

Al Mouayed Bellah Nafeh

SENIOR NATURAL CATASTROPHE SPECIALIST

Profile

Earthquake engineer and vulnerability specialist with 5+ years of experience in developing, calibrating, and validating vulnerability models for buildings and infrastructure exposed to natural hazards. Passionate about multi-region vulnerability modeling to support well-informed risk transfer strategies across residential, commercial, and industrial lines of business.

Demonstrated ability to bridge academic research and (re)insurance applications. Solid analytical and programming background (Python, R), with hands-on expertise in FEM modeling (OpenSeesPy) and regional hazard and risk calculators (OpenQuake).

Employment History

Physical Vulnerability Lead, GEM Foundation, Pavia, Italy

OCT 2023 — PRESENT

Institutional Activities

- **Lead developer** and maintainer of GEM's flagship Global Vulnerability Model, covering 1,500+ regional building classes across 12 global regions and encompassing as-built, retrofitted, state-dependent (damage-accumulation under earthquake sequences), and tectonic-regime–specific loss empirically calibrated analytical models.
- **Lead developer** of country-scale models for the United States (with USGS), Canada (with NRCan), Morocco (with FSEC and AtlanticRe), Uganda (National Building Review Board), and Taiwan (TEM).
- **Lead developer** and **maintainer** of GEM's OpenQuake Vulnerability Modellers' Toolkit (OQ-VMTK), a standardized and open-source modelling engine and library of probabilistic model development for earthquake vulnerability applications.
- **Support** the development of GEM's Global Embodied Carbon region-exposure and vulnerability models; the International Macroseismic Scale (IMS25) for standardized empirical damage data collection.

Commercial Activities

- **Vulnerability Modeler - GEM Foundation / Zurich Insurance Group**
  - Developed NAICS-classified vulnerability models for Industrial LOB vulnerability (Europe & South America), including loss to structural, non-structural, contents/business-inventory, and business-interruption components.
  - Developed NAICS-classified vulnerability models for commercial buildings (AIPAC) covering loss of property (structural + non-structural), contents, business inventories, and business interruption.
  - Developed an exposure-informed vulnerability aggregation service to propagate primary-modifier uncertainty to assess portfolio-level vulnerability efficiently.
  - Support the development of dedicated vulnerability models for high-rise buildings (AIPAC).
  - Support the development of a motor vulnerability model based on collapse volumes and debris-impact analysis.
  - Developed a service for calculating post-loss amplification factors on national and sub-national levels using stochastic event sets and event loss

Details

Pavia 27100
Italy
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Skills

Analytical Thinking Skills

Principles and Practices of Engineering

Creative Problem Solving

Languages

Arabic

English

French

Italian

Portuguese

Hobbies

Skiing, Hockey, Padel, Football, Chess, Music,

tables capturing demand surge and social-inflation effects directly relevant to insured-loss estimation.

- **Exposure Modeler - GEM Foundation/ JBA/ World Bank Pacific Alliance**
  - Updated and extended national exposure models to current replacement values and structural attributes to support flood-risk financial-impact modeling for four Latin American economies (Chile, Colombia, Mexico, Peru).
- **Risk Modeler - GEM Foundation/ Arup/ LAPI-ITB/ Kota Kita**
  - Selected and adapted vulnerability models for the local building stock and ran end-to-end risk computations for earthquake peril in the OpenQuake engine.
- **Seismic Risk Researcher - GEM Foundation/ METIS**
  - Quantified annual probability of failure for critical events to nuclear facilities, integrating probabilistic seismic hazard and fragility analyses across a European nuclear power plants inventory.
  - Synthesized literature on acceptable failure probabilities for both conventional and critical structures, and generated risk-targeted maps to support emerging topics in structural resilience and next-generation code standards.

