APPLYING "DELIBERATE DIRECTING OF DAMAGE" IDEA FOR CREATION OF REPAIRABLE STEEL BUILDINGS BY USING ROCKING TUBULAR FRAME STRUCTURAL SYSTEM AND YIELDING-PLATE DAMPERS ATFOUNDATION LEVEL

Mahmood HOSSEINI
Assoc. Professor, Structural Engineering Research Center,
International Institute of Earthquake Engineering and Seismology (IIEES), Tehran, Iran
hosseini@iiees.ac.ir

Hamidreza EBRAHIMI
Graduate Student, Department of Civil Engineering , Isfahan (Khorasgan)Branch, Islamic Azad University, Isfahan, Iran
Eng_Ebrahimi@ymail.com

Keywords: Nonlinear Time History Analysis, DADAS and MTYPED Dampers, Plastic Hinge Formation

ABSTRACT

Regarding that seismic design codes allow heavy damage to building systems in case of strong earthquake, on the one hand, and the adverse consequences of this allowance, such as very large volume of reconstruction works, on the other, creation of repairable buildings is quite desired. In this study the 'deliberate directing of damage' idea has been employed for design of repairable regular 10- to 20-story steel buildings by using tubular frame structural system with rocking motion. The rocking mechanism is created by removing all internal columns in the lowest story, and employing yielding plate dampers under all circumferential columns which give the building structure the required energy dissipation capacity. The dampers should be adjusted so that they work only in tension. In this way the base of each circumferential column can easily move upwards to make possible the building's rocking motion, while behaves almost rigidly downward. The use of tubular system helps the building to reliably carry all its weight in the columns of each of its four sides during rocking motion. To show the efficiency of the proposed structural system in creation of repairable buildings, a series of nonlinear time history analysis were performed by using a set of 3-component accelerograms of some selected earthquakes, containing both mid- and long-period ones, on some buildings with ordinary structural system, designed by using a common seismic code, and their rocking counterparts, and the plastic hinge formation were observed in the two sets. Numerical results show that the proposed rocking structure can efficiently control the seismic damage in the building, so that plastic deformation happens only in the energy dissipaters, and the main structural elements remain elastic, and therefore, the buildings designed and constructed by the proposed technique can be easily repaired even after major earthquakes having up to 0.5g PGA values.

INTRODUCTION

The provisions of seismic design codes for building systems have been intended to lead to structural systems which are prevented against collapse in case of major earthquakes. However, the buildings which are designed based on these provisions are not necessarily prevented against heavy damages, and in fact most of codes allow, either explicitly or implicitly, heavy damages to the building in case of strong earthquakes (provided that the building is prevented against collapse). Unfortunately, recent earthquakes have shown that in many cases level of the allowed damage is so high that necessitates demolishing of the damaged buildings and reconstructing and new ones. This in turn results in some unacceptable consequences in large populated cities