Summary

In this paper the performance of concentrically braced frames with friction dampers in the bracing is analysed. Two types of concentrically braced frames were analysed: (i) simple CBF and (ii) dual CBF with 2 adjacent MRF. The structures considered were analysed using 2 sets of seismic motions recordings scaled to the design spectra. The two target spectra were scaled to the fundamental period of vibration of the analysed structure, so as to yield roughly the same design seismic forces. All the analyses were made with two distinct types of dampers placed in the braces and comparing the results with the coresponding structures without dampers. The paper is structured into 6 chapters with the following topics:

Chapter 2 presents a general overview on the characteristics of seismic motions and on current use of passive damping devices in civil engineering applications. It is shown that sismic motions with long period of vibration can be caused by soft soils and the forward directivity effect. It is pointed out that the nonliniar dynamic response of the structures can have significant variations depending on the period of vibration. This led to the choice of two types of seismic motions that were used in the analyses: (i) semi-artificial seismic motions characteristic for soft soil type (Bucharest, T_C=1.6s) and (ii) artificially generated seismic motions characteristic for stiff soil (Class B soil according to SREN1998-1 with T_C=1.6s). This chapter also include an overview of passive damping devices and shows that the use of damping devices, in different configurations, is a modern and effective way of reducing seismic response of structures. It is pointed out that the behaviour of the damper prototype studied in this paper is diffrent from the general current concept of passive damper. This fact corelated with current interest worldwide towards devices that reduce seismic actions and lack of studies in this field in our country provides the motivation of this thesis.

Chapter 3 presents the experimental program for damper prototypes studied in this paper. This chapter presents the experimental tests performed on the two dampers with capacities of 800kN and 1500 kN and of a brace with damper assembly under two different design concepts. A first concept that states that the brace with damper are designed so that energy dissipation occurs in the device alone and the brace remains in elastic domain and a second design concept states that the brace will enter plastic domain and both brace and damper will contribute to final response of the assembly. As a result of the experimental tests the hysteretic behaviours of the dampers and of the brace with damper assembly were obtained.

Chapter 4 presents the numerical program performed to determine the performance of concentrically braced structures with dampers in the braces. Based on the results from the experimental program numerical models for the damper, brace and brace with damper assembly were calibrated. Nonlinear time-hystory analyses were made using two sets of seismic motions recordings scaled to their respective design spectra. Three performance levels were considered for each seismic motion corresponding to serviceability limit state (SLS), ultimate limit state (ULS) and collapse prevention (CP). Performance based evaluation was performed using acceptance criteria for plastic axial deformation in the braces and plastic rotation for beams and columns according to FEMA356. Two types of concentrically braced frames were analysed: (i) simple CBF and (ii) dual CBF+MRF without dampers. The same structures were analysed equiped with SERB dampers and with “clasic” friction damper in the braces.

Chapter 5 presents proposed design provisions for the design structures with SERB dampers and “classical” friction dampers. A design methodology is proposed for each type of damper and case studies were made following the proposed methodology. Both design methodologies proposed were applied for case studies on the structures with FD3 dampers and SERB dampers and the performance of the structures was evaluated using nonlinear TH analyses.

Chapter 6 presents the conclusions of the thesis and personal contributions of the author.