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Retrofit of short columns with fibre-reinforced polymer wraps (en ce compris une introduction à la méthodologie de la recherche)

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Retrofit of short columns with fibre-reinforced polymer wraps

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The objective of this thesis is to evaluate the residual load-carrying capacity of short reinforced concrete columns. The study considers two loading configurations: shear loading (pushover) and axial compression (pushdown). In both cases, the columns are first subjected to an initial shear loading until a prescribed damage state is reached, after which FRP strengthening is applied. The strengthened columns are then subjected to the corresponding subsequent loading to assess their residual load-carrying capacity. The study is based on an existing analytical model in which the residual strength is expressed as a function of the relative displacement between the two concrete parts formed by the critical diagonal crack. The model accounts for the different mechanisms contributing to the residual strength, including the reinforcement bars, aggregate interlock, and Critical Loading Zone (CLZ), and is extended to incorporate the contribution of the externally bonded FRP strips.

Experimental studies reported in the literature and relevant to the scope of this research are selected and simulated using the proposed analytical model. The predicted responses are then compared with the corresponding experimental results to evaluate the accuracy and reliability of the model. The comparison shows generally good agreement between the predicted and measured responses, with an average prediction-to-experiment ratio close to unity and a coefficient of variation of approximately 15%, indicating that the model is able to reproduce the main trends of the experimental response.

A parametric analysis is subsequently performed to investigate the influence of selected parameters on the response of strengthened columns. The results show that the effectiveness of FRP strengthening depends not only on the amount and mechanical properties of the reinforcement, but also on the initial damage state and on the interaction between the FRP contribution and the degradation of the existing resistance mechanisms. For shear loading, an increase in the FRP contribution does not necessarily result in a proportional increase in the global shear resistance, as FRP mobilization progressively increases with crack opening while the concrete-based contributions decrease. Under axial compression, the gain in residual capacity is more limited, with only a fraction of the available FRP contribution being effectively mobilized.

Overall, the proposed model provides a framework for assessing the residual load-carrying capacity of damaged reinforced concrete columns and for evaluating the effectiveness of externally bonded FRP strengthening under different damage and loading conditions. The results highlight the importance of accounting for the interaction between the FRP reinforcement and the residual resistance mechanisms of the damaged column when assessing the effectiveness of strengthening.