Self-adaptive thermally driven multilayered composites for vibration control

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Problem statement

How to develop a multilayered composite structure with an embedded vibration control system capable of thermally driving the shape memory polymer core of this structure, so that it self-adapts to dynamic loads and maintains its static and dynamic properties within prescribed limits?

Motivation

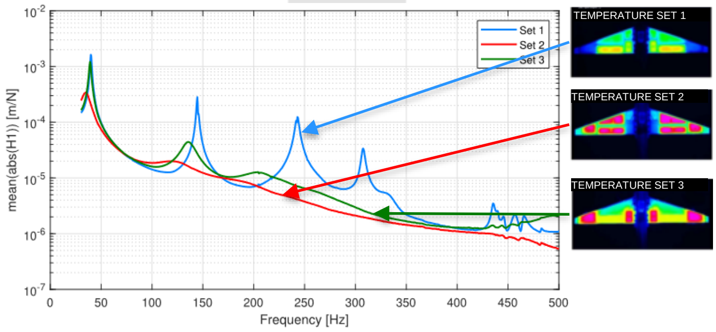
Vibration control is of interest in multiples domains:

Background

Vibrations of a wing structure can be thermally controlled thanks to the use of a Shape Memory Polymer, but:

- High computational time due to 3D modeling
- Offline computations
- No adaptation to different solicitations
- Imposed external thermal configurations

► **Towards a self-adaptive thermally driven multilayered composite structure for vibration control**



[ ] P Butaud *et al. In-core heat distribution for adaptive damping and stiffness tuning of composite structures*. Smart Materials and Structures (**2020**).

Objectives

Develop a multilayered composite structure with an embedded vibration control system:

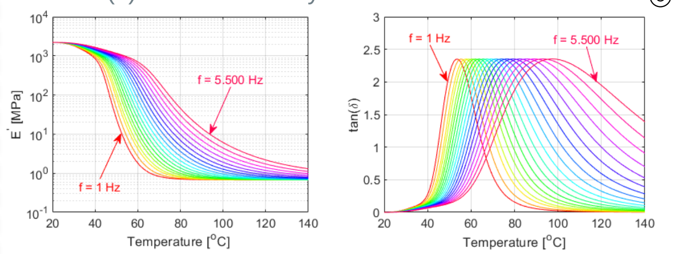
- Implement a reduced-order model of the multilayered composite structure;
- Formulate the vibration control law based on the thermal control of the structure's core Shape Memory Polymer;
- Conduct experiments to validate the application of the structure with the embedded vibration control system.

A multilayered composite structure **full-order** model:

Skins

Core

Shape Memory Polymer [ ]: storage modulus E' and loss factor tan(δ) can be thermally-driven.

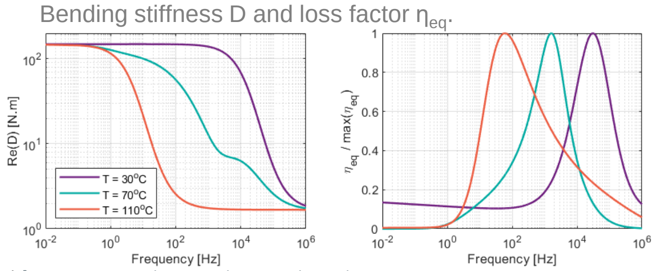


[ ] P Butaud *et al. Sandwich structures with tunable damping properties: On the use of Shape Memory Polymer as viscoelastic core*. Composite Structures (**2016**).

Presentation of the envisaged approach

A **reduced-order** model that considers the high values of the Shape Memory Polymer loss factor:

Equivalent single-layer, e.g., the Sigmoid model [ ]: Bending stiffness D and loss factor η_{eq}.

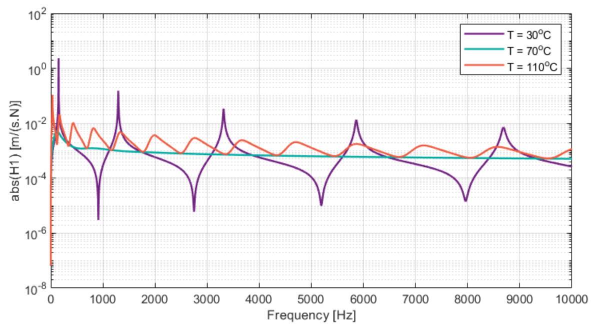


[ ] U Arasan *et al. A simple equivalent plate model for dynamic bending stiffness of three-layer sandwich panels with shearing core*. Journal of Sound and Vibration (**2021**).

max(η_{eq})		
T = 30°C	T = 70°C	T = 110°C
0.0137	3.8523	0.1966

Preliminary results

The mobility of a cantilever beam:



Preliminary results indicate that we can calculate different behaviors as a function of temperature using a reduced-order model.

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