第Ⅰ部門 **Numerical Evaluation for Optimum Design of Seismic Isolation of Equipments**

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Introduction

This paper, by proposing a method for optimum design of seismic isolation of equipments tries to determine optimum parameters of elastoplastic model (high damping isolators, lead rubber bearings, ...) by energy concept and to find their sensitivity for different level of allowable acceleration of the equipments.

Methodology

Past seismic casualties demonstrate when the elastic energy is small, the total input energy is deemed to concentrate in weakest level and if this level has not enough capacity to dissipate input energy, system will be collapsed. In this regard seismically isolated equipments with rigid body response and low stiffness of isolators has same behaviour and for this reason, design of seismic isolated equipments with energy concept has advantages over to other methods. This paper tries to determine optimum parameters of seismic isolation system for the prescribed allowable acceleration level of equipments *with maximum energy dissipation and less displacement.* Allowable level of acceleration is the maximum horizontal acceleration that equipments can resist against their inertial force without any failure. Seismic isolation system should be design to control absolute acceleration response under the allowable level.

Fig.1 clearly depicts procedure of optimum parameter recognition in ElastoPlastic model for specific allowable acceleration. In this method, equipment and raised floor are considered as a solid mass (Fig.2) that they are installed on isolation system and make a nonlinear SDOF model. Then response spectrum of earthquake is computed for various yield force ratio(f_y / W) and post stiffness of assumed SDOF model.

Now, for specific level of allowable acceleration different pairs of yield force and period ((f_y / W), T) that their acceleration are under this level are eligible to use as design parameters of isolation system of equipment. But it is easy to understand just those pairs, which are in conjunction point of allowable acceleration has minimum displacement (they have minimum period among eligible points).

Between these pairs with minimum displacement, any one has maximum energy dissipation is considered as an optimum yield force ratio (f_y / W) and optimum period of specified allowable acceleration.

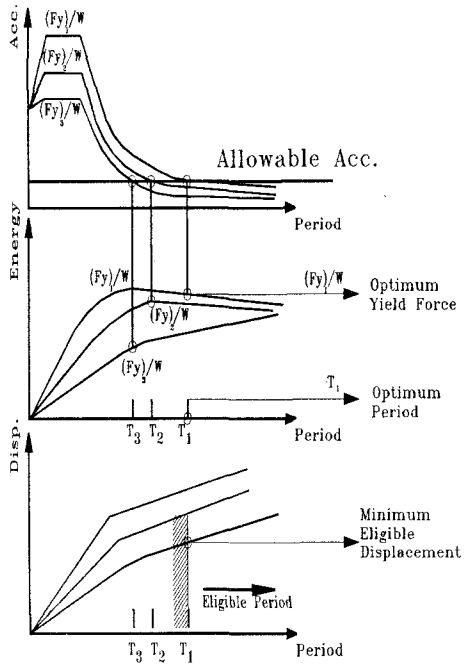

Fig.1- Procedure of optimum parameter recognition

Numerical Analysis

Response spectra and energy spectra of Elcentro Earthquake (NS 1940) are computed for 315 elastoplastic models (35 yield strength x 9 post yield stiffness) and Fig.2 shows range of their parameter. 315 points of the intersection between the straight line of the allowable acceleration and the spectrums of

all models, are selected for possible optimum parameters. each point has specific period, yield force ratio and post yield stiffness.

Fig.3 shows the total energy dissipation of the 315-selected case with various yield force ratio and period. From two figures in Fig.3, with the specific allowable level is equal to 3% of Peak Ground Acceleration of Elcentro earthquake it is found the system with yield force ratio 0.015 and period 4.7 second dissipates the maximum input energy. This figure confirms that post yield stiffness has not considerable effect on optimum parameters in selected range.

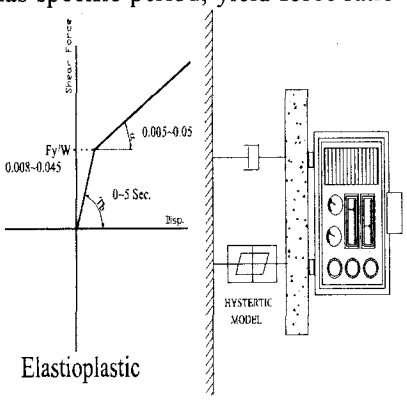

Fig.2- SDOF Elastoplastic Model with Variable Parameter

Optimum Parameters

Here, Optimum values of main parameters of elastoplastic models are determined for 7 specified allowable acceleration. Fig4 clearly depicts optimum period and yield force ratio of elastoplastic system for different level of allowable acceleration under Elcentro earthquake. This graph shows that viscous damping reduces optimum yield force ratio and increases optimum period when allowable level of acceleration is under 0.10 of PGA.

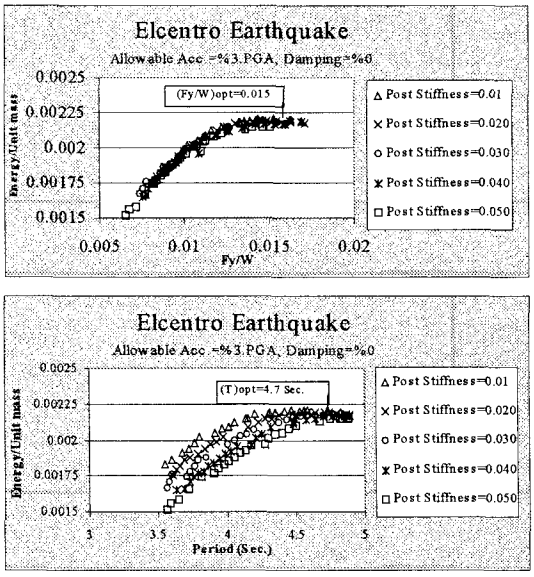

Fig.3- Variation of Dissipated Energy in Elastoplastic Model

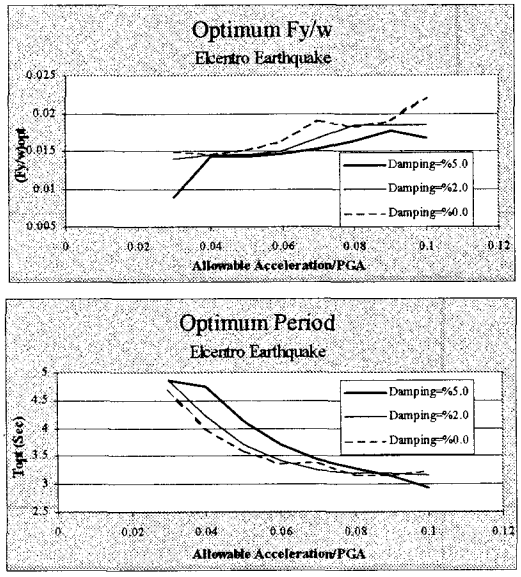

Fig.4- Optimum Parameters for Elastoplastic Model

Conclusion

In this paper, after proposing a method for optimum design of isolation system in equipment, optimum parameters of elastoplastic model under Elcentro Earthquake were determined for different allowable level of acceleration. Results of analysis show that optimum period decreases by increasing of allowable level of acceleration. Optimum yield force ratio f_y / W varies between 0.01~0.02 but it generally grow up by increasing of allowable level of acceleration.

Reference:

1. Iemura H., Ohshima K., Nakata T., "Earthquake Energy Partitioning and Reliability of bridge Structures With Seismic Isolators"