

# Seismic Loss Assessment of Existing Hotel Building in Ecuador

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# Background

- Performance-based seismic assessment of existing buildings is inherently complex
- Many of these structures lack original design documents, especially in Ecuador
- These buildings are often seismically vulnerable as they typically predate modern seismic design standards
- Assessments must rely on building-specific data, field surveys, and advanced analysis techniques to mitigate uncertainties



Hotel Quito ingreso. Fotografía: Rolf Blomberg

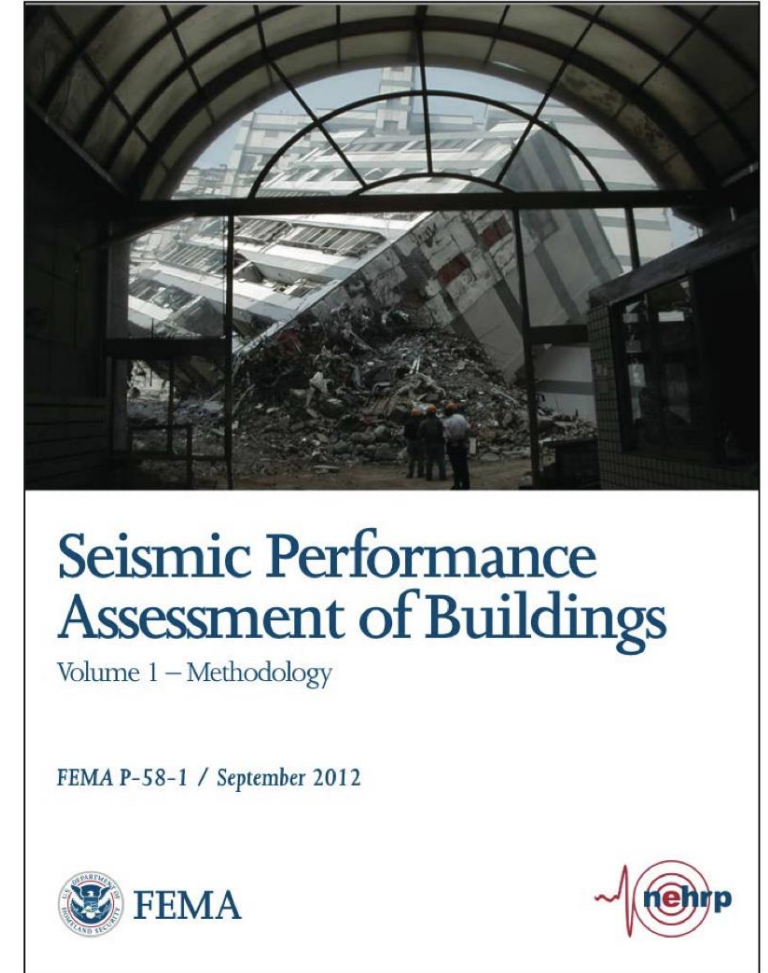


Foto aérea de julio de 1959, el hotel Quito en plena construcción, en la fotografía se observa el trazado de la prolongación de la calle Rafael León, cruzando la prolongación de la av. Orellana y desembocando en la unión entre la av. 12 de Octubre y "González Suárez". (Fuente IGM)

Report: Trama, October 2020. Pictures by Rolf Blomberg and IGM (Instituto Geografico Militar)

