound source. At the other end of the tube, the test material is placed to measure sound absorption properties. The transfer function between the two microphones and allows obtaining the absorption coefficient. For proper fitting of samples into the measurement tube, an aluminum rod was machined to a length of 40 mm and a diameter of 29 mm, it was utilized to push the material into a pre-adjusted depth. For each thickness of the material, three different sample measurements were made and the average of the measured data was presented here.

Vibration Experimental Method

For this study, composite materials have been fabricated by thermo-molding with unidirectional flax fibers and epoxy resin SR8200. Plates are thermo-pressed under 7 bars pressure and a temperature of 60°C during 8h in order to reach a fiber content of 45%. 8-plys samples of 2.77x10x140 mm are prepared for each principal fibres direction laminate (4 samples / direction). First, the samples [0°], [90°] and [±45°] have been tested by vibration analyses to extract the elementary ply viscoelastic properties. Second, a quasi-isotropic laminate [45/-45/90/0] has been also characterized. Third, the predictive method previously described is applied and comparison with experimental results are analysed.

"Oberst" method is classically used to characterize material vibrational behavior. On this system, an electrical inductor generates the excitation of ferromagnetic samples (fig.7). An "Oberst"-modified experimental device has been used in this study. This device allows high-length beams characterization on a large frequency bandwidth. The original method includes a threaded rod clamp system to screw down materials samples on the device. Here, a modified version has been used to clamp materials beam with bolted aluminum tab. This configuration permits to characterize samples without drilling. Moreover, the torque's clamp is perfectly managed (fig. 7). When a shaker unit generates harmonic excitation on a clamped-free beam sample. A spectrum analyzer calculates Frequency Response Functions (FRF) between the center-beam acceleration and the extremity-beam velocity.

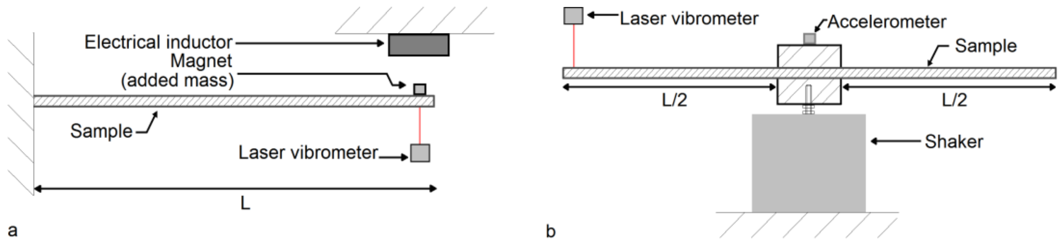


Figure 7. Oberst – Modified experimental de dynamic characterization device for free-free symmetric beam samples

Using formulas from beam theory (eq. 1 and 2) and FRF-peaks analyses, Young modulus and loss factor can be calculated as following:

$$E(\omega_r) = \frac{\rho S \omega_r^2}{\beta^4 I} \quad (1) \qquad \eta(\omega_r) = \frac{\omega_2 - \omega_1}{\omega_r} \quad (2)$$

Where ωr is the Eigen pulsation frequency, S is the beam section, ρ is the material density, I is the area moment of inertia, β is a frequency-mode related constant, and ω2 and ω1 are the frequency pulsations at -3dB of magnitude from the peak resonance one. If a swept-sine excitation type is applied to the specimen, the frequency sweep must be slow enough. This allows the signal to be locally considered as a stationary sinusoidal signal. The frequency resolution is adjusted to get a constant frequency resolution of 30 MHz. The dynamic range of the test has been fixed to 10-3500 Hz. The evolution of moduli and loss factors are then plotted [20].

Vibro-acoustics behaviours was determined for these samples. The raw results evaluation for next steps.

