Chapter 6

EXPERIMENTAL RESULTS FOR LOOSE SAND

This chapter reports the experimental results regarding effects of adjacent inclined rock face on earth pressure at-rest for loose sand. The interface inclination angles of rock face $\alpha = 0^o$, 45^o, 60^o, 70^o, and 80^o are illustrated in Fig. 6.1. The height of backfill is 1.5 m and the air-pluviation method is adopted to prepare the backfill. The loose ($D_r = 35\%$) Ottawa sand with the unit weight γ of 15.6 kN/m^3 is prepared as backfill. Based on direct shear tests (Ho, 1999), the corresponding internal friction angle ϕ is 31.3^o. The γ and ϕ values are used to calculate the Jaky's at-rest earth pressure. The testing program for this study is listed in Table 6.1.

6.1 Distribution of Earth Pressure At-Rest

Experimental results of the earth pressure at-rest at various α angles are measured and compared with Jaky's theory. The distribution of the lateral earth pressure against the non-yielding model wall for $\alpha = 0^o$ (Fig. 4.9) is illustrated in Fig. 6.2. In Fig. 6.2, the experimental earth pressure is compared with Jaky's solution for loose sand. At the elevation 0.15 m to 1.5 m, the distribution of earth pressure tends to be linear and in fairly good agreement with Jaky' solution. Mayne and Kulhawy (1982), Mesri and Hayat (1993) reported that Jaky's equation is suitable to estimate the earth pressure at-rest for backfill in its loosest state. However, the lateral earth pressures measured near the base of the wall are lower than Jaky's prediction. This is most probably due to the sudden change of stiffness at the soil-steel base plate interface.

Fig. 6.3 shows the distribution of lateral earth pressure with the interface inclination angle $\alpha = 45^o$. The steel interface plate was placed in the soil bin (Fig. 4.10) and Ottawa sand was pluviated behind the model wall. In Fig. 6.3, the measured stress is lower than Jaky's solution. The measured earth pressure is clearly affected by the rough interface inclined at $\alpha = 45^o$, the elevation 1.5 m to 1.2 m the measured σ_h is not affected by the steel interface plate. The lateral earth pressure increased with the increasing depth at elevation 1.5 m to 0.35 m. Maximum horizontal earth pressure was measured at the elevation 0.35 m. However, the measured lateral pressure decreased slowly with depth from the elevation 0.35 m to 0. It is clear in Fig. 4.10 (a) that, for the upper part of model wall, the interface plate is far from the SPT. It is reasonable to expect the measured σ_h to be identical with Jaky's formula. However, for the lower part of the model wall, the interface plate is quite close to the soil pressure transducers. As a result, the σ_h measured would be affected by the approaching of interface plate.

Fig. 6.4 shows the distribution of lateral earth pressure for $\alpha = 60^o$. The measured stress were lower than Jaky's solution especially the σ_h near the base of wall. It may be observed in Fig. 4.11(a), with the increase of α angle, the distance between the model wall and the interface plate decreased. The distribution of σ_h is even lower than that for $\alpha = 45^o$. Maximum σ_h was measured at the elevation of 0.65 m.

The distribution of σ_h measured with the interface inclined at $\alpha = 70^o$ and 80^o are shown in Fig. 6.5 and Fig. 6.6. It is obvious that σ_h decreases with the approaching of inclined interface, especially the lower part of the model wall.

The distribution of lateral earth pressure for the interface inclined at $\alpha = 0^o$, 45^o, 60^o, 70^0 and 80^o illustrated in Fig. 6.7. In this figure, it is seen that the distribution of lateral earth pressure are not linearly with depth. The measured horizontal pressure is lower than Jaky's solution. The magnitude of σ_h decreased with increasing α angle. In Fig. 6.7, the measure σ_h is significantly affected by the presence of the nearby rock face. It would be reasonable to expect the resultant soil thrust acting P_h on the wall to decrease with increasing α angle. On the other hand, it may be expected that the point of application of the total soil thrust P_h would rise with increasing α angle.

6.2 At-Rest Soil Thrust

6.2.1 Magnitude of At-Rest Soil Thrust

The variation of horizontal at-rest pressure coefficient $K_{o,h}$ as a function of interface inclination angle α is shown in Fig. 6.8. The coefficient $K_{o,h}$ is defined as the ratio of the horizontal component of total thrust to $rH^2/2$. The horizontal thrust P_h is calculated by summing the pressure diagram shown in Fig. 6.7. Without the interface plate (α = 0°), the coefficient $K_{o,h}$ is slightly less than Jaky solution. However, after steel interface plate was placed into soil bin. The coefficient $K_{o,h}$ decreased with increasing rock face inclination angle α. The measured are apparently less than the Jaky's solution. Based on the test results, an empirical relationship between the coefficient $K_{o,h}$ and the interface inclination angle α can be established:

$$K_{o,h,\alpha} = K_{o,h,Jaky} - 0.00462 \times \alpha \qquad (6.1)$$

where

$K_{o,h}$ = 1 - $sin\phi$

α = interface inclination angle (degree)

Eqn. (6.1) is applicable for loose sand with $0^o \le \alpha \le 80^o$.

6.2.2 Point of Application of At-Rest Soil Thrust

The point of application h/H of the total thrust as a function of the α angle is discussed in this section. h is the vertical distance between the total thrust and the base of wall. Fig. 6.9 shows, without the interface plate (α = 0^o), the point of application h/H of the at-rest earth pressure is located at about 0.33 H above the base of the wall. As the interface angle α increase, the earth pressure start to decrease near the base of the wall as seen in Fig. 6.7. This change of earth pressure distribution causes the total thrust to rise to higher locations as shown in Fig. 6.9. For α = 80^o, the point of application of the total thrust is located at 0.65 H above the base of the wall.