THE EFFECT OF SITE SOIL ON SEISMIC PERFORMANCE OF STEEL DAMPED STRUCTURE AT CLOSE DISTANCE OF ACTIVE FAULT

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The geological characteristics of soil materials beneath a site have a significant impact on seismic properties of earthquake waves. This phenomenon, known as local site effect, may lead to a change between the response spectrum of the surface and the bedrock, and therefore, affect the seismic performance of the structures (Behrou et al., 2017). With the aim to reduce the inelastic demand triggered by structural members of frame building during seismic excitations, one of the innovative cost-efficient solutions is the application of friction dampers (Pall, 1979). These devices rely on the resistance developed between two solid interfaces sliding relative to one another, and their efficiency has been proved through experimental (Aiken et al., 1988) and numerical (Ramirez and Tirca, 2012) studies. Moreover, the seismic fragility of friction damped braced frames (Taiyari et al., 2019) and the effect of these dampers for the mitigation of multi-hazard excitations (Downey et al., 2018) have also been investigated. Since these types of dampers depend on the story displacements (story drift ratios), they can be affected by the variation in site properties. Hence, the efficiency of this type of dampers should be evaluated by considering the site effects.

In this paper, the seismic performance of a 10-story intermediate steel damped moment frame has been studied under near-fault ground motions, which are categorized into two groups. First is raw ground motions which are recorded on the bedrock (bedrock records) and the second is same records which are passed through different soil layers (surface records), so they have changed due to site effects. Then the time-history analyses have been carried out and the seismic response of the structure is investigated under both record groups.

The comparison between the nonlinear time-history analyses with and without site effect consideration shows that the amount of absorbed energy by dampers for bedrock records is higher than the records on site surface. However, as can be seen in Figure 1, the discrepancy between the absorbed energy of bedrock and surface records is insignificant. For instance, the ratio of input to absorbed energy for Tabas bedrock and surface records are 90.1% and 85.5% respectively. This indicates that in spite of the considerable rise in input energy for the surface records, dampers are still able to absorb the great amount of it, so other structural elements can remain linear.

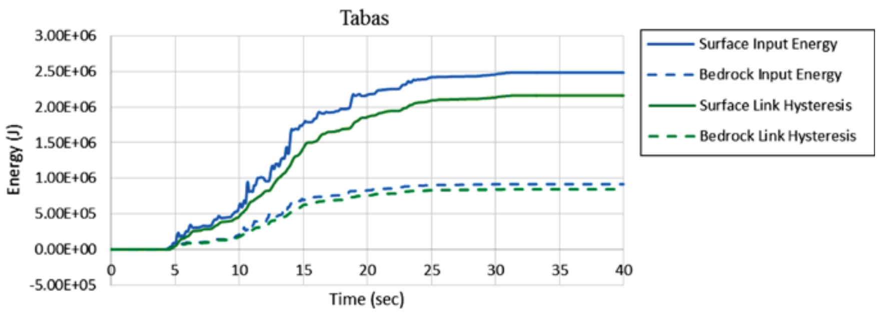
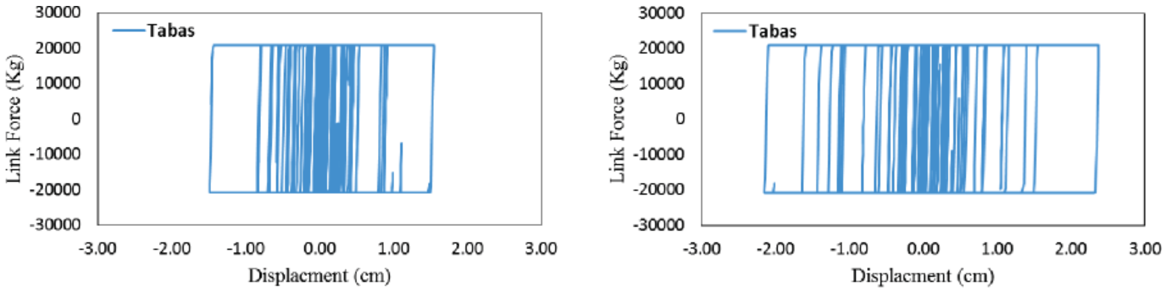


Figure 1. The input and link hysteresis energy (absorbed energy) of friction dampers.

Figure 2 depicts the hysteresis loops of the friction dampers when the structure undergoes Tabas records. In both conditions, dampers begin to displace after the link force exceeds a predetermined load. Nevertheless, the maximum displacement for surface record is considerably higher than that of the bedrock record. This difference stem from the changes occurred in the input records due to the site effects which increase the peak ground acceleration of the record. In addition, the hysteresis loops which represent the energy dissipation during load cycles are nearly rectangular and stable for both record types. As a result, the seismic performance of the dampers remains acceptable despite of the dramatic change in input record energy and characteristics.

In conclusion, for structures prone to site effects, the application of friction dampers may well be one of the convenient alternatives in order to preserve the structure from damage due to inelastic deformations of the structural elements.



(a) (b)

Figure 2. Hysteresis Loops of Friction Dampers for Tabas record, a) Bedrock, b) Surface.

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