III. Term: Finite Element Model and Optimization

Integrating uncertainty into the design process is a practice commonly used by engineers. This concerns the design of systems for critical values, the use of safety factors, and the more advanced techniques from the calculation of reliability. The aim is to design a system with statistically better performance that may often change according to uncertainty. For example, we may want to obtain a level of performance which is minimally sensitive to uncertainty. We may also not want to surpass a minimal performance threshold with a given probability. In addition, design problems are still constrained optimization problems. Where there is uncertainty, we want to identify it with a high degree of probability. [16]

We have used ABAQUS software for finite element analyses and simulation. A complete Abaqus analysis usually consists of three distinct stages: pre-processing, simulation, and post-processing. These three stages are linked together by files as shown below:

Pre-processing (Abaqus/CAE)

In this stage the model of the physical problem and create an Abaqus input file. The model is usually created graphically using Abaqus/CAE or another pre-processor, although the Abaqus input file for a simple analysis can be created directly using.

Simulation (Abaqus /Standard or Abaqus /Explicit)

The simulation, which normally is run as a background process, is the stage in which Abaqus/Standard or Abaqus/Explicit solves the numerical problem defined in the model. Examples of output from a stress analysis include displacements and stresses that are stored in binary files ready for post-processing. Depending on the complexity of the problem being analysed and the power of the computer being used, it may take anywhere from seconds to days to complete an analysis run.

Post-processing (Abaqus /CAE)

When evaluated the results once the simulation has been completed and the displacements, stresses, or other fundamental variables have been calculated. The evaluation is generally done interactively using the Visualization module of Abaqus/CAE or another postprocessor. The Visualization module, which reads the neutral binary output database file, has a variety of options for displaying the results, including colour contour plots, animations, deformed shape plots, and X– Y plots. The Abaqus/CAE is the Complete Abaqus Environment that provides a simple, consistent interface for creating Abaqus models, interactively submitting and monitoring Abaqus jobs, and evaluating results from Abaqus simulations. Abaqus/CAE is divided into modules, where each module defines a logical aspect of the modelling process; for example, defining the geometry, defining material properties, and generating a mesh. As you move from module to module, you build up the model. [21, 22]

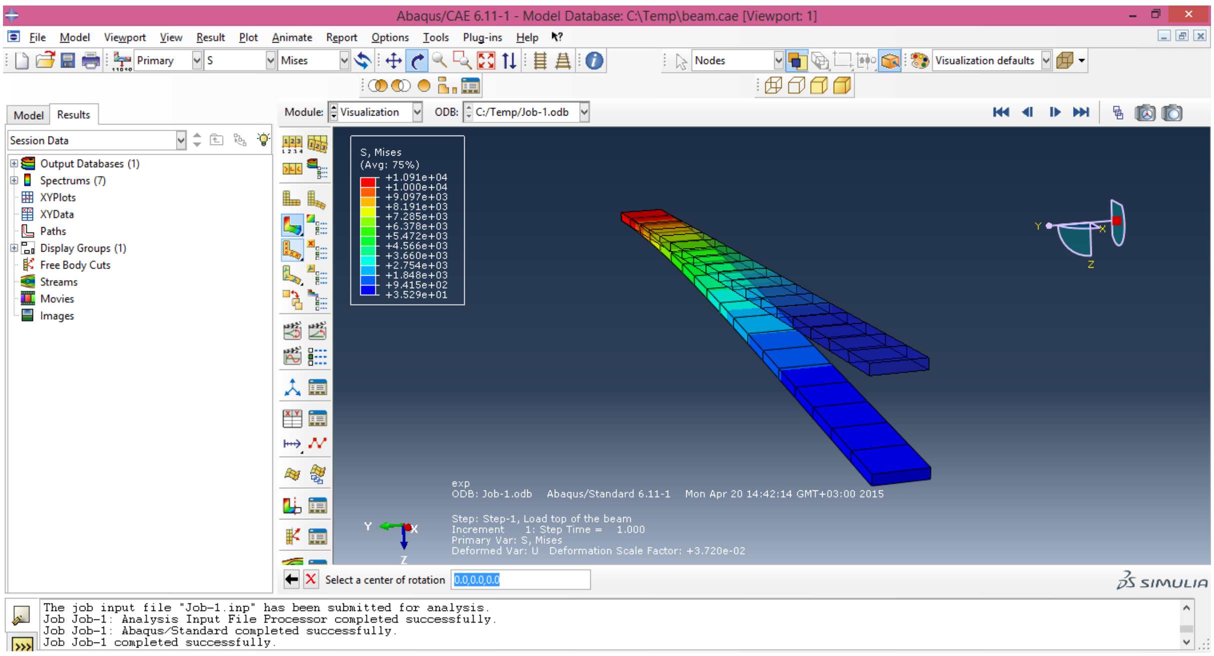


Figure 9. Fibre-Epoxy composites analysis in our work

The results obtained from ABAQUS program was processed in MATLAB. The file which is .ink translate to MATLAB where data were purified based on parameter analysis we created in MATLAB.