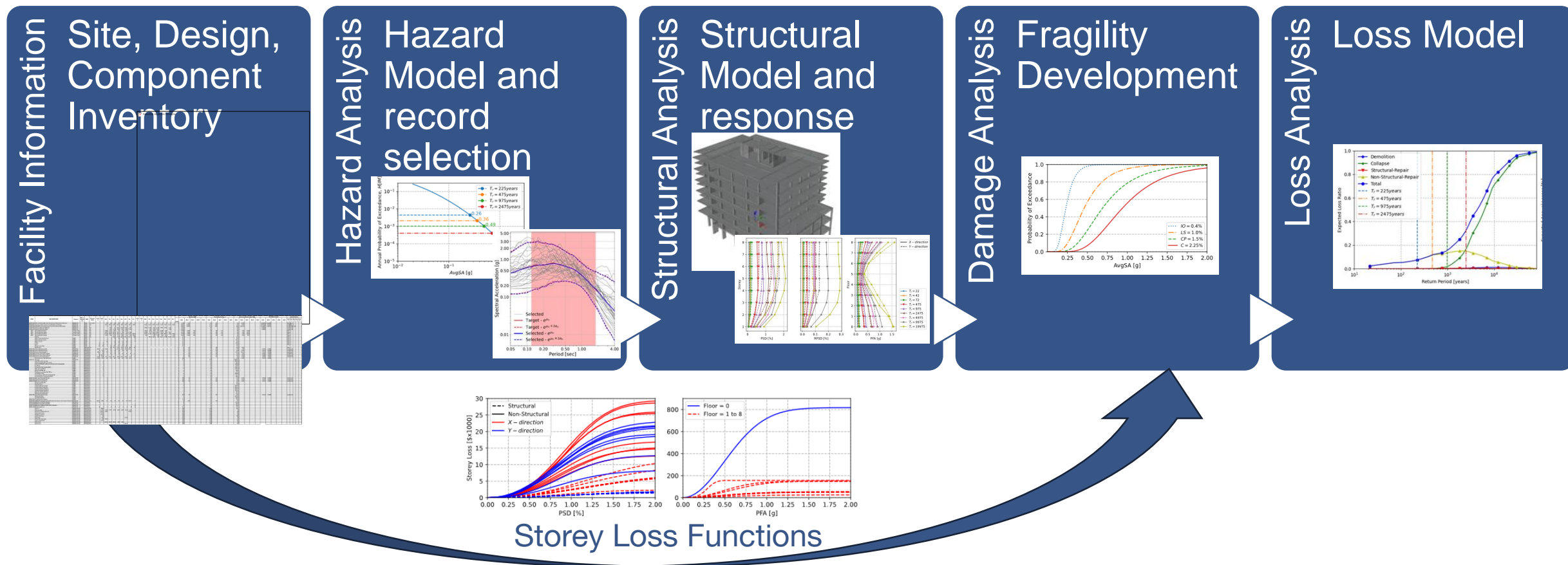
# Motivation

- Loss assessment is a handy tool in performance-based earthquake engineering
- It helps practitioners and building owners understand their building's performance much better
- FEMA P-58 and its implementation in PACT is a well-established approach
- Some issues arise:
  - Developed primarily for the US context – it needs to be adapted for other regions of the world
  - Component-based – requires a lot of input information that is not always available
- This study investigates these two issues via a case study application to a real hotel building in Quito, Ecuador



# Seismic Loss assessment

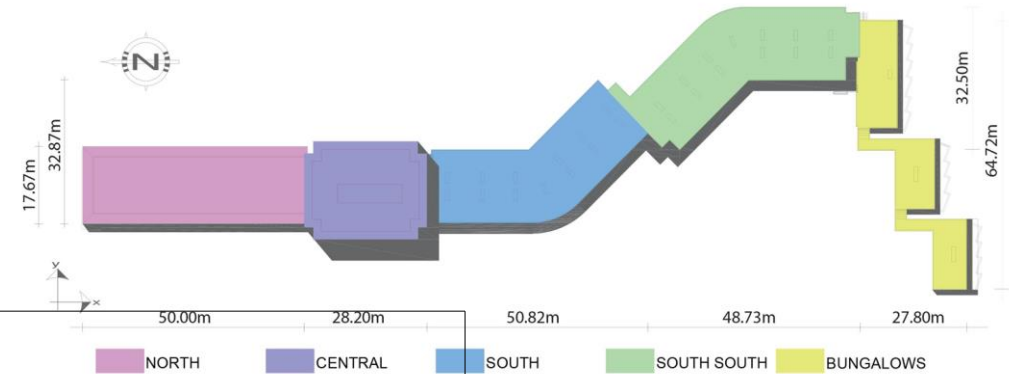
- General overview of PBEE Methodology, including storey loss functions





# Case Study

- A seven-story central block hotel in Quito, Ecuador, built in the 1950s
- The structure includes perimeter columns, concrete core walls, and unidirectional slabs with embedded beams
- Assessment included soil properties, material strength, typical reinforcement details, and ambient noise vibrations
- Damageable inventory and repair costs are considered via surveys and Building Information Modelling (BIM)

[illegible]

