Structural Control Performance of a Pendulum Damper with Viscoelastic Pounding Effects

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1. Introduction

- The significance of vibration suppression in building structures and pipeline systems is crucial to ensure the longevity of the system and also to prevent catastrophic failures.
- Current solutions to vibration suppression include various passive, active and semi-active dampers. However, the passive control typically has the advantages of mechanical simplicity, effective performance without requiring any external power source. Some of the passive dampers are traditional pendulum style dampers, tuned mass dampers (TMD), tuned liquid dampers (TLDs) and pounding tuned mass dampers (PTMD) with a rigid L-shaped beam.
- The traditional pendulum dampers inherently have light damping to dissipate vibrating energy which results in two worse resonant vibration amplitudes over a wide range of excitation frequencies.

2. Research Goal

- Design a pounding pendulum damper (PPD) consisting of a flexible steel wire, viscoelastic (VE) tapes, and a small tuned mass to increase the damper's damping capacity for effective control performance.
- Conduct a comparative study between a conventional pendulum damper and pounding pendulum damper to evaluate the effectiveness and robustness in vibration suppression on a shear building model.

3. Experimental Setup

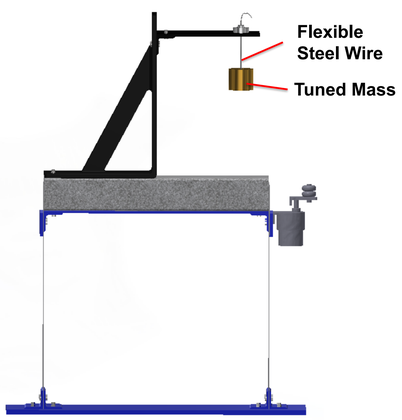

Figure 1. A Conventional Pendulum Damper

