Development of BRB_AL

Summary

In the last decades, the seismic retrofitting of old buildings or structures with deficient seismic behaviour, using seismic protection devices has been considered as a preferential approach to mitigate human casualties, damage and economic impacts resulting from collapse of such buildings during seismic events. The configuration of some old residential buildings in Lisbon, also known as "Pilotis" type buildings, combined with the fact that their seismic design is nonexistent or insufficient, constitutes a factor that accentuates the seismic risk in this city. To address the weaknesses of this type of building when subjected to strong motion earthquake events, a hysteretic dissipative brace composed of aluminium alloys was developed as an alternative to conventional BRB. As defined on the onset of the research, this alternative bracing system consists in a 2 component bracing, where a dissipative and elastic component are assembled in series, considering mainly extruded aluminium profiles in their composition. Ultimately, this brace was devised to be a sustainable, durable, reversible and effective retrofitting solution addressing the seismic weaknesses of the "Pilotis"-type buildings.

In this thesis, the development of the configuration of the dissipative bracing system was divided into the following stages: 1) the definition of the most suitable aluminium alloy for the dissipative component through a selective process comprising experimental campaigns and the application of different thermal treatments to the 6082 aluminium alloy; 2) the selection of the dissipative component configuration between two predefined configurations (configurations T1 and T2); 3) the definition of the complete configuration of the bracing system, considering both elastic and dissipative components; and finally 4) the assessment of the seismic behaviour of a case study (existing "Pilotis" type building) regarding the current regulatory requirements, followed by an assessment of the effects of the seismic retrofitting of such building using the devised bracing system.

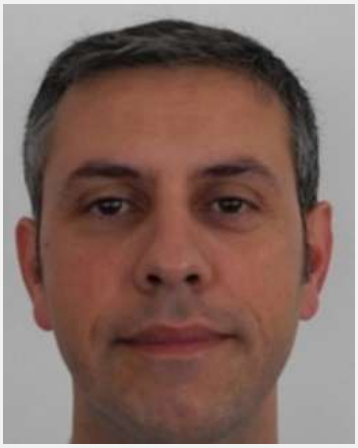
All assessments carried out concerning the development of the bracings configuration were performed using numerical finite element models. The evaluation of the numerical results indicated the selection of a particular configuration for the dissipative component: T2 configuration. The results of the different numerical models built for the assessment of the complete bracing configuration confirmed the anticipated behaviour and allowed the characterization of its cyclic behaviour through a theoretical bilinear model (MBT) built considering an alternative approach to the European standard EN 15129 methodology. Finally, a case study of a "Pilotis" type building was analysed , considering a numerical model of the building, integrating, in the unobstructed storey, a distribution of bracing elements with the characteristics of the developed bracing system. The numerical results confirmed the effectiveness of the proposed bracing system in reducing the susceptibility of the "Pilotis" type buildings to the "soft-storey" mechanism.

Keywords

Buckling restrained brace, dynamic analysis, seismic retrofitting.

(a) (b) (c)

(a)-Cyclic testing of aluminium specimens; (b) Assessment of thermic treatentments on the ductility of aluminium alloys; and (c)-TEM scan analysis of treated aluminium specimens.



PhD student
Ricardo Sousa Alves Ferreira

PhD program
Civil Engineering (IST, University of Lisbon)

Supervisor
Jorge Proença (CERIS, IST, University of Lisbon)

Co-supervisor
António Sousa Gago (CERIS, IST, University of Lisbon)

Period
2017-2022

Funding
FCT scholarship (PD/BD/135212/2017)