# Damageable inventory

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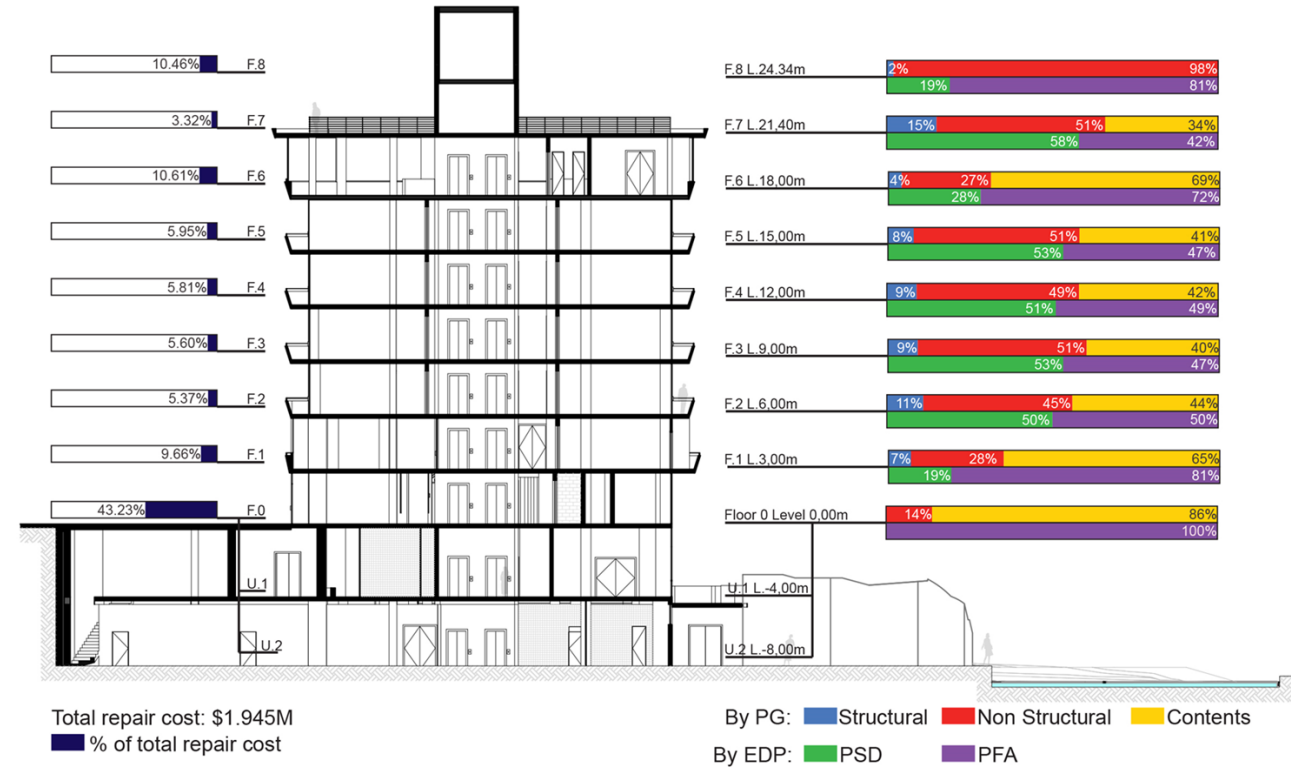
