

## Study on the Applicability of the Center Drift Advancing Method at Large Depth Ground Condition

Penta-Ocean Construction Co., Ltd. ODevini Abeyawardena  
Penta-Ocean Construction Co., Ltd. Sadatoshi Ohmori  
Tokyo Metropolitan University Nobuharu Isago

### 1. INTRODUCTION

In recent years, there have been cases where tunnel construction is being carried out under ground conditions that cover soil of 500 m or more. The method of ensuring the stability of the tunnel against the large ground load acting under the ground condition with large overburden may be to apply a support structure with high load bearing capacity or to release the ground load as much as possible.

In this study, numerical analysis is performed to see if the "dodging effect" can be expected, to reduce the displacement and deformation after the excavation by expanding the main tunnel, upon application of the advanced construction method of the central drift under the ground condition where the overburden is large.

### 2. ANALYTICAL MODEL, GROUND CONDITION AND TUNNEL STRUCTURE

#### 2.1 Analytical model

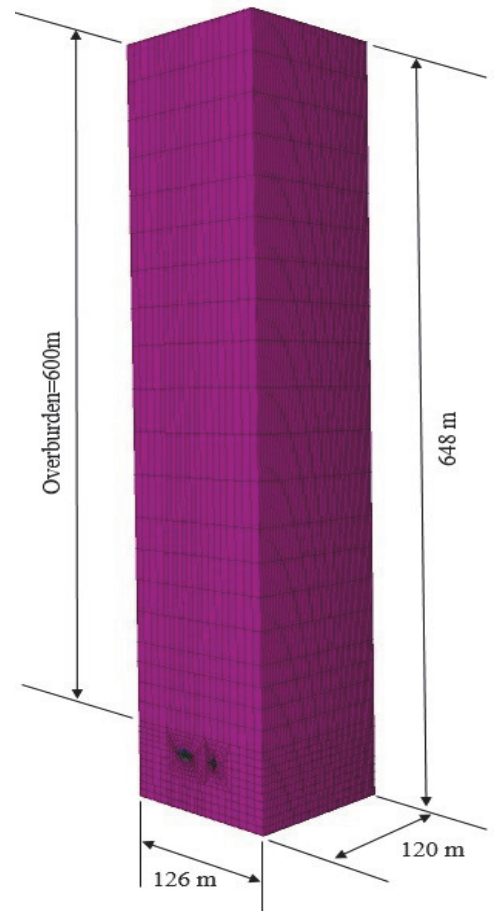
The analytical model is shown in Fig. 1 (a) and (b). The analysis model has a width of 126 m, a depth of 120 m, and a height of 648 m, and the overburden at the main tunnel is 600 m. The ground is a solid element, and is assumed to be an elastic-plastic body according to the Mohr-Coulomb failure criterion. The analysis code used was FLAC-3D, a finite difference method that can easily handle large deformations and non-linear models.

#### 2.2 Ground Condition

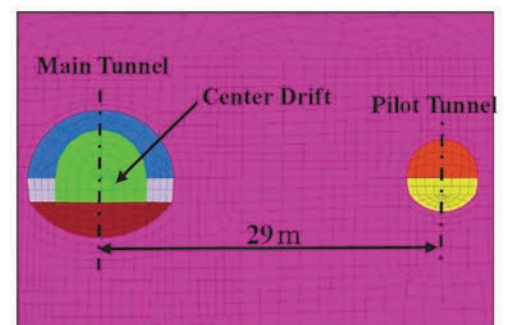
The ground conditions were determined by parameter analysis so that the convergence at the pilot tunnel was about 30 mm based on the report by Baba et.al (2020). Figure 2 shows the reproduction results of the convergence and crown settlement of the pilot tunnel by parameter analysis, and Table 1 shows the determined ground physical characteristics.

#### 2.3 Structure of each tunnel

The support patterns of the main tunnel and the center drift to be verified are shown in Figures 3 and 4. Table 2 shows the support configuration of each tunnel including the pilot tunnel. In addition, to verify the dodging effect due to the excavated area, numerical analysis was carried out using three sizes of center drifts.



