Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe

WP 15: Seismic behaviour of anchored steel sheet-piling (SSP) retaining walls

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Figure

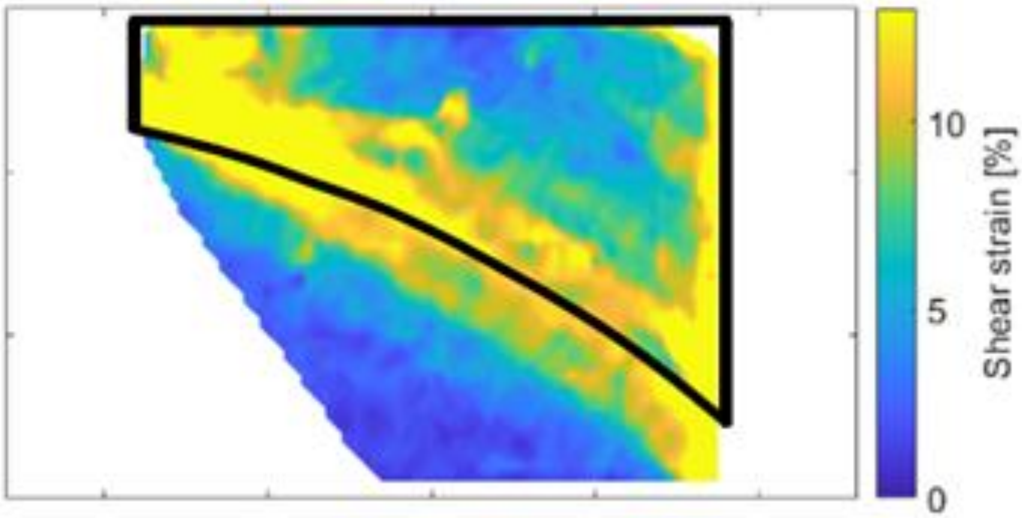

Figure 1. Comparison between predicted and observed failure mechanisms for an anchored retaining wall

Main Results

This project used the Turner Beam Centrifuge and Servo-Hydraulic shaker at the University of Cambridge to investigate the behaviour of anchored sheet pile retaining walls in the sand under earthquake loading. Tests on walls with a variety of geometries were carried out in plane strain conditions, at a centrifugal acceleration of 60 g, preparing the models within a homogeneous dry medium-dense layer (DR = 50 %) of fine-grained siliceous Hostun sand. Both the retaining wall and the anchor plate were modelled using aluminium alloy plates with a bending stiffness at prototype scale similar to that of an AZ28 steel sheet pile profile, while the tiebacks were modelled using four steel cables hinged at both ends. Displacement profiles within the backfill sand were measured using PIV photogrammetry techniques in order to illustrate the failure mechanisms mobilised during dynamic loading.

Table 1 reports, for each test, the critical acceleration and the expected failure mechanism according to the theoretical model proposed by Caputo et al. (2018), adopting two values for the soil peak friction angle, estimated using the empirical formula proposed by Bolton (1979). In the first two tests (AF02 and AF03), a local failure of the anchor system was expected, while a global failure mechanism was predicted for the last two tests (AF04 and AF05).

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ID test	a_c [g] ($\varphi = 38°$)	a_c [g] ($\varphi = 39°$)	expected failure mechanism
***AF*02**	0.21	0.24	anchor failure
***AF*03**	0.12	0.16	anchor failure
***AF*04**	0.145	0.165	global failure
***AF*05**	0.095	0.11	global failure

Table 1. Estimated critical acceleration and expected failure mechanism for each test

From the analysis of the experimental data, it was possible to compute the evolution, during the applied earthquakes, of the internal forces in the structural members (axial force in the tieback and bending moment distribution in the wall) and the displacements of the anchor plate and the main wall. Moreover, from a preliminary analysis of the experimental results, it was possible to highlight the role played by the critical acceleration on the maximum internal forces and the maximum displacements experienced by the system during the applied earthquake.

Figure 1 shows the contours of shear strains computed during the strongest earthquake applied in test AF05 (earthquake EQ3). The shear strains mainly develop along a failure surface going from the bottom of the anchor wall to the toe of the retaining wall, suggesting a global failure mechanism of the whole anchor-soil-wall system. As shown in Figure 1, this observation is entirely consistent with the theoretical log-spiral failure surface proposed by Caputo et al. (2018).

List of Publications

Fusco, A., Viggiani, G.M.B., Madabhushi, S.P.G., Caputo, G., Conti, R. & Prum, C. (2019) Physical modelling of anchored steel sheet pile walls under seismic actions. Earthqauke Geotechnical Engineering for Protection and Development of Environment and Constructions, Silvestri & Moraci (Eds.). pp. 2502-2509