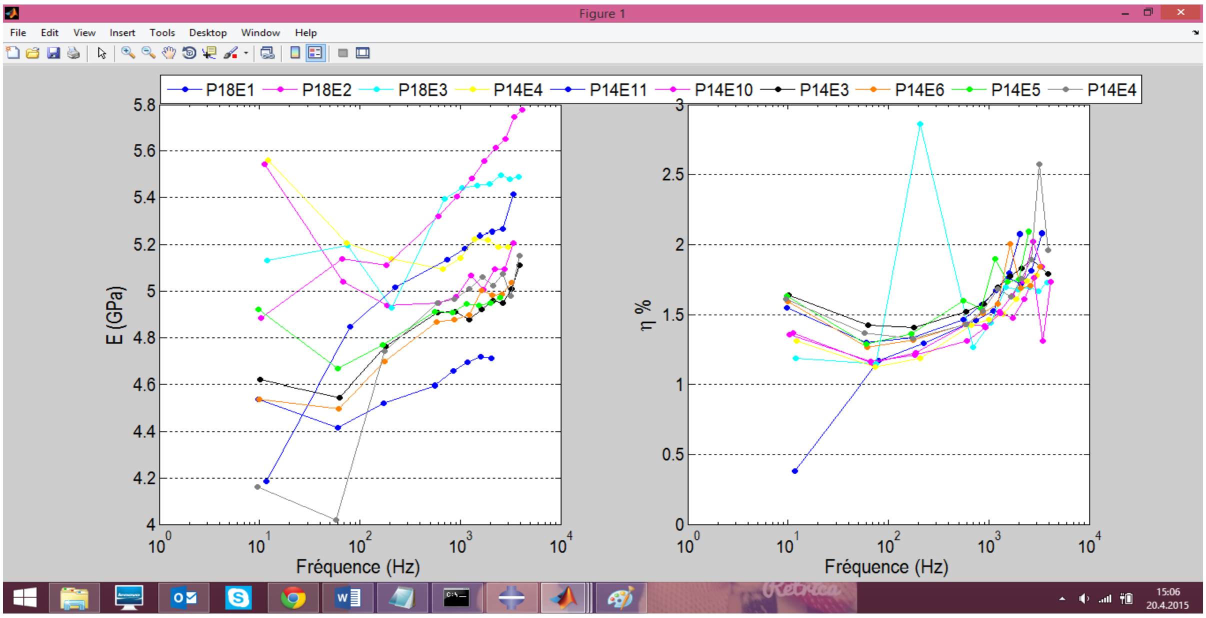


Figure 10. The results translate for superposition with MATLAB

IV.**Term: Results and Conclusion:**

We have a currency and reliability results in each two investigation. The material fabricated was continued with literature and standards. The vibro-acoustic tests applied in laboratory with expert monitoring. The vibration results were obtained each temperature and humidity separately and compose with Arrhenius equal and located on superposition. All test results crosscheck with FEM software and link with MATLAB. The investigation outcome was evaluated 1and reported.

3. Research results

Acoustics Test Results: Absorption properties of materials which were obtained by the addition of HDPE into the SBR are indicated in figure 1. One can observe a stable behaviour in the low frequency. Therefore, we did not consider necessary to test the low-frequency. The high frequency test results are presented in Figure 11.

Sound absorption of Polymer blends were examined in the frequency range 100 to 6400 Hz. The behaviours of this mixture were, within the range 0-250 Hz, quite uncertain. Results indicate that SBR addition rate causes an irregular behaviour on sound absorption coefficient.

