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Subject: Evaluation of the PhD Dissertation of Mr. Farzin Kazemi - Seismic retrofitting strategies for buildings using innovative approaches

The PhD thesis by Farzin Kazemi evaluates the topic of seismic retrofitting of existing buildings, with a multi-level approach based on analytical methods, experimental tests, and the application of modern AI data-driven techniques. The work is in my opinion very well-written and structured.

The thesis is a dissertation referred to ten peer-reviewed scientific papers, with a preliminary description of the background, objectives, methodology and conclusions. Overall, the work shows a high level of scientific maturity and a familiarity with the current state of the art by the candidate The research framework is logically organized, with a progression from basic aspects related to the definition of the seismic performance of steel and rc buildings towards the development of innovative mitigation strategies and predictive tools based on machine learning.

Even if the opinion is generally very positive, the work of thesis would benefit from more extensive validation in order to clearly demonstrate the robustness of the proposed surrogate AI models. One of the main original aspects of the thesis is the use of a combination of advanced tools and the development of a wide number of different research topics such as soil–structure interaction, pounding, influence of semi-rigid connections, shape memory alloys, novel dissipative devices and machine learning techniques. However, the wide scope of the thesis also creates some challenges in maintaining a focused research narrative.

Below, some detailed comments are provided.

Introduction (Chapter 1)

- Page 7: The motivation for seismic retrofitting is clearly presented and well aligned with current challenges in earthquake engineering. It would nevertheless be beneficial to articulate the main scientific gap more explicitly already in the last paragraph of this section, instead of postponing it almost entirely to the Objectives chapter.

- Page 9: The description of the considered structural systems (SMRFs, RC MRFs, BRBFs, IMWs and RCSWs) is comprehensive. However, the text occasionally mixes research motivation with methodological explanations. A clearer separation between "problem statement" and "methodological contribution" would improve readability.

Objectives and scope (Chapter 2)

- Page 12: The objectives are generally well defined, although they remain somewhat broad. Given the cumulative nature of the dissertation, it would be helpful to define specific subobjectives linked to the main thematic groups of papers (pounding, SSI, SMA, ML), in order to make the overall structure more transparent.
- Page 13: The description of the candidate's personal contribution is detailed and convincing. A short critical reflection on the main limitations of the performed studies would further strengthen the scientific maturity of the work.

Methodology and modelling (Chapter 3)

- Pages 14–19: The technical descriptions are generally clear and the modelling choices are appropriate. The treatment of semi-rigid connections and soil–structure interaction is particularly relevant. Nevertheless, a brief comparative justification of the selected models (e.g. Ibarra–Medina–Krawinkler) with respect to alternative formulations would be useful.
- Pages 22–24: The hysteretic behaviour of the proposed seismic damper is described in detail, but it is not fully demonstrated whether the obtained response can be considered optimal. A broader discussion on this aspect would help to clarify the limitations of the proposed solution.
- Pages 27–32: The machine-learning workflow is well structured and clearly presented. A short discussion regarding possible overfitting and extrapolation outside the training domain would further improve this section.

The following aspects related to the presented papers could be better justified in the general part of the thesis.

Paper I: Seismic probabilistic assessment of steel and reinforced concrete structures including earthquake-induced pounding

The paper addresses a relevant problem, but some methodological aspects would benefit from further clarification and critical discussion. Although the modelling of contact elements is accurate, the paper does not fully justify the selected pounding stiffness and damping parameters, nor does it provide a sensitivity analysis to demonstrate how variations in these parameters influence the final fragility curves.

The set of selected ground motions used in the nonlinear time-history analyses could be better characterized in terms of pulse-like effects, near-fault characteristics, and spectral shape variability.

The paper would significantly benefit from validation against independent numerical benchmarks or experimental case studies reported in the literature. In this context, a more explicit discussion of the adopted modelling strategy in relation to previously validated approaches by other researchers would strengthen the credibility of the proposed methodology.

Paper II: Optimal retrofit strategy using viscous dampers between adjacent RC and SMRFs prone to earthquake-induced pounding

This paper represents a logical continuation of the first study and shifts the focus from assessment to mitigation. The idea of using fluid viscous dampers installed between adjacent buildings is well justified and clearly motivated. The optimization strategy adopted in the paper is technically correct and well implemented.

Particularly valuable is the comparison between linear and nonlinear viscous dampers and the attempt to balance performance improvement with economic considerations. The paper would benefit from a more systematic identification and discussion of the critical design parameters governing the effectiveness of the viscous dampers, such as the optimal damping coefficient, velocity exponent, maximum stroke capacity, and force–velocity relationship under different seismic demand levels. A clearer sensitivity analysis of these parameters would strengthen the practical design relevance of the proposed retrofit strategy.