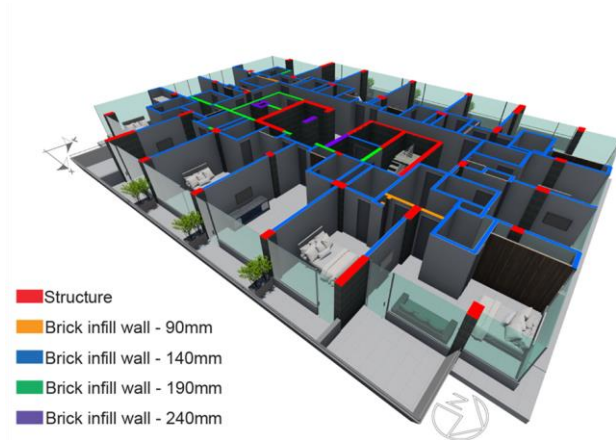
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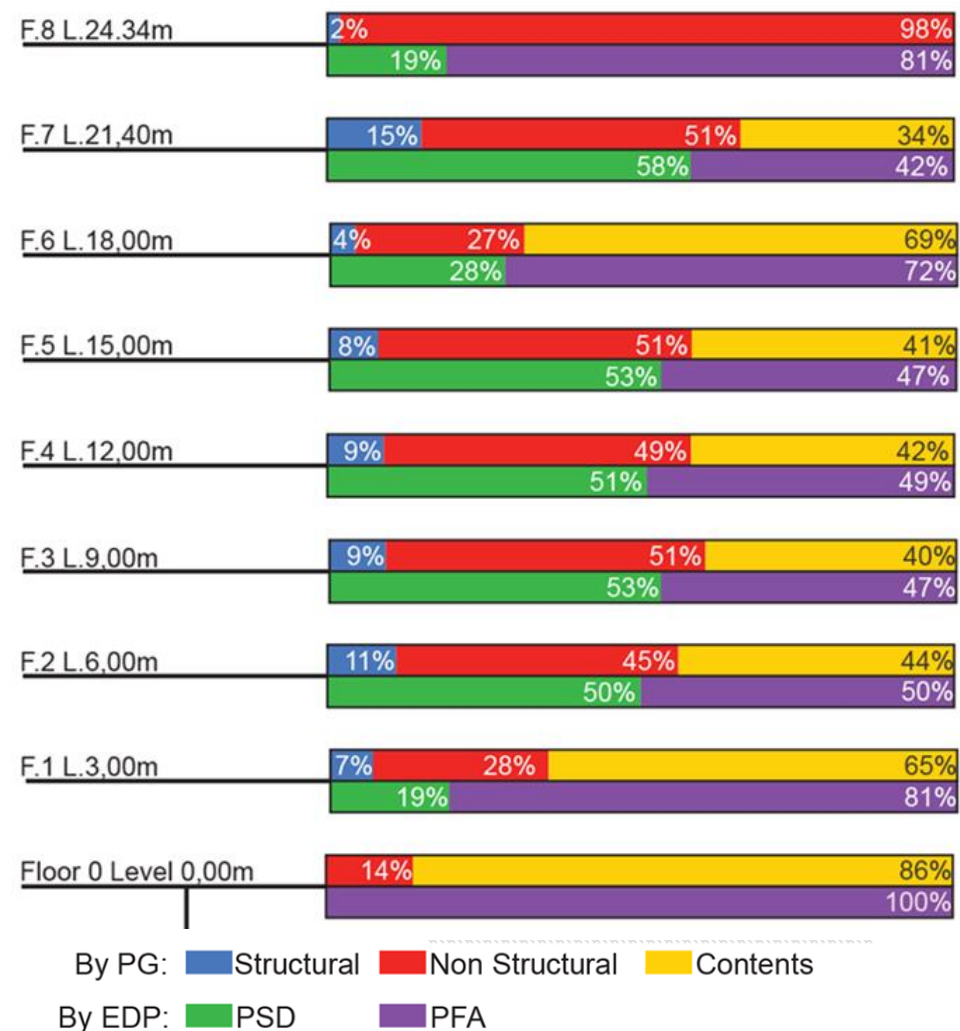
# Damageable inventory