Group-1: Sound absorption characteristics were examined in the frequency range of 800-3200 Hz. This material has an interesting absorption coefficient, throughout the frequency band from 2400 Hz to 5000 Hz. So in this frequency band, the absorption coefficient is between 0.1 and 0.2.

Group-2: This material has a good absorption coefficient in the low frequency range. In fact, the absorption coefficient reaches a maximum of 0.25 at the frequency 2000 Hz. The absorption coefficient decreases, but it remains relatively stable over a wide frequency range from 1000 Hz to 5000 Hz.

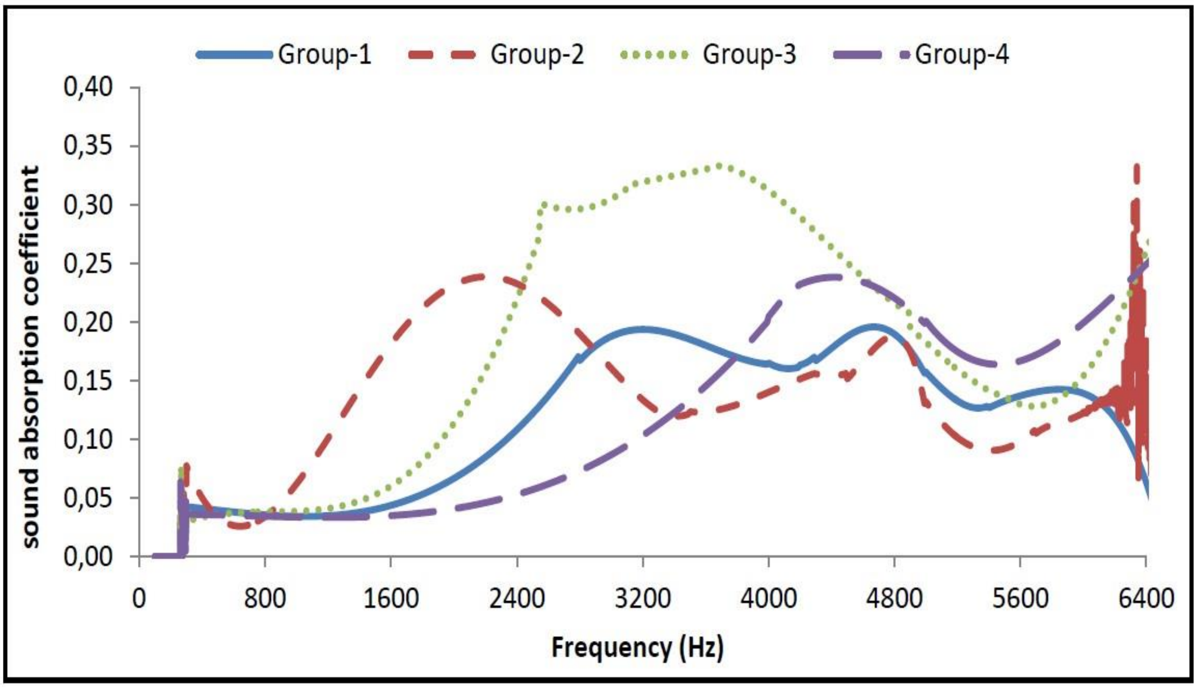


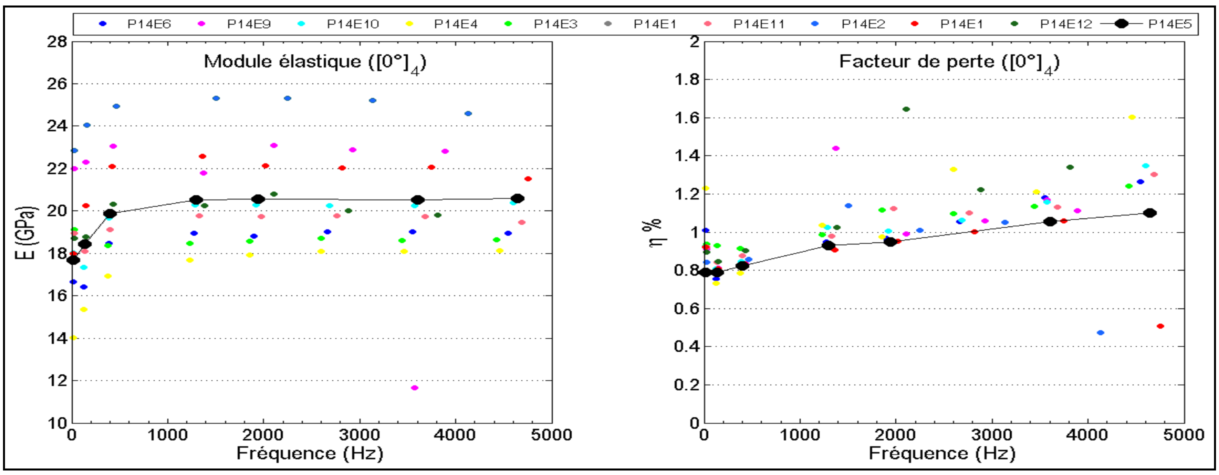
Figure 11. Acoustic tes results with HDPE/SBR composites

