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

VISCOELASTIC CONNECTION: AN EFFICIENT TOOL FOR RANDOM SEISMIC POUNDING MITIGATION

Hamed AHMADI TALESHIAN
Ph.D. Candidate of Structural Engineering, Noshirvani University of Technology, Babol, Iran
hamed_ahmadi0111@yahoo.com

Alireza MIRZAGOLTABAR ROSHAN
Associate Professor of Structural Engineering, Noshirvani University of Technology, Babol, Iran
ar-goltabar@nit.ac.ir

Javad VASEGHI AMIRI
Professor of Structural Engineering, Noshirvani University of Technology, Babol, Iran
vaseghi@nit.ac.ir

Keywords: Pounding mitigation, Random vibration, VE links, Dynamic properties, Response ratio

Use of links with limited stiffness but certain amount of energy dissipation has been made popular in structural engineering since early 90s. There exist two overlapped goals in usage of such links; one is the seismic strengthening of individual buildings without clearly referring to pounding, i.e. by assuming a safe gap size in-between, while the other goal is to consider pounding explicitly. This paper studies the effects of viscoelastic links between two adjacent buildings for pounding mitigation under random seismic input.

A formulation is first extracted for the effective modal damping ratios of the system. Then, a formulation for the response of two single DOF linear buildings connected by viscoelastic links are considered under white-noise input, following with a successful verification of the change in the displacement response. Then, Results are presented in the form of "Linked-to-unlinked response ratio". Classical damping is sufficient for negligible damping of the links, in which results demonstrate that use of link with a moderate stiffness may reduce the stiffer building displacement up to about 20% in comparison to the free displacement for the buildings natural frequency ratio of 2 as shown in Figure 1, while the seismic pounding of the adjacent buildings are effectively controlled. Further, an upper limit of link stiffness is obtained for preventing the increase in the stiffer building displacement, which may be exceeded by the minimum link stiffness necessary for pounding prevention if small gap size exists. To illustrate the significance of VE links for seismic pounding mitigation, response ratio for the displacement of the stiffer building is compared with the same quantity for the case of using minimum link stiffness for pounding mitigation, as shown in Figure 2. The result clearly shows that the influence of pounding is not more severe condition than the case of pounding incident.

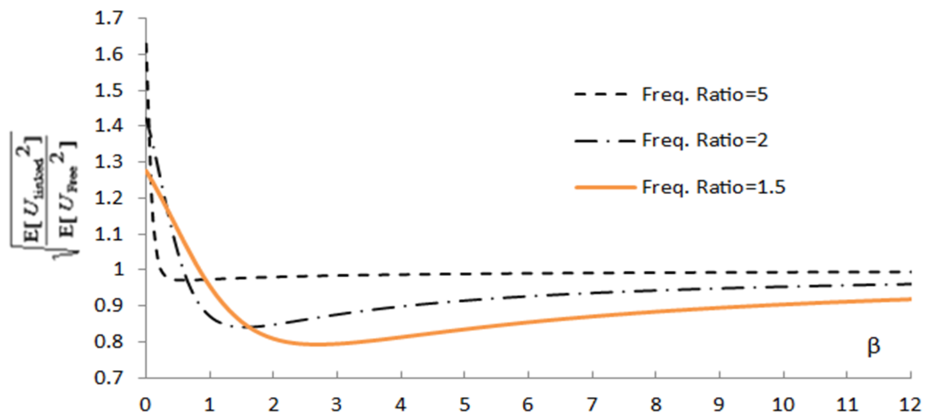

Figure 1. Linked-to-Unlinked displacement ratio for stiffer building against link to left building stiffness ratio (β).

