Procedure for rapid performance optimization of structures with advanced seismic protection systems (DAMPRO)

SCOPE

DAMPRO Project aims to develop performance-based design processes for advanced structural systems that employ modern seismic protection technologies

SUMMARY

Current building design according to seismic codes has as main objective the protection of human life, but not the structural and non-structural integrity of the building, which leads to significant, often irreparable material losses in the event of an earthquake. As real-estate investors increasingly recognize this situation, the demand grows for advanced structural solutions for seismic protection that can prevent, or at least limit, structural damage during an earthquake. Among the best-known advanced seismic protection systems are base isolation, energy dissipation using viscous dampers, and tuned mass dampers. Despite their potential, these advanced seismic protection systems are very rarely used in practice, especially in Romania, due to the complexity of the design process within a competitive market. This project targets the advancement of seismic resilience by developing performance-based design processes for structural systems, incorporating advanced seismic protection technologies. Acknowledging that current seismic codes prioritize human safety but often overlook the material losses due to structural and nonstructural damages, there's a growing demand for solutions that can prevent or minimize such damages. This initiative aims to bridge this gap by creating a software tool for rapid performance evaluation of seismic protection systems, utilizing condensed dynamic models, and establishing a multi-criteria performance decision matrix (structural and non-structural) to streamline the design process and identify economically viable advanced solutions. By combining the expertise of Popp & Asociații SRL and University Politehnica Timișoara, the project seeks to address the technical complexities of the design process, ensuring the deployment of reliable, cost-effective seismic protection solutions. The outcomes are expected to significantly enhance building safety and sustainability in seismic events.

RESEARCH TEAM

Popp & Asociații (Coordinator)

Politehnica University of Timisoara (Partner)

IMPLEMENTATION PERIOD

08.01.2025 – 31.12.2026

OBJECTIVES

- Identification of structural and non-structural performance criteria for the integrated evaluation of structural systems.
- Development of a software tool for the rapid assessment of the performance of advanced seismic protection systems, based on condensed dynamic models with one and multiple degrees of freedom.
- Development of pre-selection matrices for advanced seismic protection systems using multi-criteria (structural and non-structural) performance, enabling the cost-effective identification of optimal solutions.
- Development of technical data sheets for structures equipped with advanced seismic protection systems, in order to increase productivity and reduce design time.

RESULTS

- Twelve structural archetypes were defined (common building configurations of medium- and high-rise buildings, located in two distinct seismic hazard zones and realized with three representative structural systems: moment-resisting steel frames, concentrically braced steel frames, and reinforced concrete shear wall structures).
- Relevant performance criteria were established (related to overall structural response, protection of non-structural elements, and post-earthquake functionality requirements).
- Design seismic action parameters were defined in accordance with current regulations.
- Simplified design procedures were formulated for each type of structural system.
- The twelve archetypes were designed and then evaluated using advanced analysis methods, aiming to verify both structural compliance and the adequacy of the adopted performance criteria and design parameters.
- A design data sheet was prepared for base isolation systems, intended for subsequent use in the project for configuring and comparing different seismic protection solutions.
- Simplified single-degree-of-freedom equivalent models were developed for the considered archetypes; these models will be used in the next stage for extensive parametric analyses and for applying the proposed rapid optimization procedure.

PUBLICATIONS

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- Boloș, B.-F., and Stratan, A. (2025). The Effects of the New Eurocode 8 Provisions on the Seismic Performance of Steel MRFs. Proceedings of the International Colloquium on Stability and Ductility of Steel Structures (SDSS 2025), 8-10 September 2025, Barcelona, Spain.
- Stratan, A., Chesoan, A., and Voica, T.-F. (2025). Performance assessment of steel moment-resisting frames using equivalent single-degree of freedom models. The 20th International Scientific Conference CIBv - Civil Engineering and Building Services 2025 (CIBv2025), 6-7 November 2025, Brașov, România.
- Stratan, A., and Boloș, B.-F. (2025). The effect of the EN1998-1-2:2025 provisions on the design and performance of steel MRFs. The joint ECCS TC13 and CEN/TC 250/SC8/WG2 Meeting, Yeditepe University, Istanbul, Turkey, 16 October 2025.

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