Group-3: The best absorption coefficient is given by this material. Thus, the absorption coefficient exceeds 0.35 on a wide frequency band from 2000 Hz to 4500 Hz

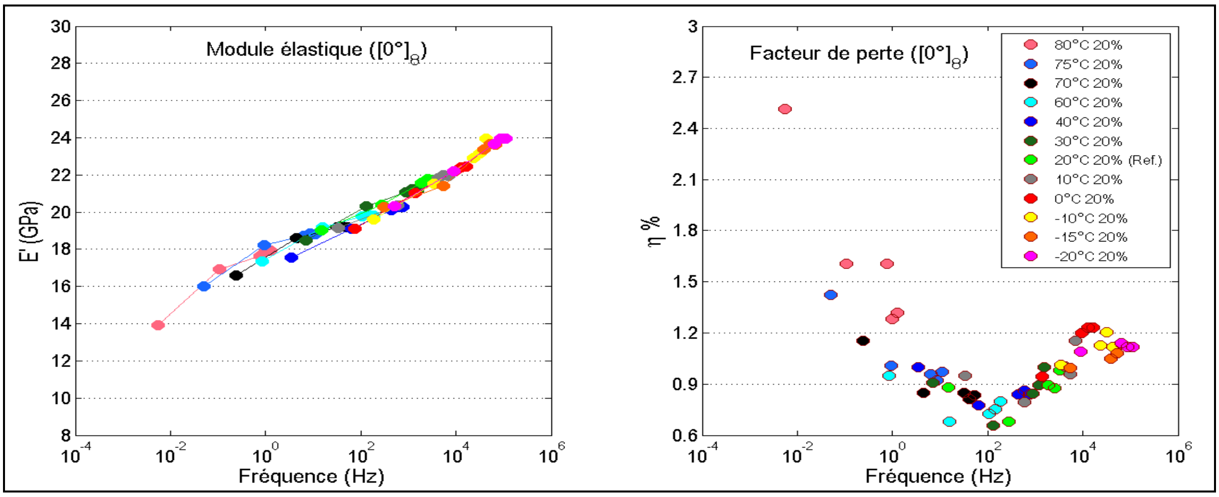
Group-4: Sound absorption characteristics were examined in the frequency range of 800-4000 Hz. the absorption coefficient reaches a maximum of 0.25 at the frequency 4200 Hz.

All the analysed groups indicate that SBR contribution affect the sound absorption coefficient. Soft structure of SBR material is created on this effect. The best performance was observed for group 3.

Vibration Test Results: The vibration test applied for 0, 45 and 90 degree fiber positions. Each degree test was conduct separately. The tests were released on two parameter which are temperature and humidity. The test performed presented in graphics in figure 12-14 for elastic modulus and loss factor.



