

Perturbation analysis of a MDOF system equipped a tuned mass damper

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Abstract: Tuned mass dampers (TMD) are commonly used to tame undesired vibrations. Several criteria exist to determine, with some sort of optimality, the parameters of the device in order to reach the desired performance. These criteria are typically expressed in one of the various closed form expressions developed over the past decades and resulting from the analysis of a primary system equipped with a TMD. However several cases of practical interest require taking into consideration the interaction of multiple structural modes of the mutual influence of several dampers. An explicit analytical treatment of a dynamical system with more than 2 DOFs is possible but results in excessively long (and therefore unpractical) equations. In this paper, we invoke the smallness of the added mass(es), with respect to the modal masses in the several (primary) modes of vibration and develop a perturbation method to determine the response of the coupled system. These developments result in neat, short and applicable expressions for the natural frequencies of a multi-DOF structure with one or several TMDs, as well as their responses to narrow- and broad-band excitations. The paper will provide the main steps of the analytical derivation, the important resulting formula and a validation and application of the concepts to a realistic problem.

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