National Conference on Advanced Research in Science, Engineering, Management and Humanities
(NCARSEMH – 2025)
27th July, 2025, Jharkhand, India.

CERTIFICATE NO : NCARSEMH /2025/ C0725749

Optimization And Reliability-Based Design of FPS And SMA-FPS Seismic Isolation Systems Using Advanced Optimization Techniques

Oza Jyoti Omprakash
Research Scholar, Department of Civil Engineering, Vikrant University, Gwalior, M.P.

ABSTRACT

Seismic isolation systems play a critical role in mitigating the adverse effects of earthquakes on civil infrastructure by reducing structural responses and enhancing overall resilience. Among the various isolation technologies, the Friction Pendulum System (FPS) and the Shape Memory Alloy-Enhanced Friction Pendulum System (SMA-FPS) have demonstrated superior energy dissipation, self-centering capability, and seismic performance. However, the optimal design of these systems remains challenging due to the nonlinear behavior of isolation devices, uncertainties in seismic loading, and the conflicting objectives of maximizing structural safety while minimizing cost and displacement demands. This research proposes a comprehensive framework for the optimization and reliability-based design of FPS and SMA-FPS seismic isolation systems using advanced optimization techniques. The framework integrates deterministic optimization algorithms with Reliability-Based Design Optimization (RBDO) to identify optimal design parameters while explicitly accounting for uncertainties in material properties, structural characteristics, and earthquake ground motions. Design variables such as friction coefficient, pendulum radius, stiffness, damping ratio, and SMA properties are optimized subject to performance constraints, including inter-story drift, base displacement, floor acceleration, and structural reliability indices. The effectiveness of the proposed methodology is evaluated through nonlinear dynamic analyses under a suite of recorded earthquake motions. Comparative assessments between conventional FPS and SMA-FPS systems are conducted to investigate improvements in seismic performance, reliability, and robustness. The results are expected to demonstrate that integrating advanced optimization algorithms with RBDO produces safer, more economical, and more resilient seismic isolation designs by achieving an optimal balance between structural performance and reliability under uncertain seismic conditions. The proposed framework provides valuable guidance for engineers and researchers in the design of next-generation seismic isolation systems for earthquake-resistant structures.

Keywords: *Reliability-Based Design Optimization, Friction Pendulum System, Shape Memory Alloy Friction Pendulum System, Seismic Isolation. Advanced Optimization Techniques.*