The 2025 World Congress on
Advances in Structural Engineering and Mechanics (ASEM25)
BEXCO, Busan, Korea, August 11-14, 2025

Vibration control of railway systems under train-induced excitations using tuned particle damper

*Chih-Shiuan Lin[1)] and Chia-Ming Wang[2)]

[1), 2)] *Department of Civil Engineering, National Central University, Taoyuan, Taiwan*
[1), *]*Presenter, jasoncslin@ncu.edu.tw*

ABSTRACT

Train-induced vibrations resulting from intensive wheel–rail interactions have long posed significant challenges across mass transit, high-speed rail, and urban light rail systems. However, conventional rail dampers typically operate within narrow frequency bands and are often inadequate for attenuating the broadband vibrations (100–2000 Hz) arising from diverse operational conditions.

Moreover, railways are frequently exposed to harsh environments, which may compromise the durability and effectiveness of traditional damping solutions due to material degradation. To overcome these limitations, this study introduces a tuned particle damper (TPD) specifically designed to suppress high-frequency vibrations in rail systems.

A novel analytical model is developed to characterize the dynamic response of a rail structure coupled with a TPD under train-induced loading. The model formulation is derived from the system's equations of motion, accounting for the coupled interaction between the rail and the particle-filled cavity. A comprehensive parametric analysis is conducted to examine the influence of key TPD design parameters, with results validated against experimental measurements. The findings confirm that the proposed TPD system effectively mitigates excessive rail displacement responses, offering a robust solution to reduce broadband vibrations caused by wheel–rail interactions.

[1)] Assistant Professor
[2)] Graduate Student