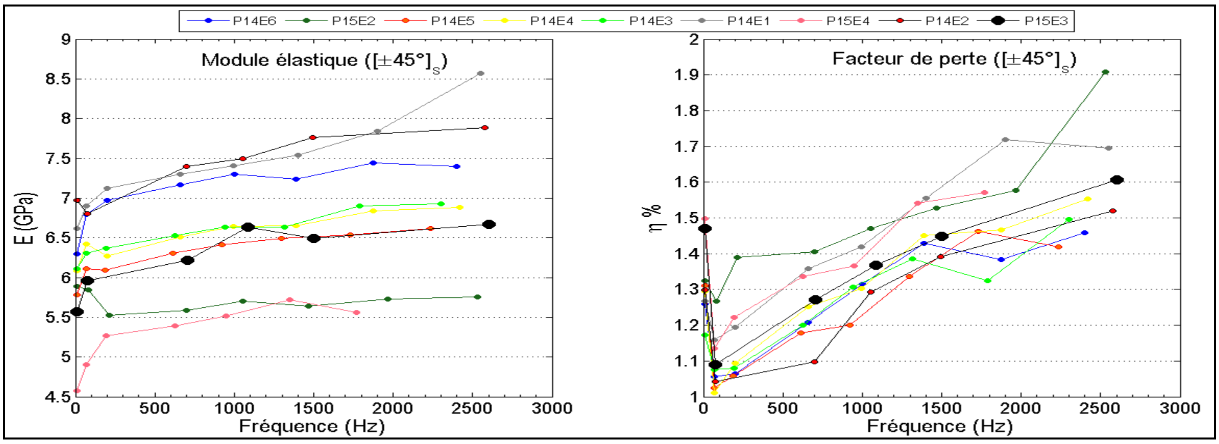
a b



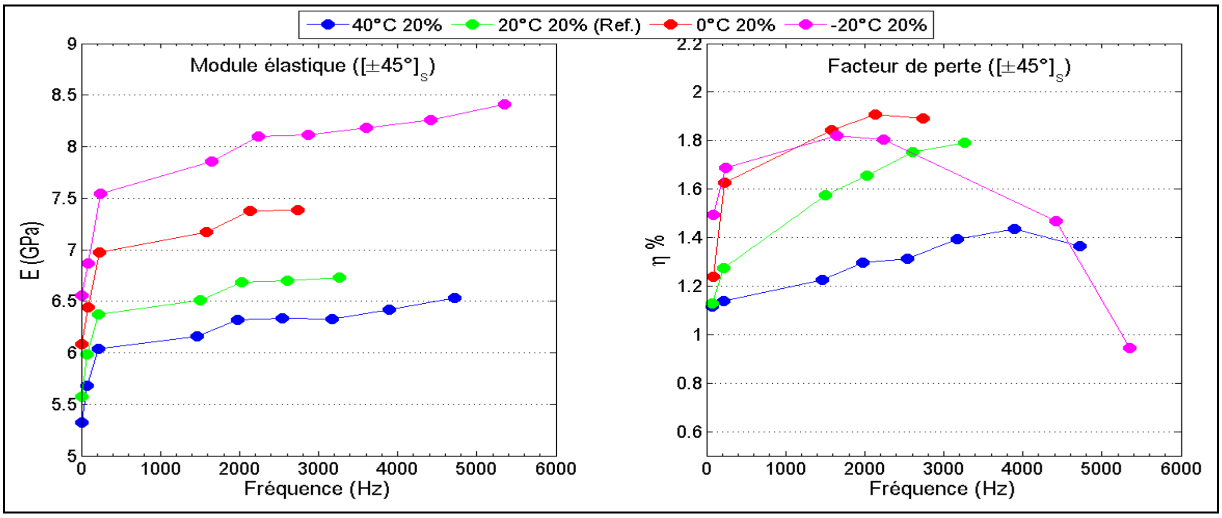
c

Figure 12. Elastic modulus (a) and loss factor (b) and under temperature for 0° angle fiber

These graphics shows (fig 12) that Elastic Modulus (a) is maximum at 0° where elastic modulus is almost 20 GPa between 0 – 5000 Hz steady. It can see loss facture is about 1%. The 0° angle fibers effect was not caused stable behaviour (c). The maximum lost factor released at high temperature. Under room temperature and its close point had a low lost factor.



a b



c

Figure 13. Elastic modulus (a) and loss factor (b) and under temperature for 45° angle fiber

It seen that 45° fiber angle ratio mean went to from 6 to 6.5 GPa till 2500 Hz. This ratio lower than 0°. Meanwhile the lost factor was going to 1.1 to 1.5 linearly. This was limited at 2500 Hz. In this angle was caused to increase proportional with frequency.

