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Design and Assessment of Base Isolated Structures under Spectrum-Compatible Bidirectional Earthquakes

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Abstract : Concave Surface Slider devices have been more and more used in real applications for seismic protection of both bridge and building structures. Several research activities have been carried out, in order to investigate the lateral response of such a typology of devices, and a reasonably high level of knowledge has been reached. If radial analysis is performed, the frictional force is always aligned with respect to the restoring force, whereas under bidirectional seismic events, a bi-axial interaction of the directions of motion occurs, due to the step-wise projection of the main frictional force, which is assumed to be aligned to the trajectory of the isolator. Nonetheless, if non-linear time history analyses have to be performed, standard codes provide precise rules for the definition of an averagely spectrum-compatible set of accelerograms in radial conditions, whereas for bidirectional motions different combinations of the single components spectra can be found. Moreover, nowadays software for the adjustment of natural accelerograms are available, which lead to a higher quality of spectrum-compatibility and to a smaller dispersion of results for radial motions. In this endeavor a simplified design procedure is defined, for building structures, base-isolated by means of Concave Surface Slider devices. Different case study structures have been analyzed. In a first stage, the capacity curve has been computed, by means of non-linear static analyses on the fixed-base structures: inelastic fiber elements have been adopted and different direction angles of lateral forces have been studied. Thanks to these results, a linear elastic Finite Element Model has been defined, characterized by the same global stiffness of the linear elastic branch of the non-linear capacity curve. Then, non-linear time history analyses have been performed on the base-isolated structures, by applying seven bidirectional seismic events. The spectrum-compatibility of bidirectional earthquakes has been studied, by considering different combinations of single components and adjusting single records: thanks to the proposed procedure, results have shown a small dispersion and a good agreement in comparison to the assumed design values.

Keywords : concave surface slider, spectrum-compatibility, bidirectional earthquake, base isolation
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