

Influence of effective rate in copy cutter length on H&V shield behavior

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1. Introduction

Shield tunneling method is a method whereby a solid cylinder or shield excavate ground for tunneling construction. This shield is called a Tunnel Boring Machine (TBM). Horizontal and Vertical shield (H&V shield) is a tunneling machine which combines two ordinary articulated shields as shown in Fig.1, so that its cross section can be changed continuously from horizontal to vertical multi-circular shape or vice versa under simultaneous construction of multiple tunnels.

Simulation algorithms²⁾ were developed to simulate the shield tunneling behavior based on the shield kinematic model³⁾. This study carried out the sensitivity analysis in term of effective rate of copy cutter length (CCL) to understand the influence of a tunnel boring machine operation on its behavior in case of H&V shield.

2. Analysis conditions

The H&V shield machine is divided into left and right body; the alignments in the left body were straight for the horizontal movement and horizontal for the vertical movement, while the right body presents a rotation around the left body. The dimensions of H&V shield in this study were assumed as follows:

- Diameter of machine : 5.85m (left and right)
- Length of machine : 8.25m (left)
7.80m (right)

The operation parameters of the shield were as follows:

- Articulated angle: 0 degree for left body
4 degrees for right body after spiral
- Jack Force is determined to keep the planed velocity, 2cm/min

The ground conditions were assumed under SPT-N value = 30 and effective earth pressure method.

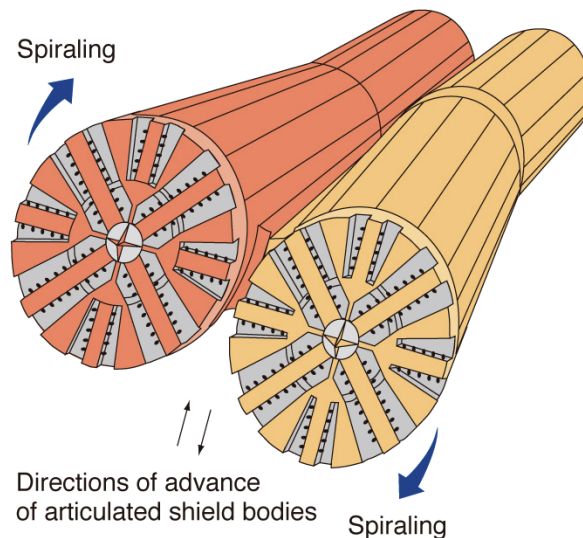


Fig. 1 H&V shield. ¹⁾

Table. 1 Sensitivity parameters for simulation.

Case No.	Effective Rate	Copy Cutter Length (mm)
1	1.00	400
2	0.75	300
3	0.50	200
4	0.25	100

The tunnel center is at GL-28.9m and the ground water level is at GL-3.9m.

3. Sensitivity analysis

The copy cutter is applied to increase the excavation efficacy and to control the alignment in tunnel excavation.

The simulation was carried out to investigate the influence of the copy cutter length (CCL) that affects H&V shield behavior. In this study, the four effective rates of copy cutter length were adopted as the analysis conditions as illustrated in Table 1.

