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Earthquake-induced displacements of anchored gravity retaining walls

○Aurelian C. Trandafir, Toshitaka Kamai, Roy C. Sidle, Mihail Popescu

During the October 23, 2004 Chuetsu earthquake, several residential developments constructed on reclaimed land in Nagaoka city, Niigata Prefecture, have experienced damages to houses and roads due to seismically-induced failure of artificial fill slopes. Post-earthquake field reconnaissance surveys revealed that many fill slope failures were caused by the excessive seismic displacements of the gravity retaining walls supporting the fill material. At present, a large number of residential areas built on artificial fills exist in Japan, and in order to avoid future seismically-induced landslide damage in these earth structures, a new national disaster reduction strategy was implemented by the authorities after the Chuetsu earthquake. One of the mitigation measures being considered is the improvement in seismic performance of the existing gravity retaining walls by anchoring the wall with nails or bolts which are inclusions into the ground designed to resist mainly tensile forces. The effectiveness of anchors in reducing the seismic wall displacements is explored in this study through a sliding block analysis of the seismic behavior of an anchored gravity retaining wall supporting a dry homogeneous fill slope subject to horizontal ground shaking. Sliding failure along the base of the wall and translational failure along a planar slip surface of the active wedge within the fill material behind the wall were considered in the formulation, whereas the anchor load was taken as a line load acting on the face of the gravity retaining wall. The effects of magnitude and orientation of anchor load on the yield acceleration of the wall-backfill system and seismically induced wall displacements were examined. It was found that for the same anchor orientation, the yield acceleration increases in a quasi-linear manner with increasing the anchor load, whereas an anchor load of a given magnitude acting at various orientations produces essentially identical yield accelerations. A dynamic displacement analysis conducted for a specific input horizontal ground motion indicates an exponential decrease in permanent seismic wall displacement with increasing magnitude of anchor load.

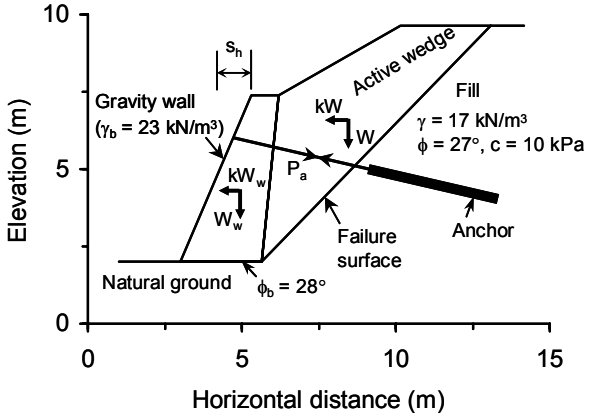

Fig. 1. Configuration of the analyzed anchored gravity retaining wall.

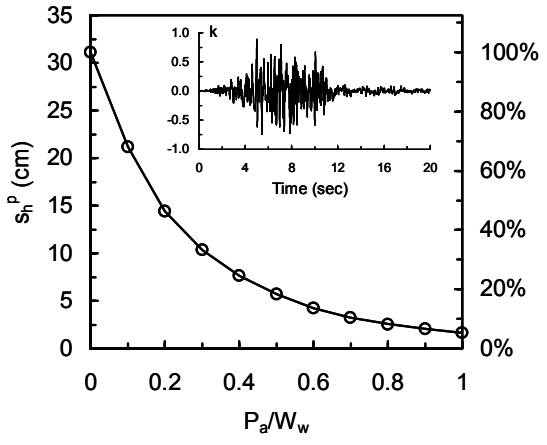

Fig. 2. Permanent seismic wall displacements (s_h^p) versus anchor load (P_a).