(III－85) A Study of Stress Change on a Series of Five Close Shields by Using Trap Doors Tests

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1. Introduction

Some studies to get a clear understanding of the earth pressure on the multi adjacent shields related to Multi Micro Shield Tunneling Method (MMST) have been undertaken up to present time. The purposes of this study is to estimate of the mechanism of stress change on continuous five trap doors relating to various tunnel excavation sequences.

Experimental Technique

2.1. Method

During the tests, the earth pressure on the trap doors was measured, and the surface of rod displacement was recorded by a laser horizontal measurement. The parameters investigated during these tests were overburden height, sequence of five trap doors downward movement and the amount of the downward movement. The varied of overburden height was representing the depth of burial according to shallow tunnel type. The sequence of shield construction was represented by changing the order of the downward movement of the trap doors and the amount of this movement was corresponding to the allowance value of ground convergence during tunneling process.

2.2 Parameter of Tests

The parameters investigated during these tests were:

(1) Height of overburden values (H) were 250 mm, 450 mm, 500 mm and 750 mm.

(2) Four different sequences were used : ABCDE, ACEBD, BDCAE and CBDAE where the trap doors were lettered consecutively (see figure 1)

(3) The effect of allowance value of ground convergence was examined by changing the downward movement of the trap door ($\triangle$h) from 0.5 mm to 2.5 mm at interval of 0.5 mm.

2.3 Model Material and Apparatus

In the model, the granular mass was represented by a stack of aluminum rods of two diameters, 1.6 mm and 3.0 mm, in the ratio of 3:2 respectively. The rods were 100 mm long, a density (γ) of 0.00215 gf/mm^3, internal friction angle (ϕ) of 30° and cohesion (c) of 0 gf/mm^3.

3. Test Results

As a sample, the test of ACEBD and BDCAE sequence, with the amount of lowering movement (Δh) of 2.5 mm and the depth of burial (H) of 750 mm will be shown. Figures 2a and b show the result of the test by lowering the trap doors attained 2.5 mm, in which the earth pressures on the trap doors, P_v, were continuously recorded. In the graphs, the normalized earth pressure ($P_v/\gamma H$) was obtained from the average normalized earth pressure of three load cells. In Figures 3a and b, the graphs show the change of earth pressure from the initial earth pressure. The earth pressure of the lowering of trap doors decreased while the earth pressure of the adjacent trap doors increased. The influence of the lowering of one trap door to other trap doors was the function of distance. The amount of change of normalized earth pressure on each trap door caused of the lower of the n^{th} neighborhood trap door can be seen in Table 1. The symbol of $\Delta\alpha(n^{th})$ was the change of normalized earth pressure before the n^{th} trap door had moved and $\Delta\beta(n^{th})$ was the change of normalized earth pressure after it had moved. The explanation of $\Delta\alpha$ and $\Delta\beta$ can be seen also in Figure 4. For H/B=0.3, the earth pressure on a trap door due to the movement of the third and fourth trap doors did not change, while for H/B=0.67, the earth pressure on a trap door was not influenced by movement of the fourth trap door. For H/B=1, however, the earth pressure on a trap door was influenced by the movement of the fourth trap door. The value of B was 750 mm as a total wide of lowering of trap doors. The final normalized earth pressure which all trap doors were lowered achieving various values between 20% γ H-140% γ H. In Figure 5, the maximum final normalized earth pressure was the average of maximum final earth pressure after all trap doors were lowered from various lowering sequences. The curves show a similarity for various of overburden height