Education

Ph.D. in Earthquake Engineering, IUSS Pavia (Scuola Universitaria Superiore Pavia), Pavia

OCT 2019 — MAY 2023

Thesis: *Advancements in Risk- and Loss-Based Methodologies for Large-Scale Assessment of Non-Ductile Infilled Reinforced Concrete Buildings.*

- Numerical modeling of archetype RC buildings across multiple seismic-code generations, capturing the impact of code-era design on vulnerability.
- Developed simplified seismic risk and loss assessment procedures (PB-RISK, PB-LOSS) intended for code implementation.
- Built analytical fragility and vulnerability models for existing Italian RC stock, benchmarked against empirical fragility models from observed damage data.
- Generated ground-motion fields for Italian earthquake scenarios using both conventional and next-generation intensity measures, with implications for hazard–vulnerability consistency in loss modeling.
- Delivered loss models for the economic loss assessment of building classes.

M.Sc in Earthquake Engineering and Engineering Seismology, IUSS Pavia / Grenoble Alpes, Pavia - Grenoble

SEPT 2015 — MAY 2017

B.Sc. in Civil and Environmental Engineering, University of Balamand, Tripoli, Lebanon

SEPT 2011 — JUN 2015

Journal Articles

- **Nafeh, A.M.B.,** Aljawhari, K., Silva, V., Ettorre, A., Crowley, H. (2026) OQ-VMTK: An Open-Source Toolkit for Earthquake Vulnerability Modelling Applications, Earthquake Spectra (*In Press*)
- **Nafeh, A.M.B.,** Aljawhari, K., Silva, V. (2026) A New Global Vulnerability Model for Regional Seismic Risk Assessments: Part 2 – Non-Structural and Building Contents Vulnerability, Bulletin of Earthquake Engineering (*In Press*)

- Aljawhari, K., **Nafeh, A.M.B.,** Silva, V. (2026) A New Global Vulnerability Model for Regional Seismic Risk Assessments: Part 1 – Structural Vulnerability, Bulletin of Earthquake Engineering (*In Press*)
- Taherian, A., Silva, V., **Nafeh, A.M.B.,** O'Reilly, G.J. (2026) OQ-VMTK: Digital Twins for Post-Earthquake Loss Assessment of Building Portfolios, Earthquake Spectra (*In Press*)
- Caruso, M., Silva, V., Aljawhari, K., Nafeh, A.M.B., & Galasso, C. (2026) Unveiling the environmental impact of earthquakes in Europe. Nature Communications, 17, 1366. https://doi.org/10.1038/s41467-025-68120-6
- **Nafeh, A.M.B.**, & O'Reilly, G.J. (2024). Fragility functions for non-ductile infilled reinforced concrete buildings using next-generation intensity measures based on analytical models and empirical data from past earthquakes. Bulletin of Earthquake Engineering, 22(10), 4983–5021. https://doi.org/10.1007/s10518-024-01955-4
- **Nafeh, A.M.B.**, & O'Reilly, G.J. (2024). Simplified pushover-based seismic loss assessment for existing infilled frame structures. Bulletin of Earthquake Engineering, 22(3), 951–995. https://doi.org/10.1007/s10518-023-01792-x
- O'Reilly, G. J., **Nafeh, A.M.B.**, & Shahnazaryan, D. (2023). Simplified tools for the risk assessment and classification of existing buildings. Procedia Structural Integrity, 44, 1744–1751. 10.1016/j.prostr.2023.01.223
- **Nafeh, A.M.B.**, & O'Reilly, G.J. (2023). Simplified pushover-based seismic risk assessment methodology for existing infilled frame structures. Bulletin of Earthquake Engineering, 21(4), 2337–2368. https://doi.org/10.1007/s10518-022-01600-y
- **Nafeh A.M.B.**, O'Reilly, G.J., (2022) Unbiased simplified seismic fragility estimation of non-ductile infilled RC structures. Soil Dynamics and Earthquake Engineering. https://doi.org/10.1016/j.soildyn.2022.107253
- O'Reilly G.J., Monteiro, R, **Nafeh A.M.B.**, Sullivan T.J., Calvi G.M. Displacement-based framework for simplified seismic loss assessment. Journal of Earthquake Engineering, 24:sup1, 1-22, https://doi.org/10.1080/13632469.2020.1730272
- **Nafeh A.M.B.**, O'Reilly G.J., Monteiro R. (2020) Development of a seismic social vulnerability model for Northern Algeria. International Journal of Disaster Risk Reduction, 50:101821, DOI:10.1016/j.ijdrr.2020.101821
- **Nafeh A.M.B.**, O'Reilly G.J., Monteiro R. (2020) Simplified seismic assessment of infilled RC frame structures. Bulletin of Earthquake Engineering; 18(4): 1579–1611. 10.1007/s10518-019-00758-2

