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Étude de la réponse vibratoire d'une gaine rectangulaire excitée par un écoulement turbulent

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Gas transport ductwork in industrial plants or air conditioning networks can be subject to vibrations induced by the internal flow. Most studies in this matter have been carried out on circular ducts. This paper focuses specifically on the vibratory response of a rectangular duct of finite length excited by an internal turbulent flow. First, a semi-analytical model taking into account the modal response of the structure due to both aerodynamic and acoustic contributions is derived. The aerodynamic component of the flow excitation is given by a Corcos-like model for the wall pressure fluctuations whereas the acoustic component is modeled as duct propagating modes. The wall pressure power spectral density, which is a quantity needed for the model, is determined by measurements and the vibroacoustic response of the structure is measured and given in terms of the space-averaged quadratic acceleration. Experimental results are given for: (i) a $0.2\times0.1\times0.5$ m^3 duct made with 3 mm steel plates excited by a turbulent air flow at different speeds (ii) a rectangular duct used in a aluminium plant excited by a constant speed flow. Comparisons between experimental results and numerical predictions show the presence of propagating modes which magnitude, given as percentage of the aerodynamic pressure field, depends on the frequency and the flow speed.