# III-A 198

## PERFORMANCE OF RETAINING WALL IN PSEUDO STATIC SEISMIC LOADING MODEL TESTS

Yulman MUNAF., Graduate Student, University of Tokyo
Junichi KOSEKI and Takeshi SATO., IIS, University of Tokyo
Fumio TATSUOKA., Dept. of Civil Engineering, University of Tokyo

### INTRODUCTION

Different performance of several types of soil retaining walls during the 1995 Hyogoken-Nambu earthquake has been reported by Tateyama et.al.[1] and Tatsuoka et.al.[2]. Back analyses of these walls based on current design procedure (Koseki et.al.,[3]) showed the need for its revision. To that end, a series of pseudo static model tests (tilting tests) have been planned. This paper describes the equipment for the tests and presents a preliminary result for a cantilever type retaining wall.

### EQUIPMENT AND SOIL PROPERTIES

Fig. 1 shows a cross-section of the equipment, which consists of : (1) a sand box; (2) a tilting system; (3) a model retaining wall and sand layers. The sand box has inside dimensions of 180 cm long, 86 cm high and 60 cm wide, made of a rigid steel frame and acrylic transparent plates as the side walls. Facing and bottom parts of the model retaining wall are made of wooden blocks reinforced with steel bars $\phi$ =10 mm. Their surfaces are covered with sandpaper to obtain rough contact with sand. To measure the distribution of normal stress $\sigma$ and shear stress $\tau$, fifteen two-component load cells, as used by Tateyama [4], were installed in the central part of the facing and the bottom. Two displacement transducers were set at the facing and one at the bottom of the retaining wall to measure displacement and rotation of the wall. Toyoura sand was used, which has $e_{max}$ = 0.977; $e_{min}$ = 0.605; Gs = 2.64 ; $D_{10}$ = 0.11 mm and $D_{50}$ = 0.16 mm.

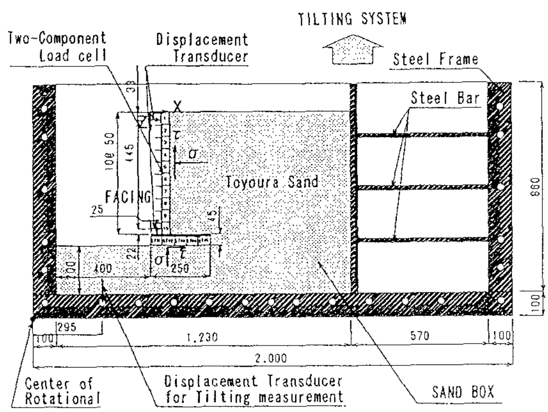


Fig. 1 Experimental Set-up All unit in mm

### TESTING PROCEDURE

The testing procedure consists of : (1) filling of sand and (2) tilting of the sand box. Air-dried sand was pluviated from the slit of a hopper into the sand box. The height of the hopper was kept always at 80 cm from the sand surface . The opening of slit and the traveling speed of the hopper were carefully controlled so as to obtain a uniform sand layer with a thickness around 0.5 cm per one travel, and $\gamma_d$ = 15.8 kN/m$^3$. After trimming the surface of the top layer to the prescribed horizontal geometry, the whole sand box was tilted. During these processes, stresses acting on the facing and the bottom , and displacement of the facing were monitored.

### TEST RESULT AND DISCUSSIONS

Fig.2 shows the normal stress distribution along the back face of the facing. The measured stress distributions were not triangular. The measured earth pressure increased during tilting. Earth pressure was calculated based on Coulomb and Mononobe-Okabe theories for active earth pressure using $\phi$ = 46° and $\delta$ = 2/3 $\phi$. The $\phi$ value was obtained by plane strain compression tests. The lateral seismic coefficient $K_h$ defined as $K_h$ = tan $\theta$, where $\theta$ is a tilting angle of the sand box. The friction angle $\delta$ between the wall and the sand was set to be 2/3 $\phi$. It may be seen that for $\theta$=0° ~20°, the calculated and measured earth pressure are similar to each other for the upper two thirds of the facing, while the measured values are smaller at the lower one third . This is likely due to the effect of the friction on the upper surface of the bottom part. Fig. 3 shows the normal stress distribution along lower surface of the bottom part of the retaining wall. The measured stress increased during the tilting of sand box. Near the toe of the wall, the rate of increase of stress was much larger than that at the other part. This result suggests that pressure at sand beneath the toe will reach first the bearing capacity value. Fig. 4 shows the measured friction angle $\delta = \arctan(-\tau / \sigma)$ at the back face of the facing, plotted against tilting angle $\theta$. Although it was not constant along the facing, the values tend to converge to a certain range $\delta = 15^\circ \sim 45^\circ$.

