Chapter 3

NCTU NON-YIELDING RETAINING WALL FACILITY

To investigate the behavior of earth pressure at-rest and its increment due to surcharge against retaining structures, an instrumented non-yielding retaining-wall facility was developed at National Chiao Tung University. This chapter introduces the model wall, soil bin, and data acquisition system of the NCTU non-yielding retaining-wall facility. For more information regarding the facility, the reader are referred to Chen and Fang (2002)

3.1 Model Wall

The model wall shown in Fig. 3.1 is 1500 mm-wide, 1600 mm-high, and 45 mm-thick. To achieve an at-rest condition, the wall material should be nearly rigid. With the application of earth pressure, the displacement of the wall could be neglected. As a result, a solid steel plate with a Young's modulus of 210 GPa was chosen as the wall material. As indicated in Fig. 3.1, the model wall is actually the front-side of the reinforced steel box. To avoid the lateral deformation of the box, twenty-four 20 mm-thick steel columns were welded vertically on the outsides of the box. In addition, twelve C-shaped steel beams were welded horizontally around the box to achieve an at-rest stress condition in the box.

Based on the study by Sowers and Sowers (1961), Mackey and Kirk (1967), Matteotti (1970), Bros (1972), NAVFAC DM-7.2 (1982), Bowles (1988), and Fang et al. (1997), the wall displacements required to achieve an active state are summarized in Table 3.1. It is clear in the table that dense sand requires much less wall displacement to reach an active state than loose sand does. Navy Design Manual DM-7.2 (1982) reported that, for loose sand, a wall movement as little as 0.0020H would cause the active soil wedge to develop. That means for a 1.5 m-high retaining wall, the active earth pressure would be induced with the tiny wall movement of 3 mm. However, the maximum deflection of the NCTU non-yielding wall is only 0.16% of the wall-movement required to reach an active state. From a practical point of view, the earth pressure against the model wall would be nearly the earth pressure at-rest.

To investigate the distribution of earth pressure with depth, sixteen soil pressure transducers (SPT) were embedded in the central zone of the model wall as illustrated in Fig. 3.2. The soil pressure transducers are strain-gage-type transducers (Kyowa PGM-02KG, capacity = 19.6 kN/m^2) as shown in Fig. 3.3. Besides, another three transducers (SPT 17,18,19) mounted horizontally between the central zone and sidewall could be used to investigate the effects of sidewall friction. To eliminate the soil-arching effect, all soil-pressure transducers were quite stiff and were installed flush with the wall.

3.2 Soil Bin

To constitute a plane strain condition for model test, the soil bin is designed to minimize the lateral deflection of sidewalls and the friction between the backfill and sidewalls. Thus, the sidewalls were fabricated of 1500 mm-wide, 1600 mm-high steel plates as illustrated in Fig. 3.1. The end-wall and sidewalls of the soil bin were made of 35 mm-thick steel plates. Outside the steel walls, vertical steel columns and horizontal steel beams were used to confine the lateral movement of the end-wall and sidewalls. From a practical point of view, the deformation of the sidewalls could be considered negligible.

To reduce the friction between backfill and sidewalls, a lubrication layer consists of plastic sheets (Fang et al.2004) was furnished for all model wall experiments. The “thick” plastic sheet was 0.152 mm thick, and it is commonly used for construction, landscaping, and concrete curing. The “thin” plastic sheet is 0.009 mm thick, and it is widely used for protection during painting, and therefore it is sometimes called painter’s plastic. Both plastic sheets are readily available and neither is very expensive. The lubrication layer consists of one thick and two thin plastic sheets were hung vertically on each sidewall of the soil bin before the backfill was deposited. The thick sheet was placed next to the soil particles. It is expected that the thick sheet would help to smooth out the rough interface as a result of plastic-sheet penetration under normal stress. Two thin sheets were placed next to the steel sidewall to provide possible sliding planes. The experimental results for the effect of the sidewall friction will be discussed in Section 5.3.

The model wall, sidewalls, end-wall, and base plate of the soil bin were welded carefully to ensure its structural integrity. The bottom and end-wall of the soil bin were covered with a layer of SAFETY WALK to provide adequate friction between the soil and the base of the bin.

3.3 Data Acquisition System

All signals collected by the soil pressure transducers, displacement transducers and load cell are processed by a data acquisition system indicated in Fig. 3.4. The analog signals from the sensors were filtered and amplified by the dynamic strain amplifiers (Fig 3.5), then digitized by an analog-to-digital converter. Finally, the digital data were stored and processed by a personal computer.