Fayoum University

Faculty of Engineering

Civil Engineering Department

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SEISMIC VULNERABILITY ASSESSMENT OF MULTI-STORY STEEL STRUCTURES

By **Eng: Mahmoud Mohammed Elsayed Ahmed**

A thesis submitted in partial of fulfillment of The requirements for the degree of

Master of Science in **Civil Engineering (Structures)**

Department of Civil Engineering Faculty of Engineering, Fayoum

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Seismic vulnerability assessment of multi-story steel structures

ABSTRACT

Real structures are almost always irregular as perfect regularity is an idealization that very rarely occurs. The increasing number of damage statistics after seismic events has provided strong evidence that irregular buildings exhibit inadequate behavior though they were designed according to the current state of knowledge existing in seismic codes. This inferior seismic performance has been attributed to the combined action of structural irregularities, i.e., to the combined non-uniform distributions of mass, stiffness and strength along the height of buildings. Prior to the 1988 UBC, building codes published a list of irregularities defining the conditions, but provided no quantitative basis for determining the relative significance of a given irregularity. However, starting in 1988, seismic codes have attempted to quantify irregularities by establishing geometrically or by use of building dimensions the points at which the specific irregularity becomes an issue as to require extra analysis and design considerations over and above those of the equivalent lateral procedure.

The main objectives of this study aimed to understand better the influence of irregularities on the seismic performance of multi-story steel structure. An extensive parametric study on the inelastic seismic response of plane steel moment-resisting frames with vertical stiffness irregularity is presented. An extensive parametric study on the inelastic seismic response of plane steel moment-resisting frames with vertical irregularity is presented using a family of around 60 frames. Those frames are designed according to the uniform building codes (UBC1994). Both analysis (THA) are performed in order to evaluate the available ductility of several multi-story steel buildings with varying flow to floor height to understand the failure mechanisms, collapse stages and patterns and ultimate performance of steel structures. The results show that the rigid and semi-rigid connections had the same trend of effect with the change of the floor height or mass with negligible difference. The results indicated that the vertical irregularities increased the maximum inter story drift at the position of the changed floor height and reduced the maximum values at most of the other floors due to the energy dissipation occurring at the changed floor level. Moreover, vertical irregularities increased the vulnerability of the collapse of the studied multi-story steel frames due to increasing the maximum drift at the critical floor which have the increased height. Finally the comparison of the results of the modal pushover analysis (MPA) and the dynamic analysis using scaled ground motion records are performed. Modal pushover analysis is found to pound the envelop of maximum inter-story drifts for all applied earthquakes except the exceptional ones which result in a complete failure.