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SEISMIC REHABILITATION AND RETROFIT OF RC COLUMNS

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The objective of this paper is to perform an experimental evaluation of seismic rehabilitation and retrofit of reinforced concrete columns with composite materials to prevent shear failure.

Mainly, the retrofit technics aim to increase the shear strength and the ductility capacity through the establishment of principles and strategies applied in an experimental cyclic campaign of RC columns, carried out in the Laboratory for Earthquake and Structural Engineering (LESE) of the Faculty of Engineering of University of Porto (FEUP). The test setup, shown in Figure 1, makes use of a 500 kN actuator to apply lateral loads and a 700 kN actuator to apply axial loads. The specimen and reaction frame are bolted to the strong floor with high strength prestressed rods. A constant axial load was applied during the tests, herein described, while the lateral loads were cycled, under displacement controlled conditions (Delgado *et al.* (2009) and Delgado *et al.* (2012)).

Figure 1. General view of the test setup at LESE laboratory

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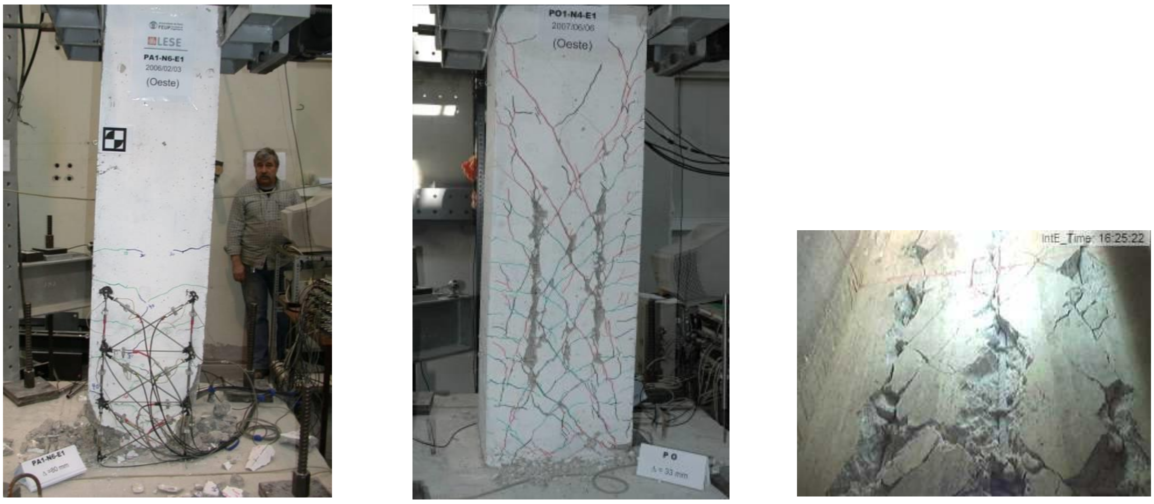
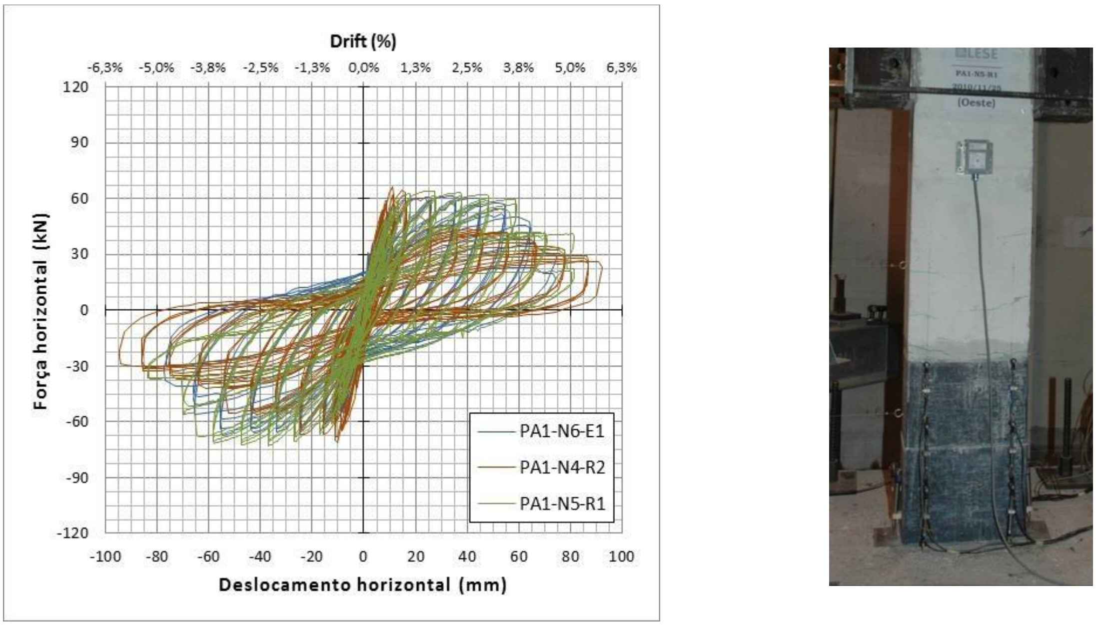
The most relevant experimental information is illustrated in Figure 2, as for instance the damage pattern of flexure and shear cracks.



