Layout optimization of elasto-plastic dampers for steel braced tubes based on Generalized Response Spectrum Analysis

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Abstract

It is growing common to employ energy-dissipation devices because numerous structures are recently required continuous use even after large earthquakes. Elasto-plastic dampers, such as buckling-restrained braces (BRBs), particularly act as fuses to prevent member buckling of axial members, and are hence suitable for seismic design of truss structures having complicated vibration characteristic. The challenge is to determine a set of discrete locations where a limited number of dampers would be most effective. The authors proposed a generalized response spectrum analysis (GRSA) for highly indeterminate 3-D structures considering not only viscous but also elasto-plastic damping (Terazawa et al. [1]). As GRSA requires few computational resources compared with response history analysis, it can be used for genetic optimization studies. However, the author's application study is limited to single-span lattice tower (Terazawa et al. [2]), and there are also few layout optimization studies of elasto-plastic dampers under seismic loads. It is premature to provide the proposed damper design routine to practitioner toward to form findings. Therefore this paper presents layout optimization studies of elasto-plastic dampers for multi-spans braced tubes shown in Fig. 1 to analyze the effective member configuration for various objective functions and layout operations, which includes replacing concentric braces with BRBs, replacing first story columns with BRBs and removing concentric braces. According to the results, (1) the proposed damper design routine can produce various design options, (2) simple single-objective optimizations minimizing a specific seismic response may produce unrealistic design solutions that reduced only the response extremely and (3) buckling demand capacity should be a penalty of a single-objective optimization to prevent member buckling.

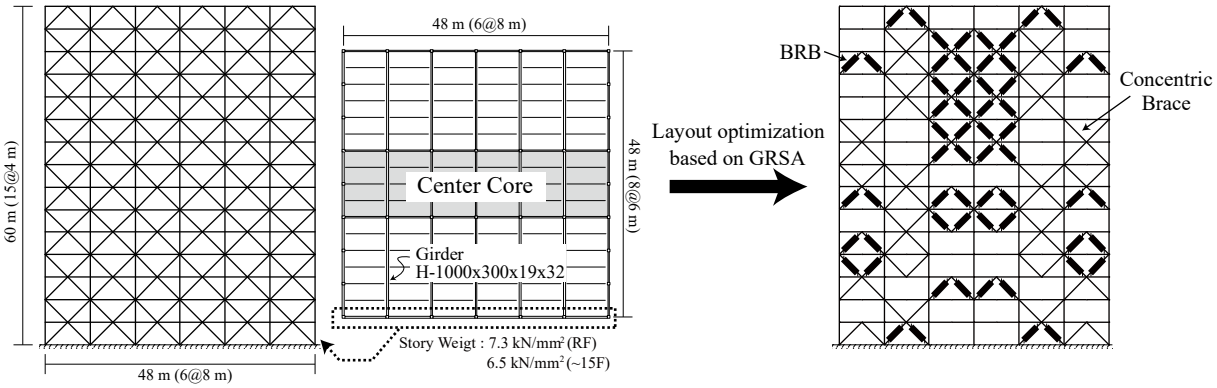

Fig. 1 Schematic image of the braced tubes.

References

[1] Y. Terazawa and T. Takeuchi, "Generalized Response Spectrum Analysis for Strucutres with Dampers," Earthquake Spectra, Vol. 34, No. 3, pp. 1459-1479, 2018.8

[2] Y. Terazawa and T. Takeuchi, "Elasto-plastic Damper Optimization Routine for Lattice Towers Based on Generalized Response Spectrum Analysis," Journal of the IASS, Vol. 59, No. 4, pp. 243-250, 2018.12