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

DYNAMIC RESPONSE OF ROCKING STRUCTURES EQUIPPED WITH VERTICALLY MOUNTED VISCOUS DAMPERS IN BOTTOM STORY

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Keywords: Viscous damper, Rocking structures, Earthquake protective systems, Low-damage structures, Uplift

Earthquake ground motions impart kinetic energy into structures. By reducing this energy, the location and the extent of the damage are controlled.

Reducing seismic response may be obtained by allowing part of the structure to lift during large horizontal ground motions. This mechanism is referred to as uplift or rocking, and involves a discontinuity of contact between part of the foundation and the soil beneath, or between a vertical member and its base. In reality, foundations are not firmly bonded to the soil underlying the structure, and supported on the soil only through gravity forces. Whether the assumption that the foundation and soil are firmly bonded is considered or not, uplifting would occur during an earthquake to an extent.

The good performance of some pre-code low-rise brittle concrete buildings in the near-fault region of the Hawke's Bay, New Zealand, earthquake of 1931 can only be explained by rocking having beneficially occurred during the earthquake. While not incorporating any energy dissipaters, these buildings relied solely on uplifting columns or rocking of foundations to produce the desired effects.

However, despite apparently favorable results, such structures have not yet been enthusiastically adopted in practice. This is probably due to design uncertainties regarding soil behavior under rocking foundations and the possible overturning of slender structures. Furthermore, after a period of tipping when the foundation slams into renewed contact with the ground, collision impulses are generated in the superstructure and the supporting soil. These short duration high intensity normal forces could conceivably endanger the stability of the structure's compression members or lead to foundation failure.

With the addition of energy absorbers (Figure 1) the above hazards are lessened, and utilization of the advantageous flexibility of uplift has been put to practical effect in completed constructions, the first such structure to be built was the South Rangitikei Railway Bridge in New Zealand.

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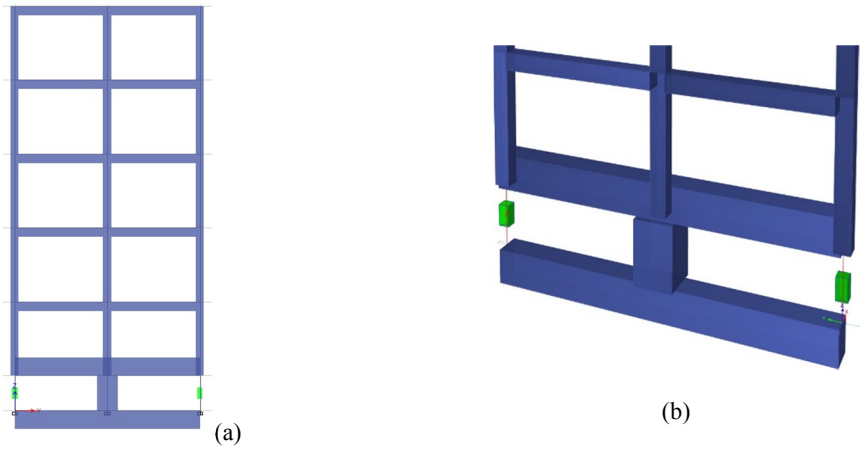

(a) (b)

Figure 1. Rocking structure equipped with vertical viscous dampers.