SUMMARY

In the dissertation, the impact of reinforced concrete structural design approaches and nonlinear modelling of frame systems on the dynamic response and the potential occurrence of progressive collapse due to column removal is analysed. The influence of the support removal rate on the structural response is investigated, taking into account the effects of both geometric and material nonlinearity.

The first part of the dissertation presents the fundamental background of the subject matter, including a review of occurred progressive collapse events and their underlying causes. It also examines procedures and strategies outlined in selected standards and guidelines for designing buildings to resist progressive collapse. A classification of progressive collapse types is provided, along with a description of the mechanisms that can trigger such failures. Methods for safeguarding structural systems against progressive collapse are described in detail, with particular attention given to defensive mechanisms such as arching action, catenary action, and, in the case of slabs, membrane action.

The subsequent part of the dissertation focuses on nonlinear inelastic modelling of reinforced concrete structures. It outlines computational analysis methods and discusses how to incorporate nonlinearity in both beam and shell elements. Key definitions related to nonlinear structural modelling are introduced within the context of the finite element method applied in the study. Detailed formulations are provided for the multilayer shell elements and fiber-based beam elements used for simulating progressive collapse.

The main part of the dissertation presents the results of original numerical analyses. It begins with an investigation of the influence of corotational geometric nonlinearity on displacements and internal forces, compared to linear analysis. A nonlinear static "pushdown" analysis is conducted, demonstrating that the numerical occurrence of the membrane action as a defensive mechanism in slabs is only possible when both material and geometric nonlinearity are taken into account. The procedure for dynamic column removal is then presented, and the effect of column removal time on the structural response is analysed through a large number of simulations (both linear and nonlinear). Dynamic amplification factors are determined by comparing the dynamic and static responses of the structure, depending on the structural load-capacity ratio. It is shown that the dynamic amplification factor may exceed the value of 2.0 recommended in many guidelines.

The final part of the dissertation focuses on the comparison between the numerical model and the results of an experiment conducted on a real slab-column structure. The differences observed in displacement values, deflections, and force increments in the columns were minor. A model calibration method was also presented, based on adjusting the support removal time to match the experimentally recorded accelerations. The study concludes with an assessment of the structure's ultimate load-bearing capacity under a corner column removal scenario.