RESEARCH ON THE DESIGN OF ANTI-SEISMIC DEVICES FOR RAILWAY BRIDGES IN HIGH-INTENSITY EARTHQUAKE AREAS AND THEIR COLLABORATIVE WORKING MECHANISM

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Extended Abstract

Southwest China features a complex geographical environment with variable and fragile geological structures, containing multiple major structural zones and seismic fault zones, where seismic intensity is high and earthquakes occur frequently. Therefore, this report selects a simply-supported T-beam railway bridge project near a fault in Yunnan Province for research. The bridge site is located in an 8-degree seismic zone with a peak ground acceleration of 0.3g, where the site period is 0.65 s. The abutment is approximately 48 m away from the boundary of the influence range of the active fault identified by geological professionals, making it a typical near-fault bridge in a high-seismic-intensity area.

This report focuses on an in-depth investigation of seismic isolation and mitigation design objectives, durability design of seismic isolation and mitigation devices, experimental research, and engineering application practices for simply-supported T-beam railway bridges near faults in high-seismic-intensity regions.

For simply-supported T-beam railway bridges, the installation positions of seismic isolation and mitigation devices are limited. In addition, the energy-dissipation performance of friction pendulum bearings is uncertain under vertical seismic excitation, and negative reaction forces may even occur, posing a risk of beam falling. Accordingly, combined with complex characteristics unique to near-fault strong ground motions such as long periods and large velocity pulses, this report proposes a combined seismic isolation and mitigation system consisting of friction pendulum bearings and multi-directional energy-dissipating steel dampers. Theoretical analysis shows that this system can effectively reduce the seismic displacement response of the beam body.

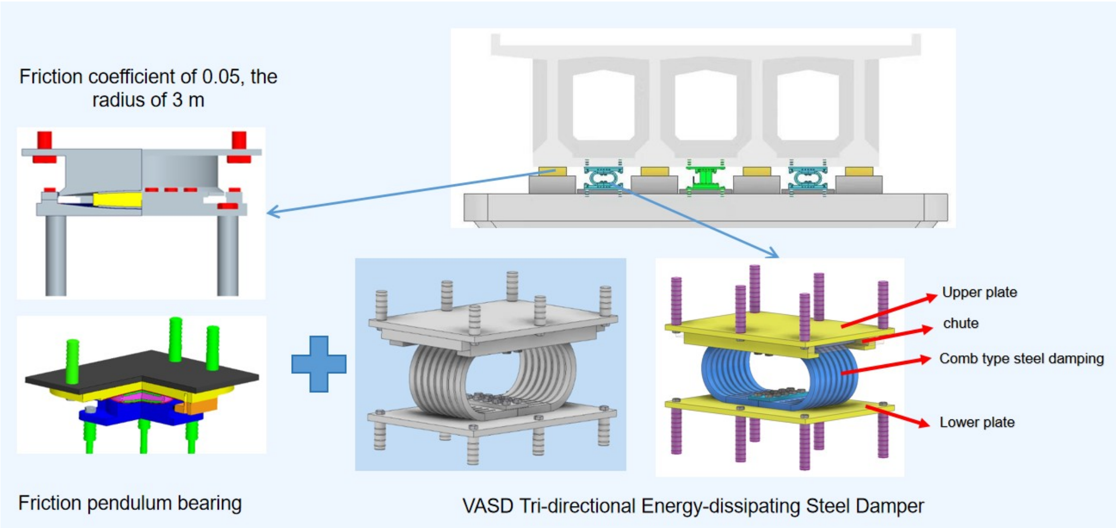
Regarding friction pendulum bearings, starting from their primary materials, this report deeply discusses durability design methods of friction pendulum bearings

suitable for railway bridges and conducts extensive experimental verification, aiming to ensure the long-term service performance of friction pendulum bearings under harsh mountainous environments and their reliability under extreme seismic loads.

For multi-directional energy-dissipating steel dampers, an innovative new tri-directional energy-dissipating steel damper is successfully developed. Centered on this new device, this report systematically and comprehensively carries out theoretical research, numerical simulation, and full-scale model test verification on its seismic energy-dissipation performance to fully evaluate its effectiveness.

Furthermore, through theoretical modeling analysis and a series of tests, this study deeply analyzes the cooperative working mechanism between friction pendulum bearings (as isolation components) and the new tri-directional energy-dissipating steel dampers (as damping components), intending to profoundly reveal the dynamic interaction law and energy transfer-distribution mechanism between bridge isolation systems and damping systems under near-fault earthquakes of high seismic intensity.

Finally, this report summarizes and extracts a complete set of design concepts and working mechanisms for the cooperative operation of isolation and damping measures, providing more solid and reliable theoretical basis, design methods, and valuable engineering-technical references for seismic analysis and durability design of seismic isolation and mitigation systems of near-fault railway bridges in high-seismic-intensity zones.



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