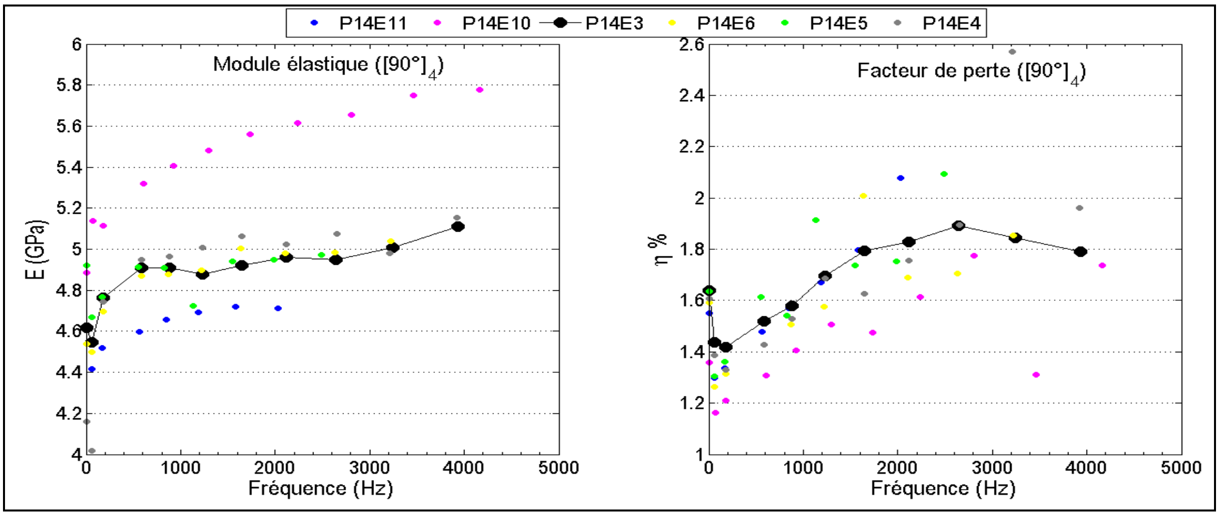


Figure 14. Elastic modulus (a) and loss factor (b) and under temperature for 90° angle fiber

These values for 90° it seen that it is compatible with literature survey. 90° fiber angle is caused to loss mechanical properties. In here elastic module is and 4.5-5 GPa and loss facture is similar Ludwig equation as between 1.4% and 1.8%

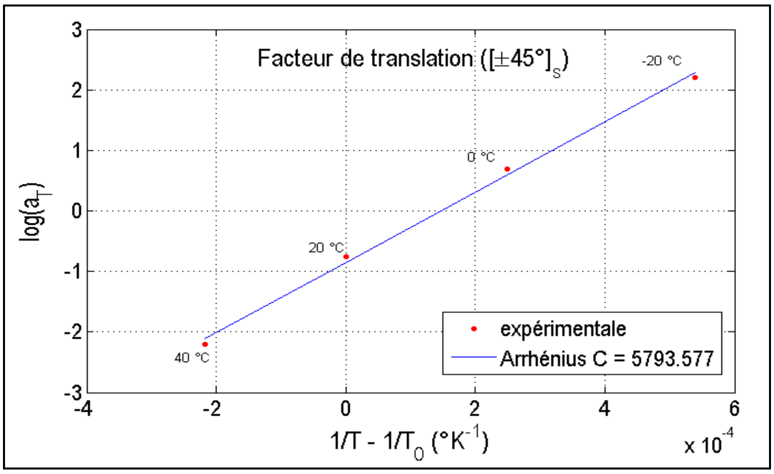


Figure 15. Superposition with Arrhenius equation for 45° angle fiber

45 degrees are central in this study where we translate vibration data with Arrhenius equation in different temperature points. Figure 15 shows experimental and theoretical results. This graphic was formed superposition approaching.