Conference Proceedings

- **Nafeh, A.M.B.**, Aljawhari, K., Silva, V. (2026) A comprehensive global vulnerability model for improved earthquake loss modelling. Proceedings of the 18th European Conference on Earthquake Engineering (ECEE26), Berlin, Germany.
- Aljawhari, K., Caruso, M., **Nafeh, A.M.B.**, Silva, V. (2026) A new database of seismic vulnerability functions for carbon emissions in Europe. Proceedings of the 18th European Conference on Earthquake Engineering (ECEE26), Berlin, Germany.
- Caruso, M., Aljawhari, K., **Nafeh, A.M.B.**, Silva, V., Galasso, C. (2026) A new global embodied-carbon seismic risk model. Proceedings of the 18th European Conference on Earthquake Engineering (ECEE26), Berlin, Germany.
- Narlitepe, F., **Nafeh, A.M.B.**, Aljawhari, K., Silva, V. (2026) Towards a state-dependent fragility and vulnerability model database for earthquake sequence risk assessment. Proceedings of the 18th European Conference on Earthquake Engineering (ECEE26), Berlin, Germany.
- Anirudh, R., Borozan, J., **Nafeh, A.M.B.**, Yepes-Estrada, C., Silva, V. (2026)

Benchmarking GEM's global seismic risk model through historical scenarios Proceedings of the 18th European Conference on Earthquake Engineering (ECEE26), Berlin, Germany.

- Taherian, A., Silva, V., **Nafeh, A.M.B.**, O'Reilly, G.J. (2026) On the digital twins for post-earthquake loss assessment of building portfolios. Proceedings of the 18th European Conference on Earthquake Engineering (ECEE26), Berlin, Germany.
- Aljawhari, K., Caruso, M., **Nafeh, A.M.B.**, Silva, V., Galasso, C. (2026) Evaluating the carbon footprint of earthquakes in Europe. 13th National Conference on Earthquake Engineering (13NCEE), Portland, Oregon.
- Narlitepe, F., **Nafeh, A.M.B.**, Aljawhari, K., Silva, V. (2026) Advancing state-dependent models for earthquake sequence risk assessments. 13th National Conference on Earthquake Engineering (13NCEE), Portland, Oregon.
- **Nafeh, A.M.B.**, Aljawhari, K., Silva, V. (2026) A new global vulnerability model for regional seismic risk assessments. 13th National Conference on Earthquake Engineering (13NCEE), Portland, Oregon.
- **Nafeh, A.M.B.**, Aljawhari, K., & Silva, V. (2025). An open-source toolkit for seismic vulnerability assessment. COMPDYN 2025- 10th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Rhodes, Greece.
- Aljawhari, K., **Nafeh, A.M.B.**, & Silva, V. (2025). A new global database of seismic vulnerability models for improved regional risk assessments. COMPDYN 2025- 10th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Rhodes, Greece.
- O'Reilly, G.J., **Nafeh, A.M.B.**, Ozsarac, V., & Silva, V. (2025). Comparing fragility functions derived from simplified analytical models to those developed with empirical data from past earthquakes. COMPDYN 2025- 10th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Rhodes, Greece.
- Taherian, A., Silva, V., **Nafeh, A.M.B.**, O'Reilly, G.J., & Vicente, R. (2025). Rapid Earthquake Loss Assessment through Digital Twins: A Machine Learning and Sensor-Based Approach. COMPDYN 2025- 10th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Rhodes, Greece.
- O'Reilly, G.J., & **Nafeh, A.M.B.** (2024). Analytical and empirical fragility functions for regionally assessing non-ductile infilled frames. 18th World Conference on Earthquake Engineering, Milan, Italy.
- O'Reilly, G.J., & **Nafeh, A.M.B.** (2024). PB-LOSS: A future candidate for seismic risk classification guidelines. 18th World Conference on Earthquake Engineering, Milan, Italy.
- **Nafeh, A.M.B.**, O'Reilly G.J. (2023) Towards the assessment and risk classification of existing building typologies using storey-loss functions. ICASP14 - 14th International Conference on Applications of Statistics and Probability in Civil Engineering, Dublin, Ireland.
- **Nafeh A.M.B.**, O'Reilly G.J. (2023) Fragility function uncertainty quantification in infilled RC frame buildings. COMPDYN 2023 - 9th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, Athens, Greece.
- O'Reilly, G.J., **Nafeh, A.M.B.**, & Shahnazaryan, D. (2023). Simplified tools for the risk assessment and classification of existing buildings. Procedia Structural Integrity, 44, 1744–1751. https://doi.org/10.1016/j.prostr.2023.01.223
- O'Reilly G.J., **Nafeh A.M.B.** (2022). Towards improved response quantification of existing infilled RC frames. 3rd European Conference on Earthquake Engineering & Seismology, Bucharest, Romania
- **Nafeh A.M.B.**, O'Reilly, G.J. (2022) Simplified Seismic Risk Assessment of Non-Ductile Infilled RC Frame Buildings. 3rd European Conference on Earthquake Engineering & Seismology, Bucharest, Romania.

