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CALIBRATION OF DAMPERS AND RESONANT VIBRATION ABSORBERS FROM DISCRETIZED STRUCTURAL MODELS

Steen Krenk

Department of Mechanical Engineering, Technical University of Denmark. Building 404, Nils Koppel's Alle, DK-2800 Kongens Lyngby, Denamrk. sk@mek.dtu.dk.

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Undesirable vibrations of instruments, machinery, vehicles and structures are often associated with one or a few potentially resonant modes, and general computational procedures based on discrete structural models are desirable. The present contribution addresses two types of vibration absorbers: a damper that may have elastic components, and resonant vibration absorbers where a mass or inertia element introduces independent vibration characteristics of the device. The procedures are presented with reference to mechanical devices, but are equally applicable to electro-mechanical devices.

A key point is that although the damping device targets a specific resonant mode it will, as a consequence of being a local device, introduce local non-resonant deformation that often influences the combined response and should therefore be accounted for. The local displacements experienced by the device, when mounted on the structure, is expressed in terms of a modal expansion of the structural response, identifying a resonant contribution and a non-resonant part consisting of the contributions from the remaining modes. The goal is to account for the effect of the non-resonant modes, without introducing a full modal analysis.

In the case of the simple damper an approximation to the sum of the non-resonant contributions to the local deformation can be evaluated from a hypothetical situation in which the damper is locked. The frequency of the locked system is determined by a standard vibration analysis of the locked system. By assuming the non-resonant contributions to be equal in the free and locked situations a general cubic equation for the complex vibration frequency is obtained. This cubic frequency leads to an explicit design procedure as well as a generic format for the root locus diagram for the damped vibration frequency. While linearized results have been use for some time, in particular in connection with damping of cable structures, the present theory covers a much larger class of problems, e.g. including beam bending as illustrated.

In the case of resonant damping devices the characteristic equation is already of degree four when neglecting the non-resonant contributions. In that case the non-resonant contribution can be accounted for via an approximate representation as an additional flexibility and inertia term. These can be included to a fair degree of approximation into the parameters of an equivalent resonant device. An explicit calibration procedure is developed in which the equivalent device parameters are determined as for an ideal system, and then modified to account for the presence of the non-resonant local contributions. The procedure offers considerable freedom in the location in the resonant device.

REFERENCES

[1] O.C. Zienkiewicz, O.C. and R.L. Taylor, *The finite element method*. 6th Edition, Elsevier, 2005.

[2] E. Oñate and M. Cervera, Derivation of thin plate bending elements with one degree of freedom per node. *Engng. Comput.*, Vol. **10**, pp. 543–561, 1993.