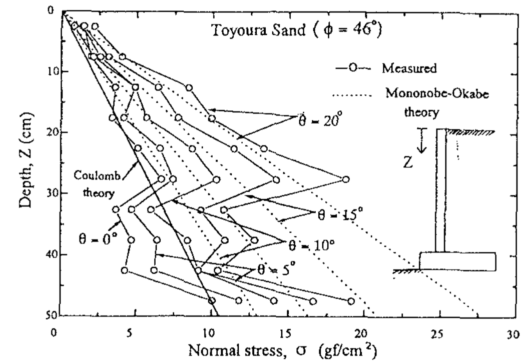


Fig.2 Normal Stress Distribution on Backface of Facing During Tilting

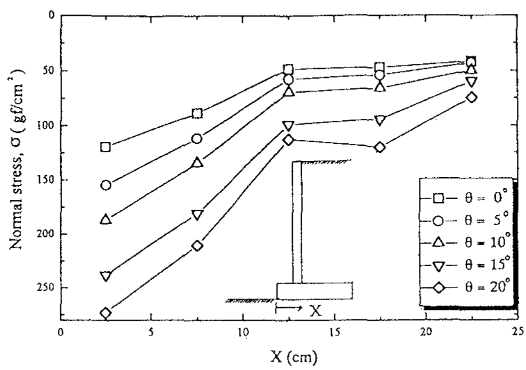


Fig.3 Normal Stress Distribution on Bottom Side During Tilting

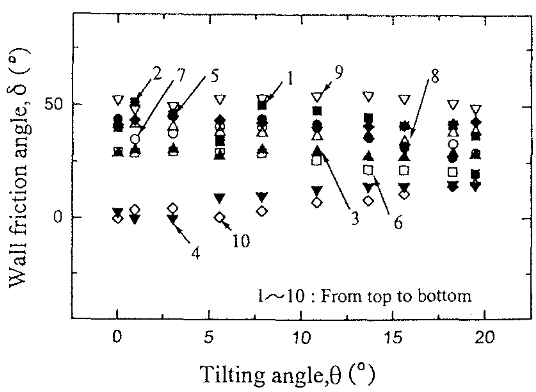


Fig. 4 The Wall Friction Angle During Tilting

SUMMARY

1. The measured normal stresses acting on the back face of the facing were not very different from the theoretical values.

2. The measured normal stress along the bottom increased during tilting, especially near the toe of the retaining wall.

3. The measured wall friction angle $\delta$ along the facing was not constant, but tended to converge to some range.

Further investigation will be conducted by performing a series of model tests for different types of retaining walls.

REFERENCE

1. Tateyama, M., et.al., Damage to soil retaining walls for railway embankments during the Great Hanshin-Awaji Earthquake, January 17, 1995, Proc. Int. Conf. on earthquake Geotechnical Engineering, IS Tokyo '95, Balkema , Vol. 1, pp 49-54.

2. Tatsuoka, F., et.al., Performance of geogrid-reinforced soil retaining walls during the Great Hanshin-Awaji Earthquake, January 17, 1995, Proc. Int. Conf. on Earthquake Geotechnical Engineering, IS Tokyo'95, Balkema, Vol.1, pp55-62.

3.Koseki, J., et.al., Back analyses of soil retaining walls for railway embankments damage by the 1995 Hyogo-ken-Nambu earthquake, Report of Committee on Earthquake Engineering, JSCE, 1996.(in preparation)

4 Tateyama, M., et.al., Lateral loading test on columns on the facing of geosynthetic-reinforced soil retainingwall, Recent Case Histories of Permanent Geosynthetic-Reinforced Soil Retaining Walls, Ed. Tatsuoka and Leshinsky, Balkema 1994