Ⅲ - A120 Shaking Table Test of Cantilever Type Retaining Wall Model

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Introduction

To compare seismic performance among different type of retaining walls, a series of tilting tests [1],[2] and shaking table tests[3] were performed. This paper summarizes the result of shaking table test for a cantilever type retaining wall.

Testing Procedure

Fig.1 shows the cross-section of a cantilever type retaining wall model, where Toyoura sand was used as the backfill and subsoil layers. After filling of sand as described in[1], the whole sand box was shaken using sinusoidal waves at a frequency of 5 Hz. Their amplitude was initially adjusted to give the desired base acceleration of 25 gals and was increased at an increment of 25 gal. At each amplitude, about 10 seconds motion were applied. Because of the capacity of data storage, the first shaking was stopped at 275 gal. The second and the third shakings were performed similarly by increasing the initial amplitude of acceleration. During these shaking steps, the earth pressures acting on the wall and its response displacements, response accelerations of the wall and the backfill sand were recorded by using transducers as shown in Fig.1. In addition, seismic stability of the model wall was predicted by pseudo-static limit equilibrium type procedures, where the seismic earth pressures were calculated based on the Mononobe-Okabe theory using soil parameters γ=1.62 gf/cm^3 and ϕ=46°. They resulted in predicted critical acceleration a_{cr} of 250 and 390 gal for mobilized friction angle between the wall and the backfill sand δ_{wall} of 1/2ϕ and 2/3ϕ , respectively, which yields safety factor against overturning equal to 1.

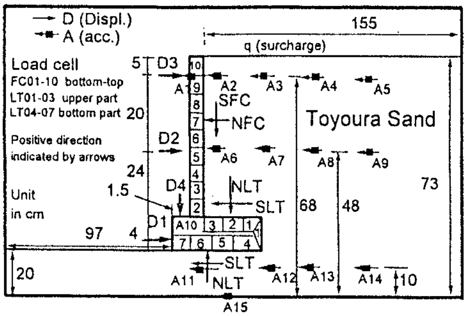

Fig. 1 Cross-section and Location of Transducers

Results and Discussions

Obvious overturning type failure, as shown in Photo 1, occurred at input acceleration about 350 gal during the third shaking at the moment denoted by F in Fig. 2. This result is in a broad sense consistent with the prediction. However, the observed failure plane was steeper than the prediction as compared in Photo 1. Fig.2 shows the input acceleration, and increment of displacements of the wall and normal earth pressures acting on the bottom of its base (NLT04-07). The horizontal displacement at the upper part of the wall (D3) was larger than at the lower part (D1), and a noticeable increase in normal earth pressure at the toe (NLT07), only a small change in the middle (NLT06) and a decrease near the heel (NLT05) were observed. These responses also indicate that overturning movement of the wall was more dominant than sliding. It should be noted that change in the residual earth pressures at the bottom of the base was gradual as shown in Fig.2, whereas dynamic component of each pressures was rather predominant at the top of the base and at the back of the facing. In order to investigate the latter component, enlarged time histories at input acceleration 275 gal are shown in Fig.3, and their phase relationships were schematically shown in Fig. 4. When the horizontal response acceleration of the backfill soil was in the direction opposite to the wall (that is, when the horizontal inertia force was acting

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toward the facing), normal earth pressure acting on the back of the facing (NFC08), on the top of the base (NLT01-03) and at the toe of the base (NLT07 and 06) increased, while those near the heel of the base (NLT05) decreased slightly. At this moment, shearing components of the earth pressures increased downwards for the back of the facing(SFC08) in the direction toward the facing for the top of the base (SLT01-03) and in the opposite direction for the bottom of the base (SLT05-07).

