EFFECTS OF MOMENT-TO-SHEAR RATIO ON COMBINED CYCLIC LOAD-DISPLACEMENT BEHAVIOR OF SHALLOW FOUNDATIONS FROM CENTRIFUGE EXPERIMENTS

By

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Abstract

Current design guidelines for shallow foundations supporting building and bridge structures discourage footing rocking or sliding during seismic loading. Recent research indicates that footing rocking has potential to reduce ductility demands on structures by dissipating earthquake energy at footing-soil interface. Concerns over cyclic and permanent displacements of the foundation during rocking and sliding along with the dependence of foundation capacity on uncertain soil properties hinder the use of footing rocking in practice. This paper presents the findings of a series of centrifuge experiments conducted on shear wall-footing structures supported by dry dense to medium dense sand foundations that are subjected to lateral cyclic loading. Two key parameters, static vertical factor of safety (FS_V) and the applied normalized moment-to-shear ratio ($M/(H \cdot L)$) at the footing-soil interface, along with other parameters, were varied systematically and the effects of these parameters on footing-soil system behavior are presented. As expected, the ratio of moment to the horizontal load affects the relative magnitude of rotational and sliding displacement of the footing. Results also show that, for a particular FS_V, footings with a large moment to shear ratio dissipate considerably more energy through rocking and suffer less permanent settlement than footings with a low moment to shear ratio. The ratio of actual footing area (A) to the area required to support the vertical and shear loads (Ac), called the critical contact area ratio (A/Ac), is used to correlate results from tests with different moment to shear ratio. It is found that footings with similar A/Ac display similar relationships between cyclic moment-rotation and cumulative settlement irrespective of the moment-to-shear ratio. It is suggested that shallow foundations with a sufficiently large A/Ac suffer small permanent settlements and have a well defined moment capacity; hence they may be used as effective energy dissipation devices that limit loads transmitted to the superstructure.

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