Paper III: Enhancing seismic performance of rigid and semi-rigid connections equipped with SMA bolts incorporating nonlinear soil-structure interaction

This paper focuses on semi-rigid behavior and nonlinear soil–structure interaction. The introduction of shape memory alloy bolts represents a clear element of originality. The numerical modelling is well executed and the parametric analyses are meaningful; however, the experimental or independent validation of the proposed models appears to be relatively limited, and this aspect could be further strengthened. One possible improvement would be to more explicitly discuss the economic feasibility of SMA solutions in real structures.

Paper IV: Probabilistic assessment of SMRFs with infill masonry walls incorporating nonlinear soil-structure interaction

This study addresses the complex interaction between steel frames and infill masonry walls, which are often treated in an oversimplified manner in design practice. The framework and the integration of soil–structure interaction effects are scientifically sound and well-motivated. The modelling of infill walls using nonlinear strut-based representations is appropriate and supported by validation studies.

A valuable aspect of this paper could be the consideration of different configurations of infill openings (e.g. windows, doors, etc.). A potential limitation is that the variability of masonry material properties is not fully explored, despite the fact that in real structures such properties are often highly scattered. Moreover, the influence of construction details, such as the actual connection conditions between frame and infills, the possible presence of gaps, and the regular or irregular layout of openings, could have been more extensively investigated, as these aspects may significantly affect the global seismic response.

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Paper V: Enhancing seismic performance of steel buildings having semi-rigid connections with infill masonry walls considering soil type effects

This paper extends the work of Paper IV by integrating connection rigidity. The multi-parametric nature of the study is a strong point, as it addresses the realistic complexity of structural behavior. The development of a graphical user interface for practical use is especially commendable and demonstrates a strong orientation toward engineering applications.

However, the proposed retrofit philosophy appears not fully optimized from a reparability-oriented perspective, as the introduction of infill masonry walls, inherently brittle elements, into steel structural systems, which should be intrinsically ductile, may compromise post-earthquake reparability and damage control objectives. This important aspect could be more explicitly discussed in comparison with alternative retrofit solutions based on more ductile or replaceable systems.

Paper VI: Seismic performance evaluation of steel buckling-restrained braced frames including SMA materials

This paper focuses on buckling-restrained braced frames and the innovative use of SMA materials. The concept is original and aligned with current research trends in smart materials and resilient structures. The analytical modelling is consistent and the performance indicators are well chosen. The study convincingly shows the potential of SMA materials to reduce residual drifts. The paper could benefit from a broader discussion on the scalability of the proposed solutions to real structures and the cost–benefit balance.

Paper VII: Development and experimental validation of a novel double-stage yield steel slit damper-buckling restrained brace

This paper is one of the most technically valuable parts of the dissertation due to its strong experimental component. The design, fabrication, and testing of a novel dissipative device demonstrate a high level of experimental skill and engineering creativity. The cyclic test results are clearly presented and properly interpreted.

The optimization of geometric configurations is systematic and convincing. However, the hysteretic behavior of the proposed seismic damper is clearly described, but it is not sufficiently demonstrated whether the obtained hysteretic response can be considered optimal. A wider discussion on this aspect would be very useful to understand the limitations of the work also comparing with other systems.

Paper VIII: Machine learning-based prediction of seismic limit-state capacity of steel moment-resisting frames considering soil–structure interaction

This paper introduces machine learning as a predictive tool for seismic performance assessment. The motivation is clearly explained, and the selected algorithms are appropriate for the engineering problem. The integration of soil–structure interaction into the ML framework is an innovative aspect.

The quality of the dataset and the chosen performance metrics are satisfactory. A potential limitation is the transferability of the trained models to structures with significantly different geometries or construction practices. This aspect should be further discussed in the thesis.

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Paper IX: Machine learning-based seismic response and performance assessment of reinforced concrete buildings
This study further develops the ML framework for reinforced concrete structures. The size of the dataset and the systematic hyperparameter tuning represent strong methodological points. The proposed GUI tool enhances the practical usability of the research results.
The paper successfully demonstrates the potential of ML models to surrogate traditional nonlinear dynamic analyses. A minor weakness is that uncertainty quantification could be explored more deeply.

Paper X: Optimization-based stacked machine-learning method for seismic probability and risk assessment of reinforced concrete shear walls
This paper represents an advanced and ambitious contribution combining stacked machine learning and optimization techniques. The methodological complexity is high, yet the presentation remains clear and structured.
The development of automated hyperparameter optimization and the generation of fragility curves through ML models is particularly innovative. A potential improvement would be to compare the proposed method with more traditional probabilistic seismic risk tools.

Final evaluation
The doctoral dissertation of Mr. Farzin Kazemi represents an original and methodologically sound work. The candidate has demonstrated a high level of independence and a clear capacity to combine numerical, experimental and data-driven approaches within a coherent research framework.

In my judgement, the dissertation satisfies the formal and scientific requirements for the award of the PhD degree, provided that the above comments are taken into account. Considering the high level of the work performed and the very advanced skills of the candidate ***I recommend also a distinction for the doctoral dissertation.***

Salerno, Italy, 28/11/2025

Prof. Massimo Latour