



Course Title: Performance-Based Earthquake Engineering

Lecturer: Gerard J. O'Reilly

Dates: 25th October – 10th November 2023

Hours: 37 hours (27 lectures + 10 tutorials)

Location: Palazzo del Broletto, Aula 1-17

Description

This course covers topics related to performance-based earthquake engineering (PBEE) of new and existing buildings. A quick background on the development of PBEE is first provided, outlining its early beginnings, followed by the notable developments in the past 25 years that have led to the current and avant-garde approaches available in the literature. This relates to the design and assessment of buildings, particularly those commonly found in Italy and Southern Europe. The course focuses on the ingredients necessary for quantifying uncertainties, calculating risk, and estimating economic losses. Advanced topics such as risk-and loss-targeted seismic design methods are presented in addition to both simplified and extensive risk assessment methods available to practitioners. Other issues relating to ground motion and intensity measure selection to characterise seismic response are also covered. The course aims to provide students who are already familiar with current building codes and other standard seismic analysis methods with a better understanding of these advanced topics and state-of-the-art methods available within modern PBEE.

Grading

Coursework 40%

Final exam 60%

Schedule

| Date | Time | Topic |
|----------------------|---------------|---|
| 26 th Oct | 09:00 – 12:00 | 1. Course Overview 2. Analysis Methods - Part I <ul style="list-style-type: none"> Non-linear static analysis Non-linear dynamic analysis MDOF vs SDOF models Incremental dynamic analysis (IDA) |
| | 14:00 – 17:00 | 3. Seismic Risk - Part I <ul style="list-style-type: none"> Seismic hazard, logic trees and disaggregation Fragility functions (FFs) Derivation of FFs from IDA Calculation of risk |
| 27 th Oct | 09:00 – 12:00 | 4. Analysis Methods – Part II <ul style="list-style-type: none"> Cloud analysis (CA) Multiple stripe analysis (MSA) Derivation of FFs from CA and MSA Simplified analysis methods |
| | 14:00 – 16:00 | Tutorial: Part 1 - Identification of case study building and site hazard |
| 30 th Oct | 09:00 – 12:00 | 5. Intensity Measures (IMs) <ul style="list-style-type: none"> Traditional definitions and novel developments IM choice – efficiency, sufficiency, practicality Potential bias in structural response Ground motion record scaling |
| | 14:00 – 16:00 | Tutorial: Part 2 - Static pushover and modal analysis |
| 31 st Oct | 09:00 – 12:00 | 7. Seismic Risk - Part II <ul style="list-style-type: none"> Demand-intensity models Sources of uncertainty |



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| | | <ul style="list-style-type: none"> • Demand-hazard curves |
| | 14:00 – 16:00 | Tutorial: Part 3 - Incremental dynamic analysis |
| 2 nd Nov | 09:00 – 12:00 | 6. Ground Motion Record Selection <ul style="list-style-type: none"> • Code-based selection • Hazard-consistency • Conditional spectrum • Generalised conditional intensity measure (GCIM) • Scenario-based analysis and spatial correlation |
| | 14:00 – 16:00 | Tutorial: Part 4 - Identification of ground motion records |
| 3 rd Nov | 09:00 – 12:00 | 8. Loss and Risk Assessment <ul style="list-style-type: none"> • Overview of loss assessment • Storey loss function-based assessment • Simplified risk assessment |
| | 14:00 – 16:00 | Tutorial: Part 5 - Multiple stripe analysis |
| 6 th Nov | 09:00 – 12:00 | 9. Risk (and Loss)-Targeted Design <ul style="list-style-type: none"> • Risk-targeted spectra • Risk-targeted behaviour factors • Yield-frequency spectra • Integrated performance-based seismic design |
| | 14:00 – 16:00 | Tutorial: Part 6 - Economic loss and collapse risk |
| 7 th Nov | 09:00 – 12:00 | 10. Typology-Specific Issues <ul style="list-style-type: none"> • Infilled frame structures • Unreinforced masonry structures |
| 8 th Nov | 09:00 – 12:00 | 11. Future Directions <ul style="list-style-type: none"> • Downtime and functional recovery • Indirect losses |
| 10 th Nov | 09:00 – 12:00 | Final Exam |