- BIM aids in visualising and grouping components together and then estimating their respective quantities like mechanical and electrical equipment, piping, partition walls, contents, sanitary units, and façade elements
- A local expert compiled repair and replacement costs after conducting a detailed pricing analysis for the building's specific units and country context



# Relative distribution of replacement value

- From the analysis, we could quickly identify:
  - Relative distribution of the value of the damageable components
  - Which group they belonged to (i.e., structural or non-structural)
  - Which types of demands they were sensitive to (e.g., drifts or accelerations)
- With this kind of information, the source of losses and relative distribution can be easily identified



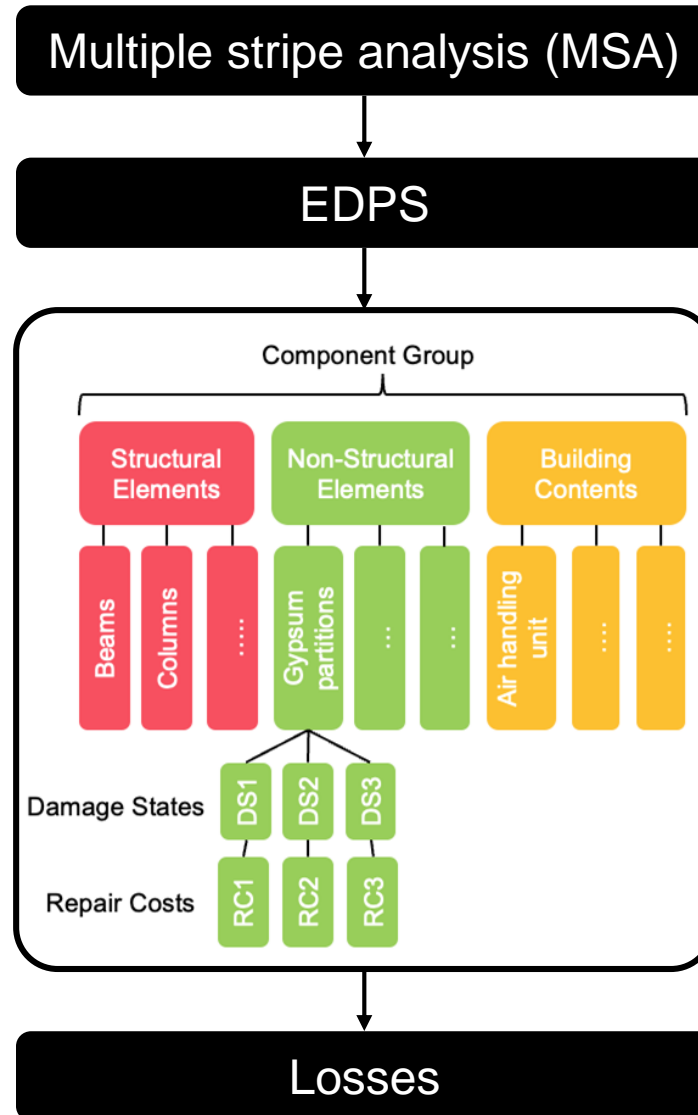
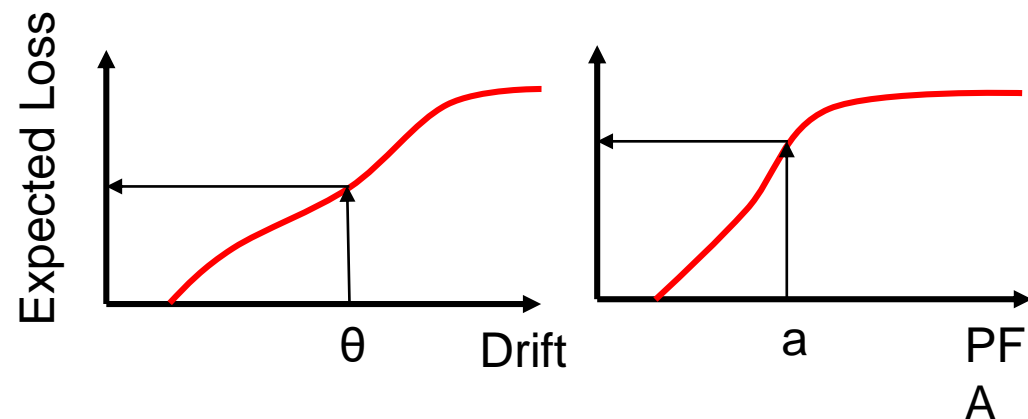
PSD – Peak Storey Drift