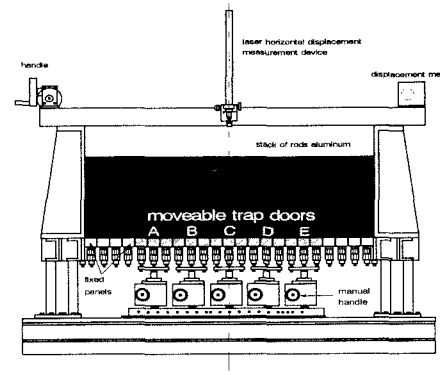

Figure 1 Trap Doors Apparatus

[Keywords] MMST Trap Door Normalized Earth Pressure

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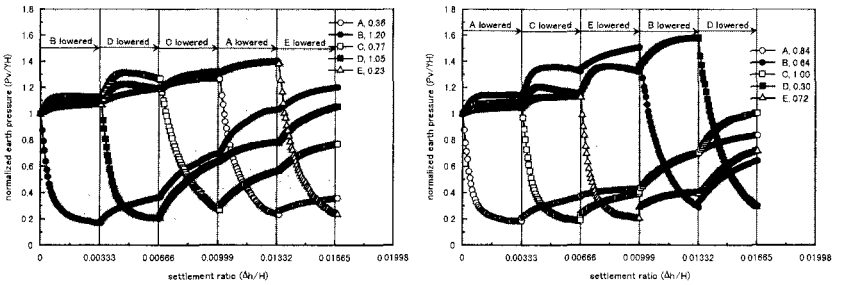
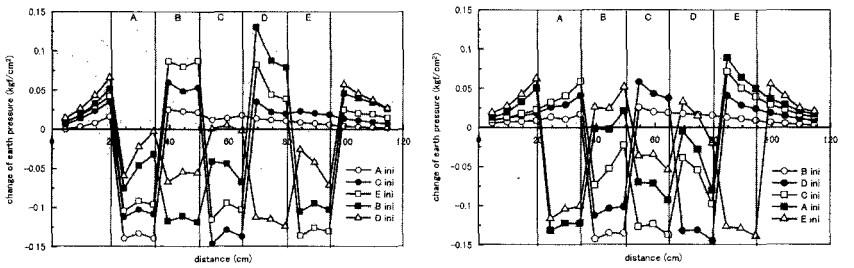


(a)ACEBD sequence (b)BDCAE sequence

Figure 2 Normalized Earth Pressure



(a) ACEBD sequence (b) BDCAE sequence

Figure 3 Change Earth Pressure

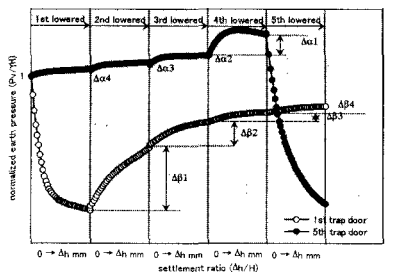


Figure 4 Explanation of $\Delta\alpha$ and $\Delta\beta$

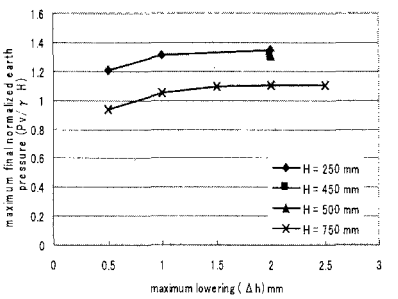


Figure 5 Maximum Final Normalized Earth Pressure

3. Conclusions

The study of the five continuous trap doors shows : (1) the maximum final normalized earth pressure acting on trap door decreases as the ratio of height of overburden and the trap door width increases, (2) the maximum final normalized earth pressure varies with the downward movement of trap door and it will reach a constant value after a certain value of lowering of trap door, (3) the increase normalized earth pressure subsequent to each movement stage is smaller before that trap door had moved than after it had moved, (4) the influence range of lowering of one trap door to other trap doors increases as the height of overburden increases, (5) the maximum final vertical pressure (P_{vf}) has variation : for H/B=0.3, $P_{vf}=1.4\gamma H$, for H/B=0.67, $P_{vf}=1.3\gamma H$ and for H/B=1, the value of $P_{vf}=1.2\gamma H$.

Table 1 Change of Normalized Earth Pressure

Case	$\Delta\alpha1$	$\Delta\alpha2$	$\Delta\alpha3$	$\Delta\alpha4$	$\Delta\beta1$	$\Delta\beta2$	$\Delta\beta3$	$\Delta\beta4$
Δh=0.5mm, H=250 mm	0.22	0.04	0	0	0.33	0.05	0	0
Δh=0.5mm, H=750 mm	0.13	0.07	0.05	0.03	0.19	0.10	0.06	0.04
Δh=1.0mm, H=250 mm	0.29	0.05	0	0	0.44	0.07	0.01	0
Δh=1.0mm, H=750 mm	0.15	0.08	0.07	0.05	0.27	0.15	0.10	0.05
Δh=1.5mm, H=750 mm	0.15	0.10	0.09	0.05	0.31	0.19	0.12	0.07
Δh=2.0mm, H=250 mm	0.31	0.04	0	0	0.50	0.06	0	0
Δh=2.0mm, H=450 mm	0.26	0.09	0.05	0	0.43	0.15	0.08	0.02
Δh=2.0mm, H=500 mm	0.25	0.11	0.06	0.01	0.41	0.17	0.08	0.03
Δh=2.0mm, H=750 mm	0.14	0.10	0.08	0.06	0.36	0.18	0.11	0.06
Δh=2.5mm, H=750 mm	0.13	0.11	0.08	0.06	0.33	0.21	0.14	0.08