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Seismic Upgrading of the ۱۱۱ Serie Residential ۱۰ Story R.C.Frame Buildings in Armenia, using Additional Isolated Upper Floor

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Abstract

Widely distributed ۱۱۱ serie, ۱۰ story R.C. frame buildings are constructed during former soviet union in Armenia and Nagorno Karabakh province. Current research is completed to illustrate the concept of seismic upgrading of above mentioned buildings, using an Additional Isolated Upper Floor (AIUF). After constructing the finite element model, Time history analyses are applied on it, using six pair of accelerograms recorded on rock or very stiff soil (۷۵۰<V_s<۱۲۰۰ m/s), and loose rock or stiff soil (۳۷۵<V_s<۷۵۰ m/s), scaled to S_a=۰،۴g. Later, the AIUF which behaves as a Tuned Mass Damper (TMD) is added to the model and after tuning for the frequency and damping ratios, the same time history analyses are applied on this new model too. The final analyses results show considerable reduction on lateral displacement and base shear force when using AIUF, satisfying the overall seismic behavior of the building.

Keywords: Seismic upgrading, accelerogram, lateral displacement, Time History analysis, Additional isolated upper floor

۱. Introduction

Previous experience of earthquakes illustrates that many types of structures behave nonlinearly during a severe earthquake. So a huge amount of input energy is mainly dissipated through the form of damping and hysteresis. The aseismic behaviour analysis and accurate design of structures for severe earthquakes are mainly carried out using Nonlinear Time history Analysis method (NTHA). The Tuned Mass Damper Passive Aseismic Control system (TMD) reduces both the lateral displacement and base shear forces caused by the earthquakes. If truely tuned, structures equiped with TMD could behave linearly during a severe earthquake. The TMD control system could be used for to be constructed buildings and also for buildings which do not satisfy the seismic code requirements. In this research, by using the TMD concept, an Additional Isolated Upper Floor (AIUF) is added to the top of the ۱۱۱ serie, ۱۰ story R.C. frame building, and tuned for the frequency and damping ratios, so that could reduce the lateral displacements and base shear forces to a great extent, to ensure the overall linear behavior of the building during a severe earthquake.

۲. Tuned Mass Damper's (TMD) Theoritical Bases

The two-DOF systems shown in Figure ۱ is excited by a harmonic force $p_1(t) = p_o \sin\omega t$ applied to the mass m_1. For both systems the equations of motion are as equation (۱):

$$\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix} \begin{Bmatrix} \ddot{u}_1 \\ \ddot{u}_2 \end{Bmatrix} + \begin{bmatrix} k_1 + k_2 & -k_2 \\ -k_2 & k_2 \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \end{Bmatrix} = \begin{Bmatrix} p_o \\ 0 \end{Bmatrix} \sin \omega t \qquad (۱)$$