Influence of viscous dampers uncertainties on the seismic risk of a low-rise steel building

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Fluid viscous dampers are widely employed to control and enhance the seismic response of structural systems [1,2,3]. However, the reliability of these devices may be significantly affected by the uncertainty inherent to the manufacturing process, which might lead the dampers to respond in an unexpected way. The main international codes [4,5] acknowledge the aforementioned issue and provide some acceptance criteria requiring that the response of prototype tests, generally expressed in terms of force-velocity relation, does not deviate from the nominal design condition by more than a tolerance. However, no prescriptions or limits are imposed on the viscous damper constitutive parameters (viscous coefficient c and velocity exponent α), whose admissible ranges of variability are unknown. As an extension of a previous work [6], the present paper aims to investigate how the seismic performance of a structural system, described in terms of mean annual rates of exceedance of the relevant response parameters, is affected by the uncertainty of damper properties. The investigation is carried out on a benchmark case study consisting of a low-rise steel moment-resisting frame building equipped with a set of linear and nonlinear viscous dampers, designed to achieve the same deterministic target performance for a reference seismic scenario. The study results show that the damper properties variability affects differently the various response parameters considered, and that in some cases significant seismic demand amplifications can be observed.

REFERENCES

[1] C.Y. Seo, T.L. Karavasilis, J.M. Ricles and R. Sause, Seismic performance and probabilistic collapse resistance assessment of steel moment resisting frames with fluid viscous dampers. *Earthquake Engineering and Structural Dynamics*, Vol. **43**(14), pp. 2135-2154, 2014.

[2] E.M. Güneyisi and G. Altay, Seismic fragility assessment of effectiveness of viscous dampers in R/C buildings under scenario earthquakes. *Structural Safety*, Vol. **30**(5), pp. 461-480, 2008.

[3] L.R. Barroso and S. Winterstein, Probabilistic seismic demand analysis of controlled steel moment-resisting frame structures. *Earthquake Engineering and Structural Dynamics*, Vol. **31**(12), pp. 2049-2066, 2002.

[4] American Society of Civil Engineers, Seismic Evaluation and Retrofit of Existing Buildings: ASCE Standard ASCE/SEI 41-13. American Society of Civil Engineers, 2014.

[5] European Committee for Standardization, *EN 15129:2010 - Antiseismic devices*, Brussels, Belgium, 2010.

[6] A. Dall'Asta, F. Scozzese, L. Ragni and E. Tubaldi, Effect of the damper property variability on the seismic reliability of linear systems equipped with viscous dampers. *Bulletin of Earthquake Engineering*, Vol. **15**(11), pp. 5025-5053, 2017.