CERIS Civil Engineering Research and Innovation for Sustainability

Optimization of the seismic design of reinforced concrete bridges using evolutionary algorithms

Summary

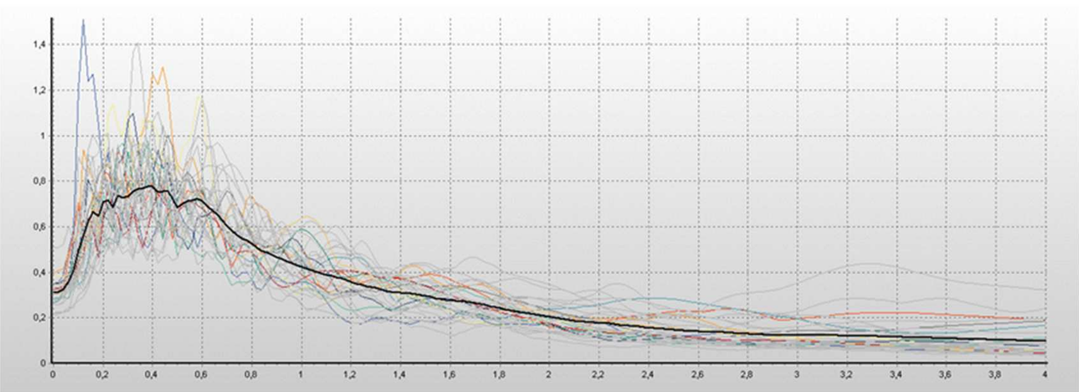
The seismic design of bridges, particularly long irregular ones, can be complex, due to several factors such as relevance of higher order modes, change of dynamic behaviour during the earthquake, etc. The seismic design of such bridges is, therefore, a complex procedure, usually done via trial and error, with subsequent confirmation through dynamic analysis. In this thesis, the goal is to define analysis methodologies that can result in, not only the optimization of such structures, but also the optimization of the design procedure itself.

By applying machine learning techniques for multi-objective optimization problems, and by processing the results of the generated solutions, it is possible to gain some grasp on the impact of the design variables on bridge dynamic behaviour, for different lengths and irregularity profiles. From these results, plenty of information can be extracted, such as calibration of behaviour factors, important indicators for pier design and design procedures obtained via employing classification trees. In addition, the relevance of spatial variability of seismic signals is investigated with an assessment of how it can affect bridges, according to length and irregularity.

Overall, this thesis defines and employs optimization methodologies to a given type of reinforced concrete (RC) bridge and analysing its results to attain design rules and guidelines. All the while, traditional design notions are commented on and updated considering a comprehensive study on ductility of reinforced concrete elements.

Keywords

Nonlinear seismic analysis, structural optimization, evolutionary algorithms, seismic design of RC bridges, spatial variability of seismic actions.



Spectra of 16 pairs of natural earthquake signals and their mean spectrum (vertical axis- acceleration (g); horizontal axis- Period (s)).

PhD student

Vítor Armando Teixeira Camacho

PhD program

Civil Engineering (IST, University of Lisbon)

Supervisor

Mário Lopes (CERIS, IST, University of Lisbon)

Co-supervisor

Carlos Sousa Oliveira (CERIS, IST, University of Lisbon)

Period

2015-2021

Funding

FCT scholarship (PD/BD/127802/2016)