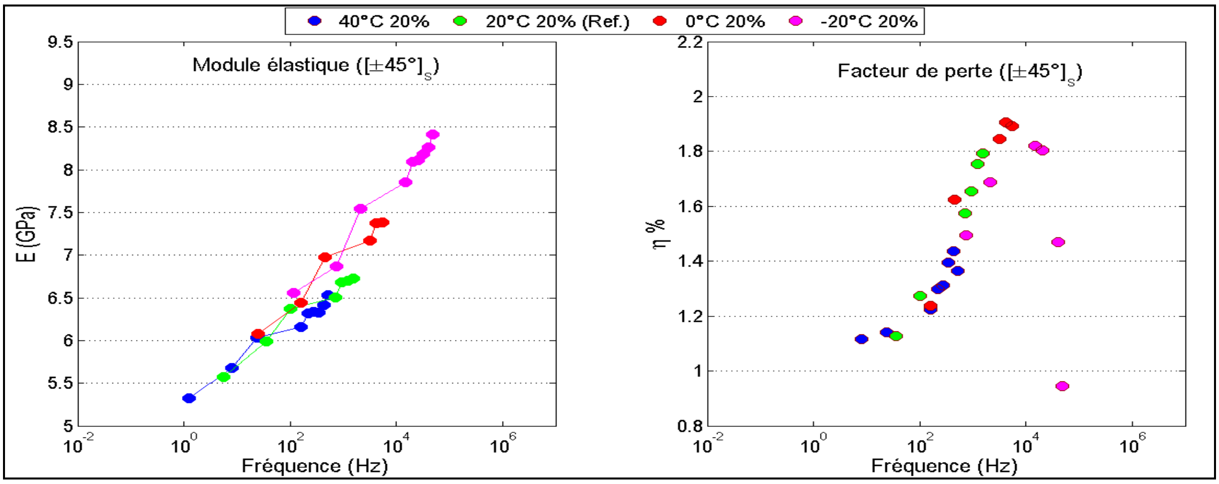


Figure 16. Final results for selected samples for 45°.

Finally the selected 45° samples process Matlab and formed with superposition approaching. The elastic modulus increase to lower the temperature of the high temperature. And it seen alike behaviour in loss factor graphic. But -20 dgree temperature was not homogeneous distribution.

4. Conclusion and Comments

Acoustics: To sum up, although all materials have impact on different regions, all of them have similar behaviour. They were rising slightly and reach peak point. After then they keep a stable behaviour. Finally, all these materials have frequency bands for which they provide interesting acoustic properties. We feel that our study enhances understanding the sound absorption coefficients and their instability behaviour depending on their hardness and their morphological properties.

Vibration: The presented characterization method allows the measurement of moduli and loss factor of unidirectional composite beams in a large band frequency range (10 - 3500 Hz). On this range, storage modulus increases by 6-10% and loss factor increases by 46-51%. Based on the elastic-viscoelastic correspondence principle, classical laminates theory has been used to predict the linear viscoelastic behavior of a quasi-isotropic laminate composite. The results show a 10% storage modulus overestimation but an accurate prediction of the laminate loss factor frequency.

5. **Outputs**

a. Taşdemir M, Ersoy S. (2014). Friction and wear performance of HDPE/talc-calcium carbonate polymer composites against sliding distance and applied load. Romanian Journal of Materials, 44(3), 257-264.
b. Ersoy, S., El-Hafidi A.; Determined To Sound Properties Of High Density Polyethylene / Styrene Butadiene Rubber Polymer Composites By Experimental Method, The International Journal of Acoustics and Vibration, In Review
c. Belaid, M., Ersoy, S., El-Hafidi, A.; On Temperature-Frequency Analysis Of Flax Fibres Composites Laminates Dynamic Mechanical Behaviour; Journal of Vibration Control, In Review

Note: The accrued rate of the proposed study should be reflected to the report.

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