- O'Reilly, G.J., Shahnazaryan, D., **Nafeh A.M.B.**, Ozsarac, V., Sarigiannis, D., Dubini, P., et al. (2022) Utilization of a sensor array for the risk-aware navigation in industrial plants at risk of natech accidents. Proceedings of the ASME 2022 Pressure Vessels & Piping Conference PVP2022, Las Vegas, Nevada, USA.
- **Nafeh A.M.B.**, O'Reilly, G.J., Monteiro, R. (2021) Simplified Seismic Assessment of Infilled Reinforced Concrete Frames. 17th World Conference on Earthquake Engineering, Sendai, Japan.
- **Nafeh A.M.B.**, O'Reilly G.J., (2021) Accurate Collapse Capacity Quantification for Infilled RC Frame Buildings. COMPDYN 2021 - 8th International Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, DOI: 10.7712/120121.8658.18545.

Teaching and Academia

Instructor at IUSS Pavia, Pavia

SEPT 2024 — PRESENT

Second-level masters course on GEM Models, OpenQuake Engine and Tools Training

Ph.D Co-Supervisor, Pavia

SEPT 2024

- Furkan Narlitepe - Topic: Development of damage-dependent models for large-scale earthquake sequence loss assessment applications
- Amir Taherian - Topic: Digital twins for post-earthquake loss assessment of building portfolios

M.Sc Co-Supervisor, Pavia

- Marco Edwin Zakhia - Topic: Improving the seismic exposure model of Lebanon: A risk sensitivty analysis (In collaboration with the American University of Beirut)

Conference Organisations and Seminars

- Co-Chaired Special Session on *Advancing Vulnerability Modelling for Regional Risk Assessment and Resilient Communities* at the 18th European Conference Earthquake Engineering (ECEE2026) held in Berlin, Germany.
- Co-Chaired Special Session on *Recent Advances in Vulnerability Modeling of the Global Built Environment for Natural Hazards* at the 14th International Conference on Structural Safety and Reliability (ICOSSAR25) held in Los Angeles, California.
- Co-Chaired Special Session on *The International Macroseismic Scale of 2024 (IMS-2024)* at the 39th General Assembly of the European Seismological Commission (ESC2026) held in Corfu, Greece.