PFA – Peak Floor Acceleration



# Storey loss functions

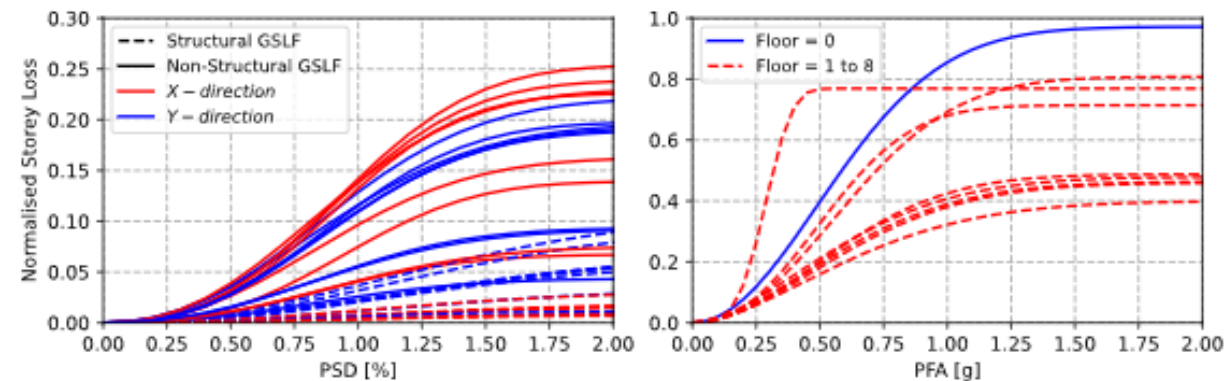
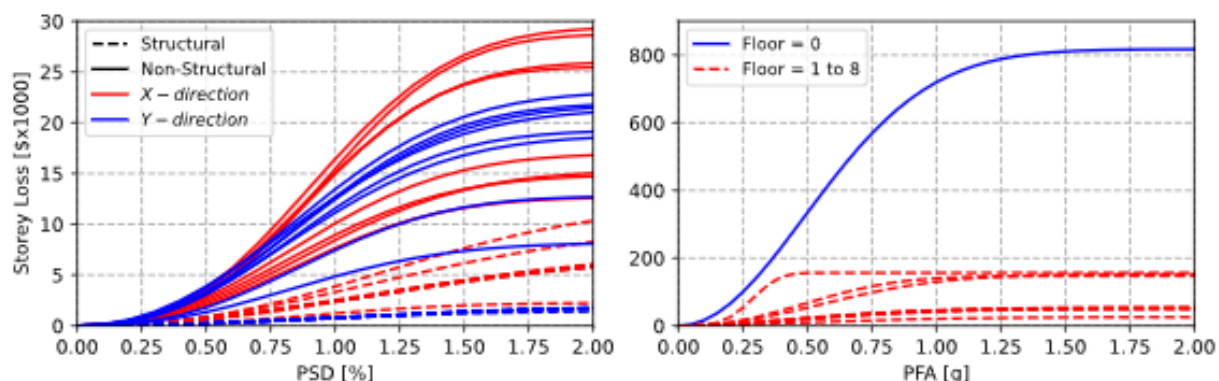
- Because the damageable inventory, fragility functions and repair cost functions are known, it is possible to simplify greatly
- Ramirez and Miranda (2009) proposed condensing these steps down to a few functions
- These are **storey loss functions** that link EDP directly to the expected economic loss
