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The effect of concentrated masses on the response of a plate under a turbulent boundary layer excitation

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ABSTRACT

This work is aimed at the numerical analysis of the vibration response of a plate, carrying one or more concentrated masses, under a stochastic, and convective load. The pressure load is a typical turbulent boundary layer excitation (TBL) and the structural configurations reproduce common experimental situations because the concentrated masses can be considered similar to accelerometer sensors.

The models adopt the Corcos TBL model and the concentrated masses are simulated with the Dirac singularity function. The approximations, introduced with the above assumptions on the concentrated masses, and the necessary numerical accuracy, in calculating the structural responses, are discussed.

The added masses do not lead to a relevant modification of the global structural response but, on the contrary, the results show that the local effects can be relevant: the paper highlights the differences of the vibration responses from the analogous structural configurations under a stochastic load without convective characteristics.

1. Introduction

It is well-known that transducers, used for measuring cinematic quantities, can alter the system dynamic response. Their effect is more relevant as excitation frequency increases: this is one of the most intriguing points of the experimental mechanics.

At the simplest level, one has to carefully consider if the impedance of the system can be influenced from the impedance of the sensor mass and in which frequency band this effect becomes relevant, [1]. The point impedance is fully defined as the ratio of the mechanical force over the velocity of the excited point, $Z=F/v$. The point impedance tends to asymptotical values for increasing excitation frequency and standard formulas are available in literature for both infinite and finite systems for each specific waveguide. For a given pressure distribution on xy plane, $p(x,y)$, the impedance requires more attention since it can be only defined on infinitesimal area

$$dZ=\frac{p(x,y)dxdy}{v(x,y)}, \qquad (1)$$

where the velocity distribution, $v(x,y)$ is needed.

Nevertheless, by using approximated numerical models (e.g. finite element method), it is possible to estimate if the sensor affects the response or which accuracy degree is necessary to highlight the effect, [2,3]. The critical point is the analysis of which type of singularity correctly models the presence of one or more added masses.

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