A TYPE OF UPLIFT RESTRAINER FOR THE OPRCB ISOLATORS

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

Sadegh MAHMOUDKHANI
Adjunct Lecturer, Islamic Azad University, Tehran, Iran
s.mahmoudkhani@srbiau.ac.ir

Keywords*:* U-Shape Uplift Restrainers, Finite Element Analyses, Nonlinear Regression Analysis, OPRCB Isolator, Uplift Forces

ABSTRACT

Orthogonal Pairs of Rollers on Concave Beds (OPRCB) isolator is a recently introduced seismic isolating system which in their original form is weak against uplift. In this study a type of U-shape restraining system is proposed for making the OPRCB isolators resistant against uplift. At first the geometrical features of the restrainer system, which has been obtained by nonlinear regression analysis, is explained and then it mechanical resistance against the uplift forces is examined by finite element analysis. Numerical results show that the proposed restraining system can tolerate uplift forces up to 8.4 tonf in elastic range within a maximum deformation of 1 mm. This amount of uplift force is a reasonable value for 5-story buildings equipped with OPRCB isolators.

INTRODUCTION

It is well-known that most of seismic base isolation devices are weak against uplift, and this is more crucial in case of roller-based devices. Retraining seismic base isolators against uplift has been a concern for researchers since late 80s (Kelly et al., 1987), and some preliminary studies have been conducted in that time (Griffith et al., 1988). Studies in this regard have been continued in 90s (Nagarajaiah et al, 1992) and also during the last decade (Roussis and Constantinou, 2006).

Kelly et al. (1987) proposed a displacement control and uplift restraint device for base isolated structures, which can be installed within multilayer elastomeric base isolation bearings. The device acts to limit the displacement of the bearings and can also be used to take uplift tension forces if necessary. Their device was tested in earthquake simulator tests of a nine-story, 1/4scale steel frame model. Following, Griffith et al. (1988, 1988) performed some earthquake simulation tests on a 1/5-scale, 7-story reinforced concrete structure, and also a 9-story braced steel frame. One of the main objectives of those studies was to evaluate the feasibility of base isolation for medium-rise structures subject to column uplift during severe seismic loads. Those studies showed that either rubber or lead-plug bearings do not show suitable behavior subjected to uplift, even when shear keys are used. Nagarajaiah et al. (1992) conducted an experimental study to evaluate the feasibility of using a sliding isolation system with uplift restraint devices for medium-rise buildings subject to column uplift. They used a Teflon-disc sliding bearing with built-in uplift restraint devices for isolating a quarter-scale, 52-kip (231-kN) model of a six-story structure. Roussis and Constantinou (2006) proposed an uplift-restraining friction pendulum seismic isolation system, called XY-FP isolator, which consists of two orthogonal opposing concave beams interconnected through a sliding mechanism that permits tension to develop in the bearing, thereby preventing uplift.

Hosseini and Soroor (2011) introduced a kind of rolling isolators called Orthogonal Pairs of Rollers on