REDUCED ORDER MODELS FOR THE DAMPED LINEARIZED RESPONSE OF A DEFORMABLE STRUCTURE CONTAINING A LIQUID

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ABSTRACT

In the framework of the vibratory study of structures, we propose a method to take into account the coupling with an internal liquid (like a fuel, a cryogenic liquid, etc.). Assuming that the amplitude of the system movements remains small (within the meaning of a linearity criterion), the dynamic response of the viscous incompressible liquid can be represented by an added-mass operator and its first sloshing modes [1], to which modal damping coefficients will be associated in order to take into account the viscous dissipation phenomena in the liquid [2]. The mass, stiffness and damping matrices of this fluid-structure system being unsymmetrical, its left and right coupled eigenmodes are complex but verify certain bi-orthogonality properties. Therefore, they can be used to construct a linear Reduced Order Model (ROM) of the fluid-structure system using Petrov-Galerkin projection. The efficiency of this ROM to compute the frequency or (linearized) time responses of the coupled system will be illustrated on some tank examples (cf Fig. 1). Its convergence to the Full Order Model (FOM), with respect to the number of complex coupled modes considered in the ROM, will also be discussed (cf Fig. 2).

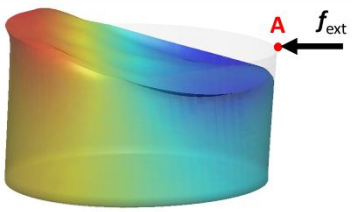
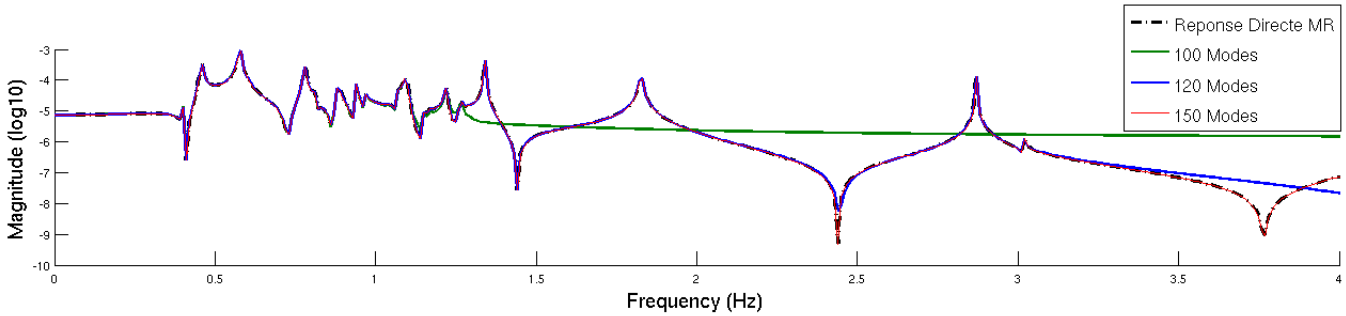


Fig. 1: Example of academic test case (a cylindrical brim-full container clamped on its base)

Fig. 2: Amplitude of the impulse response (liquid pressure fluctuation at point A). Comparison between the FOM (**-.**) and ROMs with 100 (-), 120 (-) and 150 (-) complex modes



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