Keywords TBM, H&V shield, Copy cutter length

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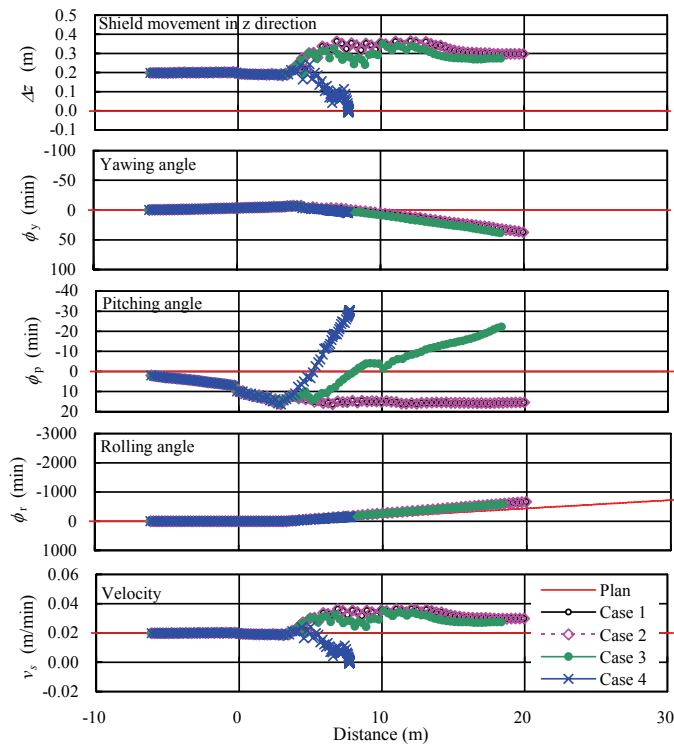


Fig. 2 Planed and calculated H&V shield behaviors.
(Right rear body)

4. Effect of copy cutter length

The influence of copy cutter length on H&V shield behavior is shown in Fig. 2. The graph tendencies in Case 1 and Case 2 are similar on the shield behavior. On the other hand, the advanced distance of the shield decreases when effective rate reduces, especially in Case 4 the advanced distance is less than 10 m. That means the shield advance becomes more difficult when the effective rate decreases because of ground reaction force.

The velocity, v_s , and the movement of the shield in z direction, Δz , have shown similar trends. Moreover, when the effective rate decreases the pitching angle, ϕ_p , substantially increase, this related to the velocity, v_s . These mean that the shield changes the direction to go upward, the velocity, v_s , decrease, when the effective rate of copy cutter length decrease.

Fig. 3 shows the contour map of the gap between the initial excavation surface and the skin plate of the right body, Un . From this figure it was found that Un in Case 3 increases at the lower part of the front body and the top of the rear end of the rear body, compared with Case 1.

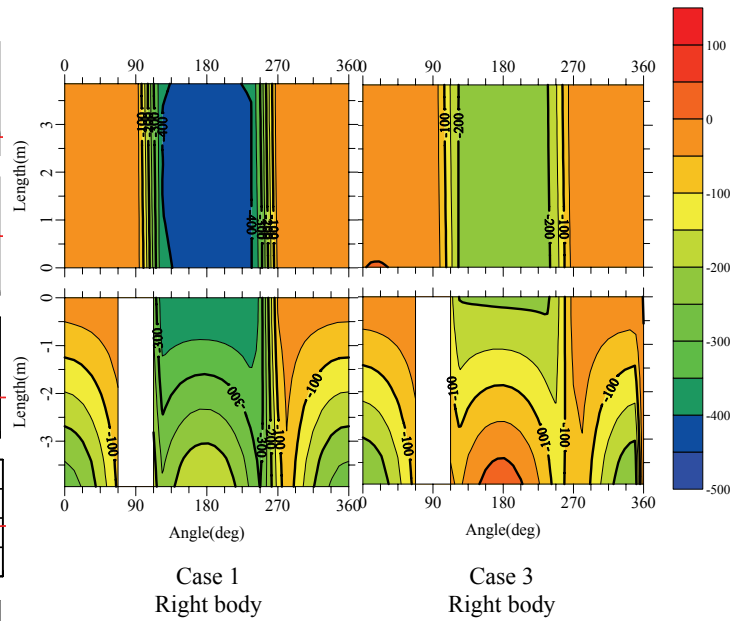


Fig. 3 Contour map of Un .

This indicates that the increase of the skin friction due to decreasing, Un , causes the decrease of v_s . Furthermore, the pitching angle, ϕ_p , upward due to decreasing Un comes from the followings:

- 1) The articulated angle is kept as 4 degrees even Un decreases; and
- 2) The whole body satisfies the equilibrium conditions.

5. Conclusions

The copy cutter length gives much influence to the shield behavior, especially in velocity and pitching angle, ϕ_p , because the increase of copy cutter length (CCL) produces the reduction of ground reaction.

References

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