ECCENTRICALLY KNEE BRACING: IMPROVEMENT IN SEISMIC DESIGN AND BEHAVIOR OF STEEL FRAMES

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The use of passive control systems is widely considered as a reliable approach for controlling earthquake vibrations in steel structures. For some decades now eccentrically braced frames (EBFs) have been indicated as the distinctive elements of a structural typology suitable for satisfying the different design objectives of modern performance-based seismic engineering in medium or high-rise steel buildings. They have often been proposed as a cheaper and more valid alternative to the most common moment resisting frames (MRFs) and concentrically braced frames (CBFs), as they incorporate the good qualities of the abovementioned structures. Indeed, owing to the presence of bracings and links, EBFs are expected to incorporate characteristics of both high lateral stiffness and high energy dissipation capacity. Experimental investigation has gradually persuaded the scientific community of the structural effectiveness of EBFs and, hence, induced building codes to propose rather high values of the behaviour factor for the design of such structures. An alternative system which combines the advantages of the moment resisting frame and those of the concentric braced frames is the knee braced frames (KBFs), where one end of the brace is connected to a knee member (anchor) instead of the beam-column joint. In this system, the knee element acts as a "ductile fuse" to prevent collapse of the structure under extreme seismic excitations by dissipating energy through flexural and shear yielding. A diagonal brace with at least one end connected to the knee element provides most of the elastic lateral stiffness. As the nature and occurrence of earthquakes are random, it is necessary to consider different levels of earthquake intensity in designing earthquake resistant structures. To improve the seismic performance of the steel framed structures, further modification to enhance the structural performance is essential. In this paper, one of the most effective braced frame systems through which a high level of energy dissipation capacity may be attained is investigated. For this purpose, a modified structural form that adopts knee brace elements in the corner regions of the beams and columns, namely Eccentrically Knee Braced frame (EKB) and this paper describes the seismic behavior of EKB, as shown in Figure 1, is considered in this study. The design of an EKB is based on creating a frame which will remain essentially elastic outside a well-defined link and knee. During moderate lateral loads, the knee element deform inelastically and during extreme loading it is anticipated that the link and the knee will deform inelastically with significant ductility and energy dissipation.

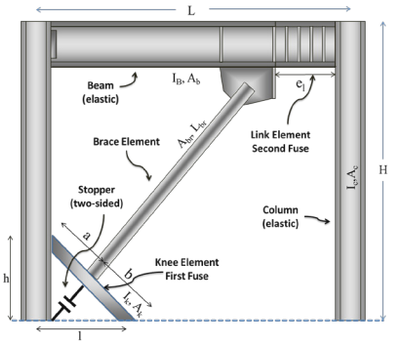

Figure 1. The proposed frame configuration

The numerical modelling of the EKB model is conducted using finite-element method software under cyclic load, with the goal of evaluating the behavior of shear links. The cyclic behavior and ductility of EKB is also studied. Finally, the increase of ductility coefficient for the prototypes with EKB is studied. The prototypes are also subjected to time-history analysis using scaled earthquake records, with the purpose of studying the energy parameters of the models.

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