a) Solid sections b) Web of hollow sections c) Internal view of hollow sections

Figure 2. Columns damage

Columns were retrofitted with CFRP, acording to Priestley *et al.*(1996), and the evaluation of the retrofit solutions efficiency was also performed. These columns rehabilitation and retrofit intended to replace or improve the initial conditions. For solid sections columns with flexural damage the CFRP sheets were applied at the bottom (near the foundation, see Figure 3) and for hollow section columns with shear damage the CFRP strips were applied along the entire height (Figure 4).

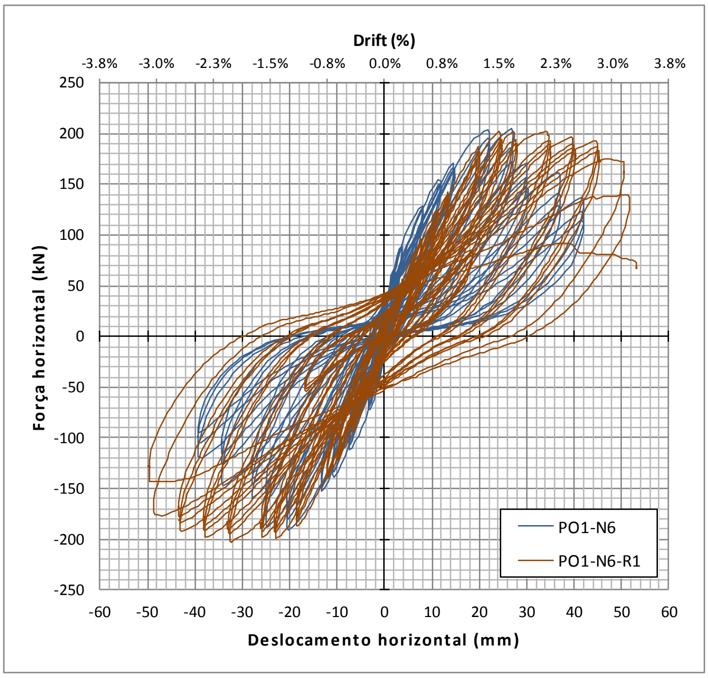


a) PA1-N6-E1: no retrofit; PA1-N4-R2: CFRP + laminates; PA1-N5-R1: 2 x CFRP

b) View of column PA1-N5-R1

Figure 3. Experimental results for solid sections columns retrofitted with CFRP

The column PA1-N4-R2 was retrofitted with CFRP jacket and longitudinal CFRP laminate (anchored at the base), while the columns PA1-N5-R1 was also retrofitted with CFRP jacket, but with the double of previous column layers. Due to an insufficient anchorage length to the foundations the column PA1-N4-R2 shows quick reductions of lateral force and insufficient ductility capacity (Figure 3). On the other hand, column PA1-N5-R1 shows a good ductile behaviour and for the same lateral force of the column tested before retrofit (PA1-N6-E1).



a)
PO1-N6: no retrofit; PO1-N6-R1: retrofitted with CFRP strips

b)
Final damage of PO1-N6-R1

Figure 4. Experimental results for hollow sections columns retrofitted with CFRP

Column PO1-N6-R1, with hollow section retrofitted with CFRP strips (Figure 4b), shows excellent ductility capacity. In comparison with the same column without retrofit (PO1-N6), this shear retrofit technique allows to keep the maximum lateral force for a displacement ductility of 3, typical of a flexural behaviour, and the column failure was achieved after the rupture of the first CFRP strip near the base (Figure 4).

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