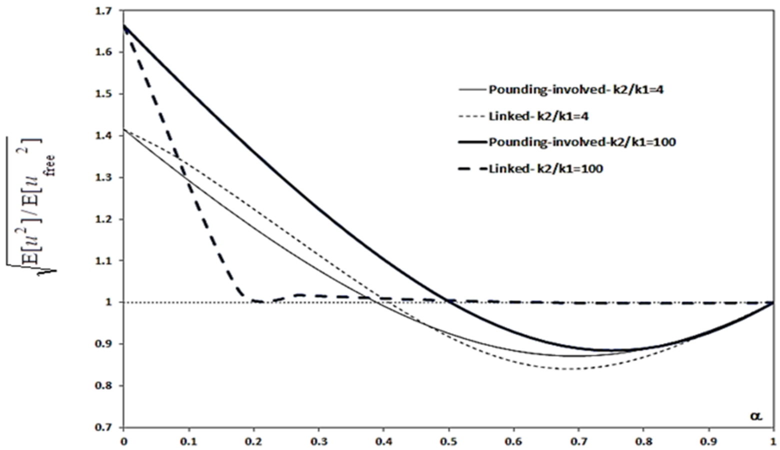

Figure 2. Comparison of linked-to-unlinked and unlinked pounding-involved displacement of the stiffer building.

For the case of considerable energy dissipation of the links, both non-classical damping scheme and also a classical equivalent one with the actual modal damping are used. Comparison of the two schemes demonstrates the efficiency of using classical analysis with a moderate safety of factor, instead of non-classical counterpart. In the case of added damping due to the connection of buildings, a considerable reduction in the individual, as well as relative, displacement of the buildings is observed by damping values within the seismic codes. The inelastic behavior is also taken into account by using equivalent natural frequencies and damping ratios of the buildings as functions of linear values, in addition to ductility and post-yield stiffness ratios. Taking into account the typical practical ranges of ductility, results demonstrate that the elastic response is more critical than the inelastic one.

Finally, the effect of ground dominant frequency and damping on the displacement response is also investigated by using Kanai-Tajimi white noise as the random input. It becomes clear from the results that though an irregular pattern governs the linked-to-unlinked ratio of the relative displacement of the buildings, but linked-to-unlinked response ratio of stiffer building displacement increases if the ground frequency lies between individual frequencies of adjacent buildings. This increase may be effectively attenuated by increasing the ground damping, as shown in Figure 3 for rigid linkage and against different values of ground-to-left building frequency ratios (m) and ground damping ratios.

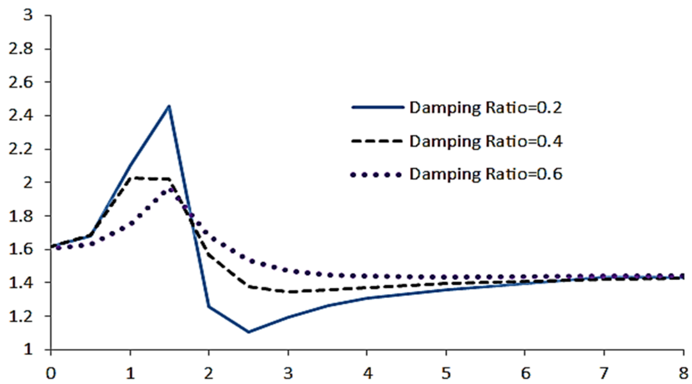

Figure 3. Effect of ground damping on the linked-to-unlinked response ratio (Displacement of stiffer building).

REFERENCES

Jankowski, R. and Mahmoud, S. (2016). Linking of adjacent three-storey buildings for mitigation of structural pounding during earthquakes. *Bull. Earth. Eng.*, *14*(11), 3075-3097.

Mirzagoltabar Roshan, A., Ahmadi Taleshian, H., and Eliasi, A. (2017). Seismic pounding mitigation by using viscous and viscoelastic dampers. *Proceedings of the International Conference of Scientists (ICS)*, Moscow, Russia.

Miari, M., Choong, K.K., and Jankowski, R. (2019). Seismic pounding between adjacent buildings: Identification of parameters, soil interaction issues and mitigation measures. *Soil Dyn. Earthq. Eng.*, *121*, 135-150.

Westermo, B.D. (1989). The dynamics of interstructural connection to prevent pounding. *J. Earth. Eng. Struct. Dynam.* *18*(5), 687-699.