Investigation on seismic retrofitting behavior of unreinforced masonry buildings by sliding isolation system

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Abstract

Base isolation through reducing transmitted acceleration into superstructure is a useful method for retrofitting masonry buildings, since decoupling would only disturb building at isolation level. In this study professional finite element code is employed for analytical study where nonlinear behavior of masonry units (mortar and brick) is considered by equivalent modeling. Efficiency of sliding isolation system is investigated by nonlinear time history analysis. Seismic performance of isolated masonry building is evaluated and effects of different parameters are studied. Adequacy of sliding isolation for retrofitting unreinforced masonry building is demonstrated.

Keywords: retrofitting, unreinforced masonry, sliding isolation, nonlinear time history.

1. INTRODUCTION

In recent years manufacture of isolator devices caused this method of retrofitting come to practical engineering. In the past decades it was just first principles that provided today's engineers with the knowledge of the improving the seismic safety. Also the advances in finite element programs made this opportunity to predict the structures behavior.

We know stiff buildings will be damaged because of high acceleration during the earthquake, on the other side, flexible buildings have large story drifts and deformations. Between these two cases we need complex criteria for suitable design. There are lots of masonry buildings which are not constructed according to seismic codes. Some of them are rural buildings which is better to be replaced with new ones. Some others _like historical buildings_ deserve to be retrofitted even by high cost methods. So there is a need for rehabilitation provisions besides the seismic codes.

In this study SAP2000 was employed to investigate the behavior of the structure since this program has the ability to model the isolation system. At first the properties of models introduced here. And then it is checked to see how a single degree of freedom model (model 2) approximates the first model.

2. MODELS PROPERTIES

Here we have two models. The first one is a single room with dimensions of 6m length, 4m width and 3m height. Each wall has an opening which three of them are windows and one of them as the door. The thickness of walls is considered to be equal to 0.3m. Dimension of door is 2x1.5m and for the windows we assign 1.5x2m openings. Isolators are beneath every joint of walls.

The second one is a single solid object. It has the same mass as the previous model. The isolators are located at 4 sides of the solid object.

Although masonry materials have little tension strength it is preferred to consider a value equal to 1.265E-03 for the strain and 929.38 KPa for the stress. It is because that developed tension forces make a couple with compression forces and resists the moment of external forces. The other values for stress and strain is given in reference [1].

The 1940 El Centro earthquake is used in this study. The time steps are provided at an equal interval of 0.01 sec. 4096 data for the acceleration is recorded, so we need more than 41 second for the time history analysis, since at the end of earthquake the velocity of superstructure is not necessarily zero. But actually in this study 15 sec was considered to analyze. The first model which described above includes 292 area objects, and output time step size is 5e-3(the larger values were not appropriate for convergence). For this