- Remove the need for a component-based analysis



Ramirez, C. M., & Miranda, E. (2009). Building Specific Loss Estimation Methods & Tools for Simplified Performance Based Earthquake Engineering. Blume Report No. 171.

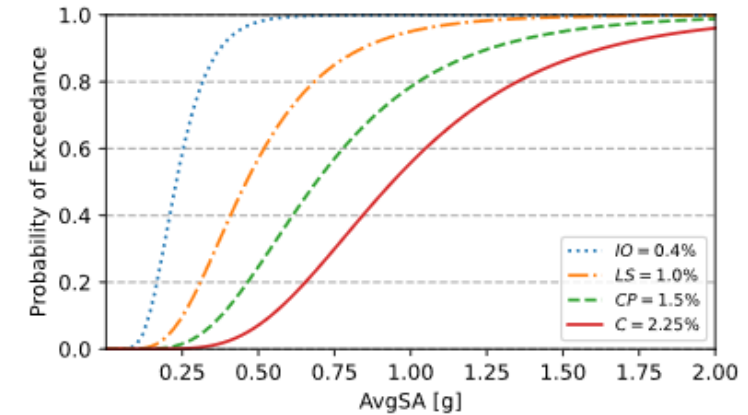
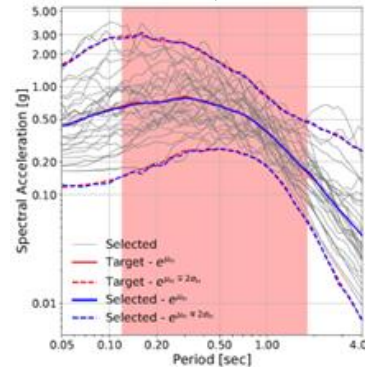
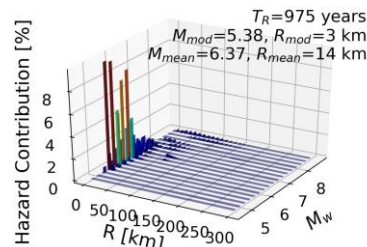
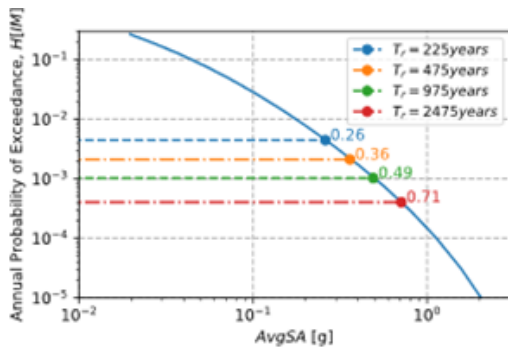
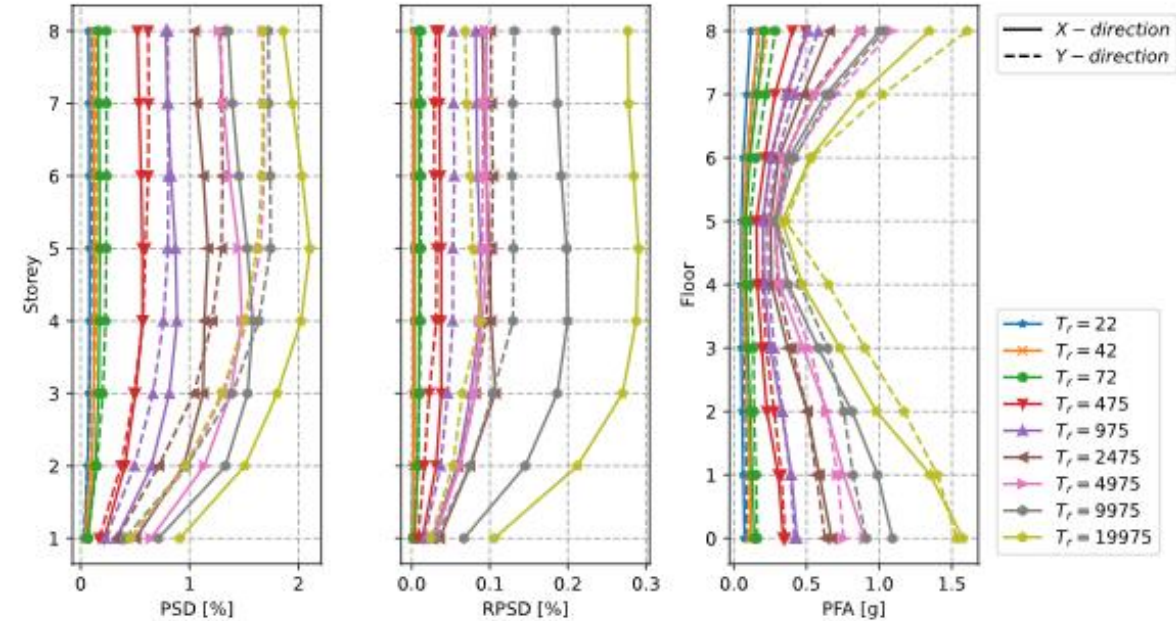
# Storey loss functions

