A robust calibration procedure for multiple electromechanical shunt absorbers on a flexible structure

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ABSTRACT

Electromagnetic and piezoelectric transducers are electromechanical devices that enable conversion between mechanical and electrical energy, whereby they are applicable for vibration damping of mechanical vibrations by the introduction of suitable dissipative shunts. For dynamic problems dominated by resonance, the supplemental pole of a vibration absorber can be precisely synchronized with the target mode of the host structure to effectively mitigate excessive vibrations and add substantial system damping. The present contribution concerns a calibration procedure for multiple resonant shunt absorbers with respect to a specific vibration mode of a flexible structure.

It is initially demonstrated that electromagnetic series RC and piezoelectric parallel RL shunt damping can both be represented by an equivalent mechanical vibration absorber with a spring, dashpot and inerter in series. This particular absorber model also allows for the contribution of intrinsic device damping. A common calibration procedure for these electromechanical shunt absorbers is therefore obtained from this mechanical equivalence, which furthermore includes the influence from the residual vibration modes of the flexible structure via an augmented modal representation of the absorber motion with two additional correction terms [1]. It is demonstrated how the corresponding fictitious absorber parameters are explicitly calibrated from the natural frequencies associated with fully locked absorber dashpots. Furthermore, the mechanical equivalence between the two shunt dampers implies that the electromagnetic shunt can be directly calibrated from well-developed principles derived within the piezoelectric community, and vice versa.

The calibration procedure is finally expanded to multiple vibration absorbers targeting a single resonant vibration mode. The numerical examples demonstrate that accurate and robust absorber calibration is achieved, even for very local absorber locations on a structure with non-oscillatory rigid body modes.

REFERENCES

[1] S. Krenk and J. Høgsberg, “Tuned resonant mass or inerter-based absorbers: unified calibration with quasi-dynamic flexibility and inertia correction”, *Proceedings of the Royal Society A - Mathematical, Physical and Engineering Sciences*, Vol. **472**, paper 20150718 (23pp), (2016).