8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

# MODELING AND INVESTIGATION OF THE FLOOR ISOLATION EFFECT AND APPLICATION OF YEILDING DAMPERS BY NONLINEAR DYNAMIC ANALYSIS

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**Keywords:** Seismic isolator, Yielding damper, Nonlinear analysis, Dynamic analysis, Modeling

## INTRODUCTION

The decrease in the seismic demand of structures is one of the important research areas among earthquake and structure researchers. Different approaches have been presented in this regard. One of the effective approaches is using seismic isolators against seismic forces, which limits the internal energy of structural components, thereby reducing structural components damage (Soong, 1990). One type of isolators is active isolator. This system, using an external source, can control the energy of the structural vibrations under lateral forces. Therefore, the absorbed energy by the structural components is limited (Soong and Constantinou, 1994). Another type of isolators is base isolation. This system can limit the entered energy to the structure and do not let the structural components experience great damage (Skinner, 1993). Floor isolation of buildings is one type of seismic isolation systems (Lyan-Ywan Lu et al., 2013; Shi et al., 2012).

Yielding dampers, as passive dampers, are the other effective approaches in structural control. In this research, the seismic behavior of the structure combined with yielding dampers and floor seismic isolation is investigated.

## MODELING

The proposed structure for this investigation is a three-story frame that in each story, the mass of the floors is connected to the frame by yielding springs. In this model, for the simplification, the mass of structural components is ignored compared with the mass of the floors. Figure 1-a shows the proposed structure schematically. In this figure, Ki, mi and kdi are representative of stiffness, floor mass and stiffness of yielding damper of $i^{th}$ story, respectively. According to Figure 1-b, the stiffness of stories is modeled as linear springs and it is assumed that yielding does not occur in stories. The yielding springs, as dampers, are considered with elastoplastic behavior.

## METHOD OF THE ANALYSIS

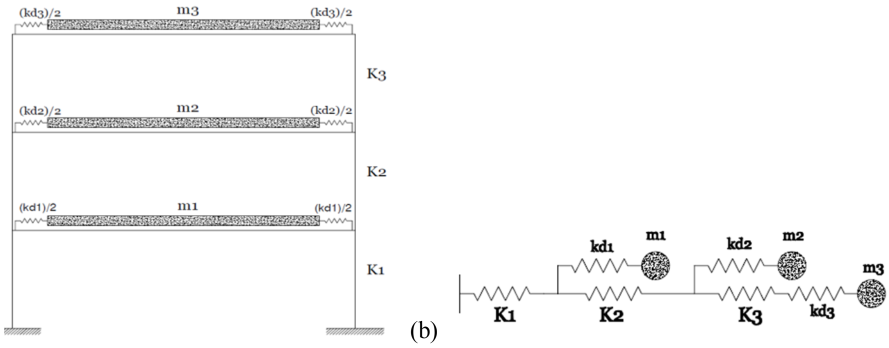
MATLAB program is used to obtain answer of the system under the ground motion. First, some values are considered for the characteristics of the structure to investigate the effect of stiffness and yielding strength of floor isolator springs. Then, with changing two variables, the results are gained and compared. The characteristics of the assumed structure are written below.

$$K_1 = 1.4 * K_3,\ K_2 = 1.2 * K_3,\ K_3 = 2e6\ N/m \quad (1)$$

$$K_d = Nk * K_3 \quad (2)$$

$$F_y = Nfy * F_{elstic} \quad (3)$$

$$m_1 = m_2 = m_3 = 1e4\ kg \quad (4)$$




(a) (b)
*Figure 1. (a) three-story frame with seismic isolator schematically, (b) Equivalent model of spring and mass.*

## NONLINEAR BEHAVIOR

$N_{fy}$ is the ratio of yielding strength of isolator springs to maximum force in the linear state. Having two variables of stiffness ratio and yielding strength ratio of the isolator, two figures are presented for the maximum story drifts. It is assumed that there is no nonlinear behavior in stories; therefore, the reduction in story drifts is due to change in stiffness and yielding strength ratio of isolator springs. Figure 2 shows the effect of these two parameters on the ratio of maximum story drifts in the nonlinear state to maximum story drifts in a linear state.

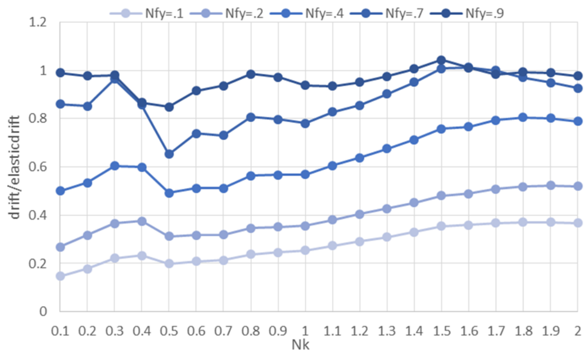



*Figure 2. Maximum story drifts of the structure having nonlinear behavior for constant strength ratio.*

## RESULTS

- Generally, change in stiffness of yielding isolator leads to a change in seismic demand of the structure. However, it is not observed a constant trend in changes. Because of the changes in the dynamic characteristics of structure, in this case, a constant trend is not observed.
- Seismic demand significantly decreases with a reduction in strength ratio in the seismic isolator system. This represents the efficiency of this system.
- Finally, in this research considering these structural characteristics and selected accelerations, yielding isolator of floors with $N_k$=1 and $N_{fy}$=0.5 leads to a reduction of 40% in seismic demand of the structure.

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