- Development of Storey Loss Functions (SLFs) by Monte Carlo simulations for Peak Story Drift (PSD) and Peak Floor Acceleration (PFA) as the Engineering Demand Parameters (EDPs) due to their common usage and available fragilities for non-structural elements (NSEs)
- Generalized Storey Loss Functions (GSLFs) facilitate using SLFs for similar case studies in other studies beyond the current one. The obtained SLFs were normalized by the total repair cost for each story



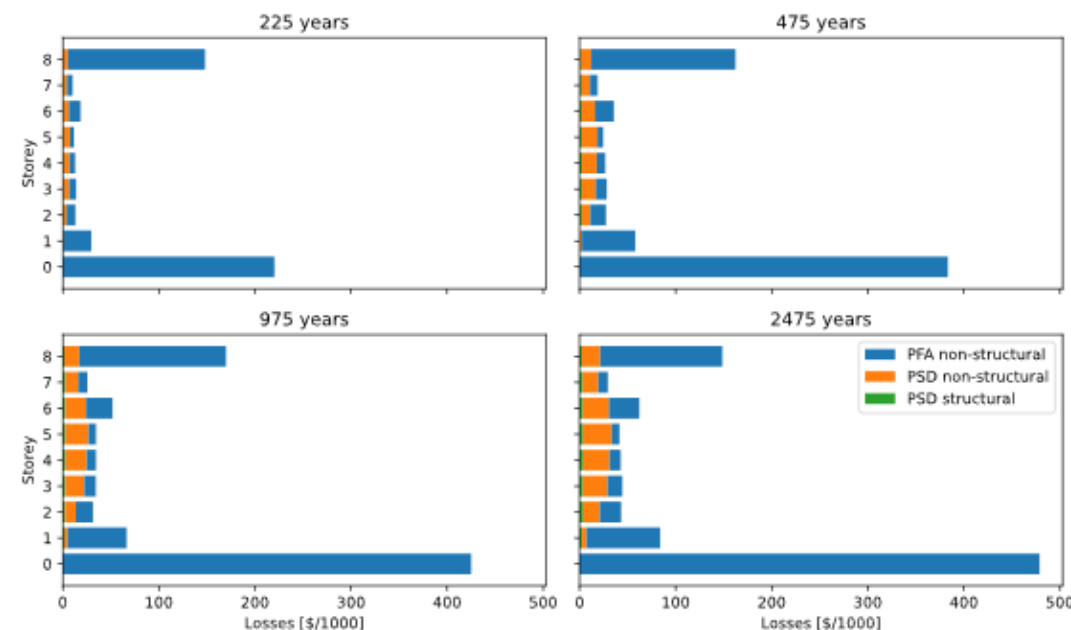
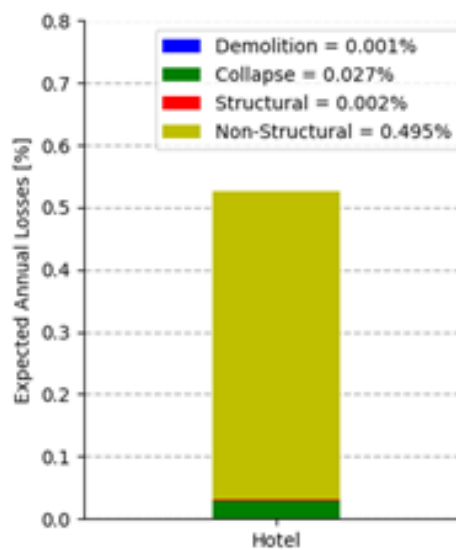
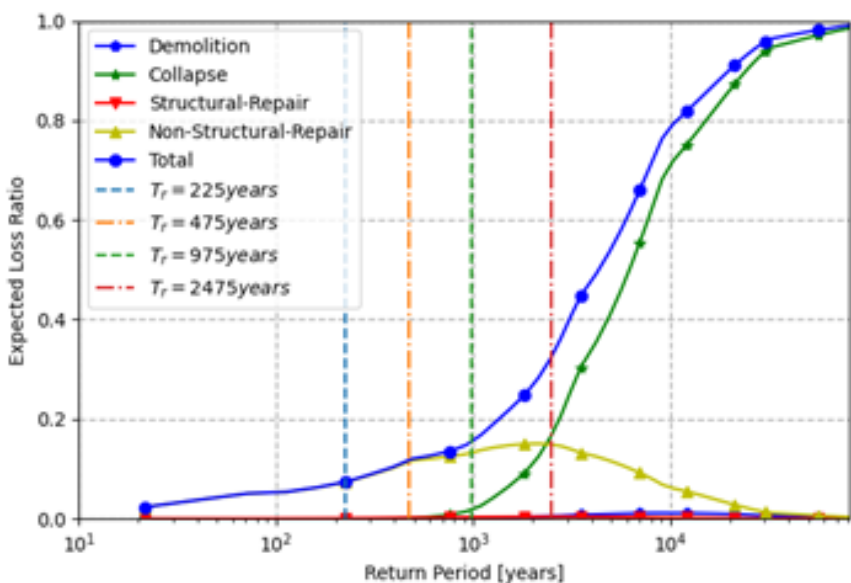
# Analysis

- Probabilistic seismic hazard analysis (PSHA) with average spectral acceleration (AvgSA) as the intensity measure (IM), seismic disaggregation for 10 return periods, and 30 ground motion records selected with conditional spectra
- Non-linear analysis includes PSD and PFA as EDP
- Derived fragilities for four damage states.
- Collapse was defined by 2.25% Storey drift
- Demolition was defined by 1.5% Residual storey drift



# Expected annual losses

- The vulnerability function of the expressed hotel in terms of the expected loss ratio, normalised to a total replacement cost of \$6.4 million and disaggregated for collapse, demolition, and structural and non-structural repair losses
- EAL computed to be 0.525%
- Disaggregation of repair losses for each of the eight stories, categorised by EDP, and for four return periods





# Summary

Seismic Loss Assessment is a valuable tool that helps practitioners and building owners understand their building's performance

- Building Information Modeling (BIM) aids in visualising and grouping components together, then estimating their respective quantities
- Locally compiled repair and replacement costs contribute to develop Seismic Loss Functions (SLFs) and Generalized Loss Functions (GLFs) for the ecuadorian context, extending their applicability
- Loss assessment facilitates the identification of the sources of losses and their relative distribution



Questions?



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