

Evaluation of extent of earthquake damage to geogrid reinforced soil walls by the settlement of backfill surface

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Geogrid reinforced soil walls (GRSWs) is recognized to have high seismic stability. However, in the recent large earthquakes, significant amount of wall deformation was observed, though the walls did not collapse completely. Stability of damaged GRSWs against the next big event is unknown. It is necessary to evaluate the extent of their damage to assess necessity of repairing or reconstructing them. For the quick recovery of infrastructures, such assessments should be made without time-consuming investigation such as boring. Wall inclination was proposed to be a good index to evaluate the extent of GRSW damage. However, determining wall inclination would be challenging in real-world scenarios due to factors like difficulty in approaching the damaged wall, which is often screened by vegetation, right after the event. Settlement of the backfill surface is easier to be measured by UAV than the wall inclination. In this study, laboratory model shaking table tests were carried out to study settlement profiles in the backfill surface and their correspondence with the extent of damage of GRSWs.

A typical layout of model wall is shown in Fig.1. Toyoura sand ($D_r=80\%$) was used for both backfill and foundation. Optical targets were placed within the backfill soil to monitor strain condition by a camera fixed in front of the model. LiDAR was fixed above the model to monitor the settlement profile. High stiffness (H-type) and low stiffness (L-type) geogrids were used. The H-type showed the maximum pullout resistance value around four times greater than that of the L-type. A total of six model tests were conducted, each with a different combination of geogrid type, and geogrid length. Models H40, H50 and H60 used H-type geogrid and models L40, L50 and L60, used L-type. The second part in the model name represents the geogrid length to the wall height, H , ratio (%).

The model walls were subjected to seismic loading in a shaking table using a sinusoidal wave with a predominant frequency of 5 Hz. The amplitude of the wave was increased by 50 gal every 10 seconds until the walls collapsed completely. Arias Intensity, I_A , shown in Eq. (1) was used as an intensity of input acceleration, $a(t)$.

$$I_A = \frac{\pi}{2g} \int_0^T a(t)^2 dt \quad (1)$$

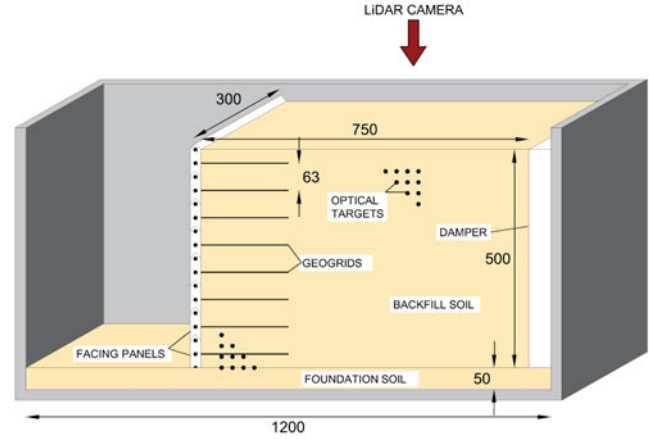


Fig. 1. Typical layout of the model wall.

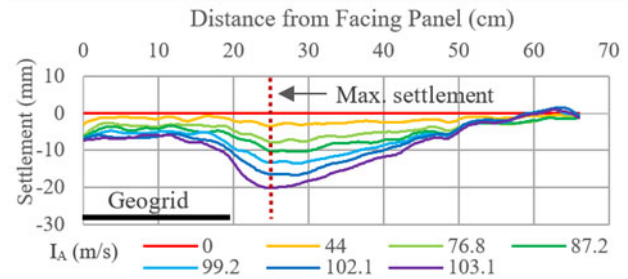


Fig. 2. Settlement profile in the case of H40.

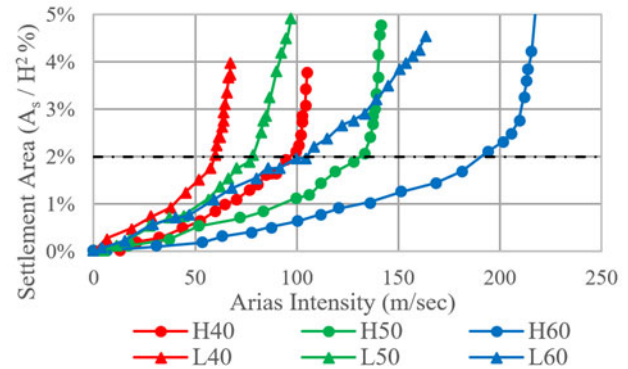


Fig. 3. Settlement area vs Arias Intensity.

Settlement profile in the case of H40 is shown in Fig.2 as an example. The settlement increased with the increase in I_A . The settlement trough area nondimensionalized by H^2 , also increased with I_A as seen in Fig. 3. The walls in this test series could not bear additional shaking and collapsed when the normalized settlement area reached about 2%. This seems to be suitable indicator for damage.