Dynamic performance of vibration absorbers for low-frequency vibration isolation systems

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The present study introduces a novel mass-spring system utilizing a well-designed polyurethane pad vibration isolator conceptually designed as a floating slab track structure. The floating slab track is considered one of the most efficient countermeasures for attenuating the vibration impacts of underground high-speed railways. The dynamic performance of the polyurethane slab track structure was studied and compared with the steel-spring floating slab track using a conventional mathematical approach based on the principle of influence lines. The study examines vibration isolation performance under dynamic vehicle loads at speeds ranging from 180 to 300 kmph. Results indicate a significant reduction in slab dynamic responses with increasing speed. Both systems demonstrate excellent vibration-damping ability, with the steel mass-spring system being approximately 18% more efficient in vibration reduction than the polyurethane mass-spring system.

Keywords: Deflection, fatigue, natural frequency, stiffness, stress, vibration attenuation.

advanced mitigation theory into civil engineering, initiating subsequent studies on structural vibration isolation.

HSR has specific attributes, constraining its use to higher speeds, heavy load distribution, and laying track structures on bridges, tunnels, etc. The high-magnitude vibrations caused by HSRs can be monitored at various stages throughout the direction of wave propagation from the source to the receiver end[5,6]. In most cases, the most practicable means of vibration mitigation is at the source, which is the track structure itself, achieved by modifying track characteristics and/or incorporating elastic bearings into the track[7–10]. One of the most vital vibration mitigation measures adopted at the source is using ballastless slab tracks with very low stiffness, commonly utilized in HSR corridors[7]. In this study, we consider one such ballastless slab structure, namely the floating slab track (FST). FSTs are generally designed using two important damping materials: steel springs (SS) and rubber/polyurethane (PU) pads[1,2,11–13]. With a sequence of SS isolators and PU pads, these FSTs support the second-stage concrete, also known as the