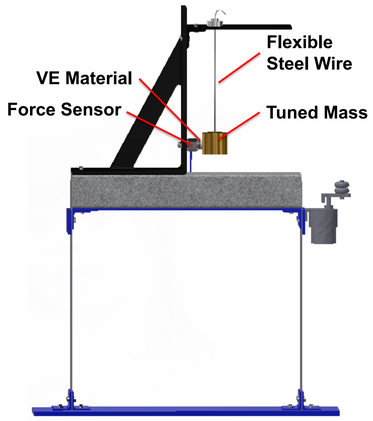

Figure 2. A New Pounding Pendulum Damper

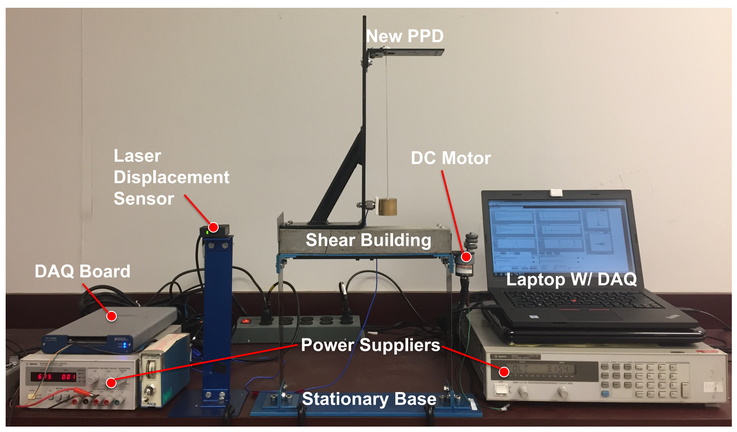

Figure 3. Experimental Testing Setup

4. Experimental Results

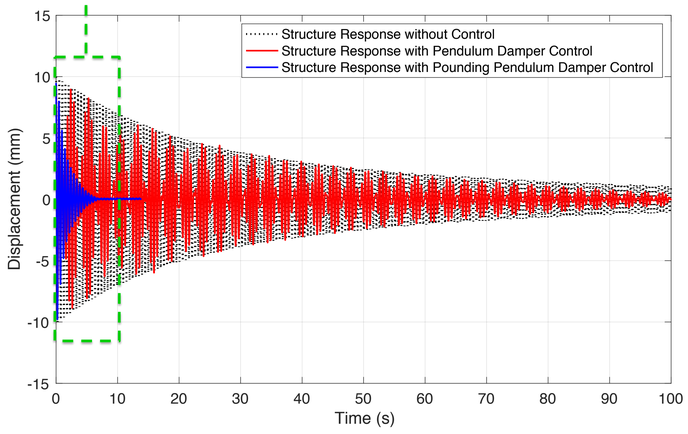

Figure 4. Structural response of free vibration

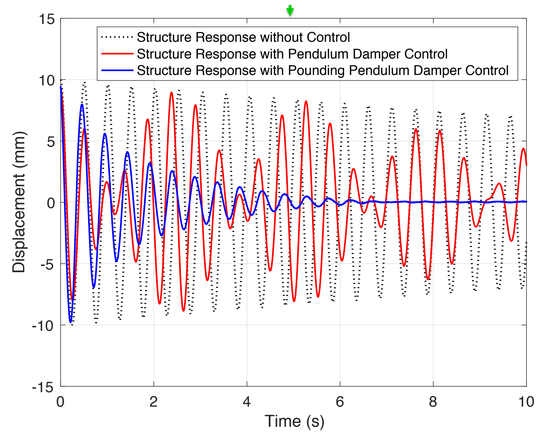

Figure 5. Zoomed-in view of structural response of free vibration

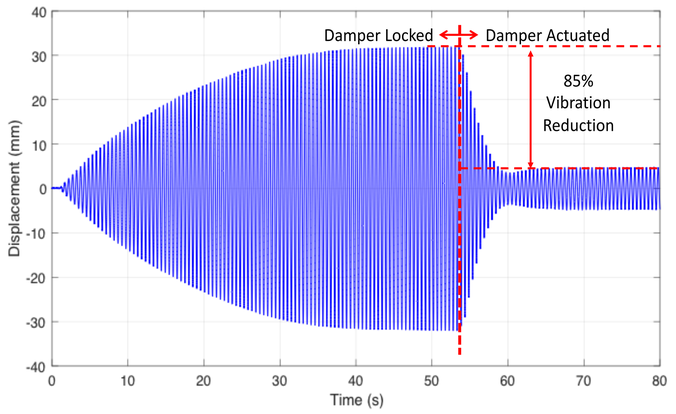

Figure 6. Structural response with and without control of PPD

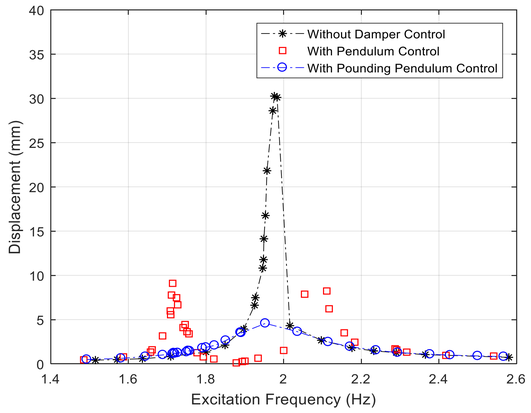

Figure 7. Structural response in frequency domain

5. Viscoelastic Pounding Study

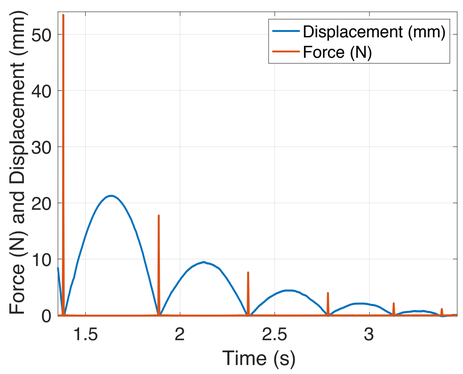

Figure 8. Force vs Displacement During Impact

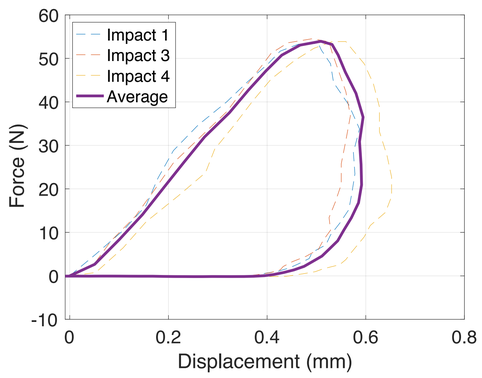

Figure 9. Hysteresis Loop of Pounding Model

6. Conclusions

- This research project explores control performance of a conventional pendulum damper and our newly designed pendulum damper with viscoelastic pounding effects, namely, pounding pendulum damper (PPD).
- Structural vibration responses illustrate the PPD can suppress free vibrations dramatically faster than a conventional pendulum damper.
- PPD can suppress more than 85% of uncontrolled structural vibration motions over a wide range of frequency domain, while the conventional pendulum damper induces two worse resonance peaks.
- Therefore, PPD has been demonstrated to be a more effective and robust structural control device.

Acknowledgements

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