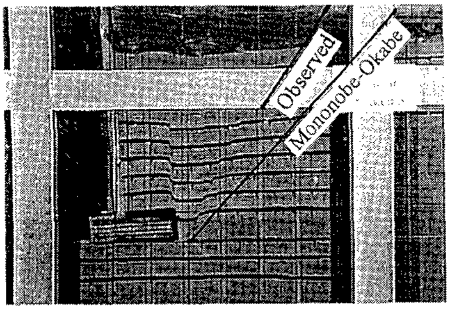

Photo 1 Comparison of Failure Plane

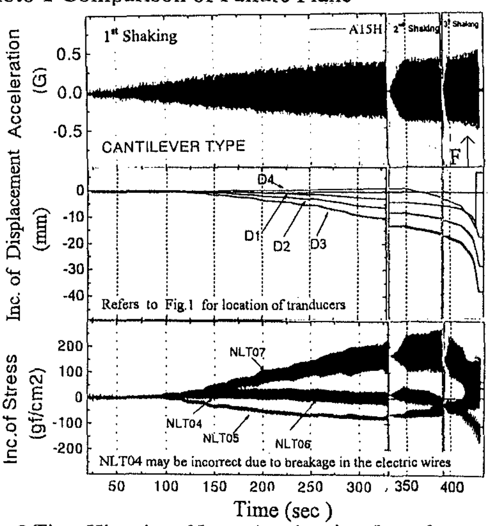

Fig. 2 Time Histories of Input Acceleration, Inc. of Displacement and Normal Earth Pressure at its Base

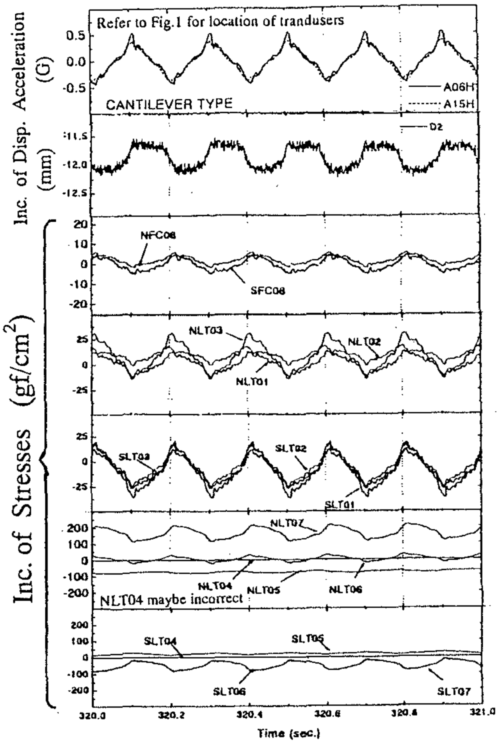

Fig.3 Enlarged Time Histories at Input Acceleration about 275 gal

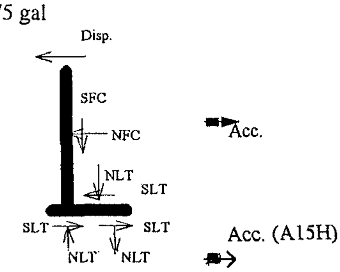

Fig. 4 Phase Relationships of Displacement, Acceleration Earth Pressure Acting on the Wall Based on Fig. 3

Conclusions

1. For uniform input motions, although the observed critical acceleration and major failure pattern were consistent with pseudo-static limit equilibrium type prediction, the observed failure plane was much steeper than the predicted value. It may suggest that seismic behavior assumed in the prediction is not fully correct.
2. The normal earth pressures observed at the bottom of the base gradually changed during shaking, whereas dynamic components in the observed earth pressures were rather predominant at other locations with their phase relationships as summarized in Fig. 4.

References 1). Munaf. Y., et al.(1996): Performance of Retaining Walls in Pseudo Static Loading Model Tests, the 51st annual meeting of JSCE. 2) Munaf, Y., et al.(1997): Failure Pattern of Several Retaining Wall Models by Tilting Tests. The 32nd annual conference of JGS. 3) Kojima, K., et al.(1997): Shaking Table Test of Leaning Type Retaining Wall (in Japanese), ditto.