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A REDUCTION MODEL FOR FORCED RESPONSE OF DAMPED VISCOELASTIC SANDWICH BEAM

F. Boumediene[1], E.M. Daya[2,3], J.M. Cadou[4], L. Duigou[4],

[1] Laboratoire de Mécanique Avancée, Faculté de Génie Mécanique & Génie des Procédés, USTHB, BP 32, El Alia, 16111 Bab Ezzouar, Alger, Algeria,
[2]Laboratoire d'Etude des Microstructures et Mécanique des Matériaux, UMR CNRS 7239, Université de Lorraine, Ile du Saulcy 57045 Metz Cedex, France
[3]Laboratory of Excellence on Design of Alloy Metals for low-mAss Structures ('DAMAS'),University of Lorraine, Metz, France.
[4]Laboratoire d'Ingénierie des Matériaux de Bretagne, Université Européenne de Bretagne, Université de Bretagne Sud, Rue de Saint Maudé, BP 92116, 56321 Lorient Cedex, France,

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To reduce vibrations and noise, viscoelastic materials are often used in many domains (e.g., the aerospace industry, the automobile industry) as passive damping solutions. To maximize this kind of damping, these materials are usually sandwiched between two identical elastic layers (Figure 1). In this configuration, the damping is introduced by an important shear deformation in the viscoelastic central layer. The governing equation, for a beam excited by a force ***P***, is nonlinear with respect to circular frequency and displacement as follows:

$$\left[\mathbf{K}_0 + E(\omega)\mathbf{K}_\mathrm{v} + \omega^2\mathbf{M}\right]\mathbf{U} = \mathbf{P} \tag{1}$$

where: ω is the vibration circular frequency; $\mathbf{M}$ is the global mass matrix; $\mathbf{K}_0$ and $\mathbf{K}_\mathrm{v}$ are real constant stiffness matrices; $E(\omega)$ is the complex Young's modulus of the viscoelastic core.

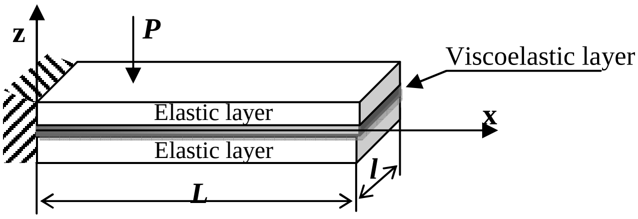

Figure 1. Cantilever viscoelastic beam excited by ***P***

Many investigations have focused on viscoelastic sandwich structures modeling. A review of various theories can be found in references [1, 2]. The most methods used in the literature could lead to high computational cost in the case of large scale structures, and only a few studies have focused on cost reduction. From the solutions proposed in the literature one can found: the condensation method, substructuring technique, one-mode Galerkin's procedure and Padé approximants [3, 4, 5].

In this paper, a reduction method is combined to asymptotic numerical method [6] for solving the governing equation (1). In this way, one can reduce the computational cost and memory space considerably. Three reduction bases are tried:

- The first matrix contains the linear eigenvectors $\mathfrak{R} = \mathbf{\Phi}$;
- The second one contains the linear eigenvectors enriched by vectors computed by considering the viscoélastic properties: $\mathfrak{R} = \left[\mathbf{\Phi} \quad \mathbf{K}^{-1}\mathbf{K}_v\mathbf{\Phi}\right]$.
- The third one is built by initial resolution of the equation (1).

The validity of the present method is illustrated in the example of cantilever beam (Figure 1) with dimension $(177 * 12{,}7)mm^2$ [7]. Results from the full calculation without reduction and those from the reduced calculation are superposed for comparison (Figure 2). The results shown represent the evolution of the transverse displacement W at the excitation point with respect of the circular frequency. Twenty orthonomalised vectors are used in reduction matrices. One can note that the first basis gives good results for small amplitudes only. The two last bases give good results comparing to those from a full calculation.

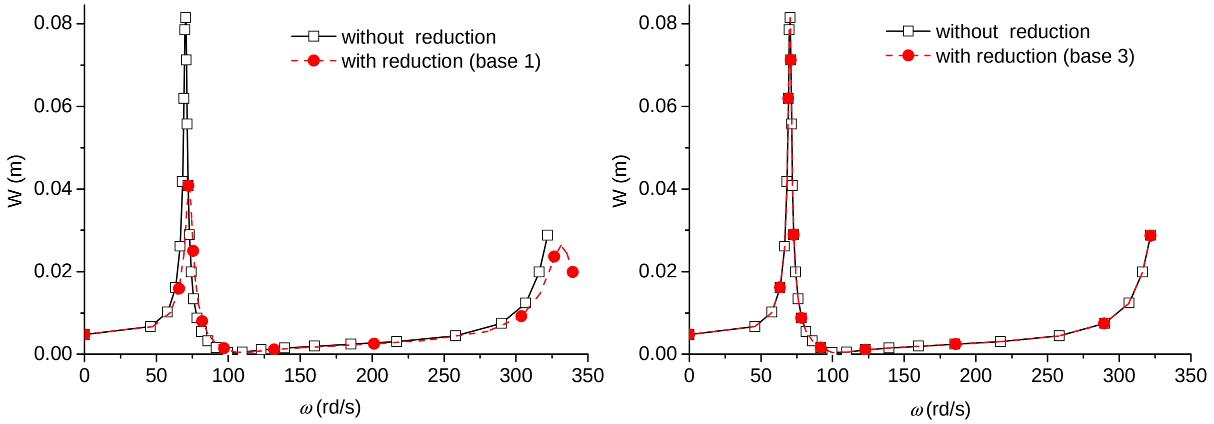

Figure 2. Transverse displacement with respect of circular frequency

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