(a) Full view of model



(b) Detailed view of model  
Fig.1 Analysis model

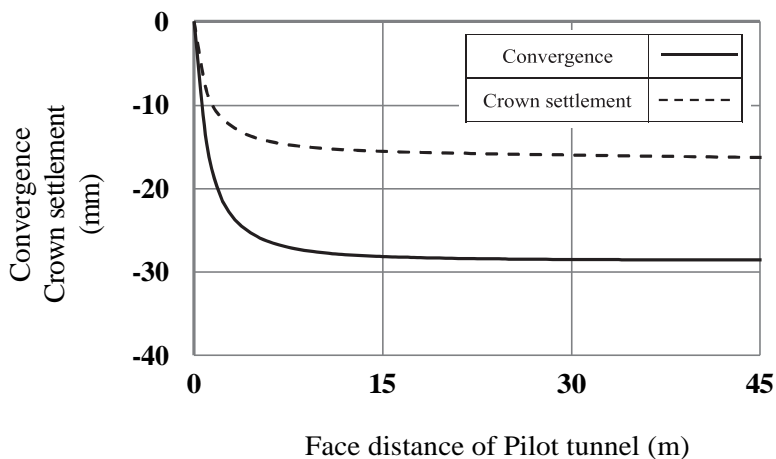


Fig.2 Convergence and crown settlement of pilot tunnel

Table 1 Ground condition

$q_u/\gamma h$	1.67
Density ( $\text{kg/m}^3$ )	$2.7 \times 10^3$
Young Modulus ( $\text{N/m}^2$ )	$2.7 \times 10^9$
Poisson Ratio	0.48
Cohesion ( $\text{N/m}^2$ )	$4 \times 10^6$
Friction Angle	$50^\circ$

Keywords: mountain tunnel, center advancing drift, dodging effect, high overburden, numerical analysis  
Contact address: 2-2-8 Koraku, Bunkyo-ku, Tokyo, 112-8576 Japan, Tel: +81-3-3817-7531

Table 2 Support properties

		Pilot Tunnel	Center Drift	Main Tunnel
Steel Support size		H-150	H-100	H-200
Sprayed Concrete	Thickness (m)	0.30	0.15	0.25
	Compressive Strength (N/mm <sup>2</sup> )	36	18	36
Elastic Modulus (N/m <sup>2</sup> )		$1.07 \times 10^{10}$	$6.97 \times 10^9$	$1.31 \times 10^{10}$
Poisson Ratio		0.202	0.202	0.203
Density (kg/m <sup>3</sup> )		2,470	2,480	2,540

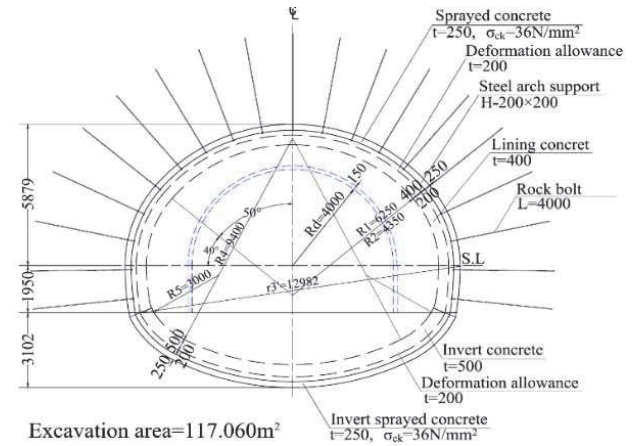


Fig.3 Support pattern of main tunnel

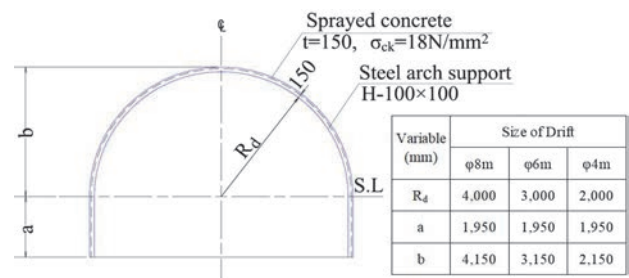


Fig.4 Support pattern of main tunnel

**3. ANALYSIS RESULT AND DISCUSSION**

Figures 5(a) and (b) show the calculation results of convergence and crown settlement after the expanding excavation of the main tunnel using the analysis model and geological characteristics. In the figure, the calculation results when the center drifts of different sizes are applied and that when the center drift is not applied are compared and shown. The horizontal axis in the figure is the face distance after the expanding excavation of the main tunnel, and the vertical axis is the convergence and the crown settlement.

From these figures, it can be seen that the convergence and crown settlement are smaller when the center drift is applied than when the center drift is not applied. It was also found that the larger the size of the center drift, the smaller the convergence and the crown settlement. From this, it was found that the dodging effect can be expected to reduce the displacement and deformation after expanding excavation of the main tunnel by applying the center drift under the ground condition of a large overburden of 500 m or more.

**4. CONCLUSIONS AND FUTURE WORK**

In this study, the dodging effect obtained by applying the center drift advancing method under the ground condition with a large overburden of more than 500 m was verified by numerical analysis. As a result, the following was found.

- 1) The dodging effect can be obtained because the displacement and deformation after the expanding excavation of the main tunnel are reduced by applying the center drift.
- 2) As for the dodging effect by the center drift, the larger the size of the drift, the smaller the displacement and deformation after the expand excavation of the main tunnel.

Ohmori et.al (2020) point out that the ground arch formed around the drift reduces the displacement and deformation of the main tunnel after the expanding excavation. In the future, it will be necessary to verify whether the displacement and deformation of the main tunnel excavation will be reduced by the same ground arch mechanism even under the ground conditions where the overburden is large. In addition, it is necessary to verify whether the same effect can be obtained depending on the ground conditions and the bearing rigidity of the drift's support.

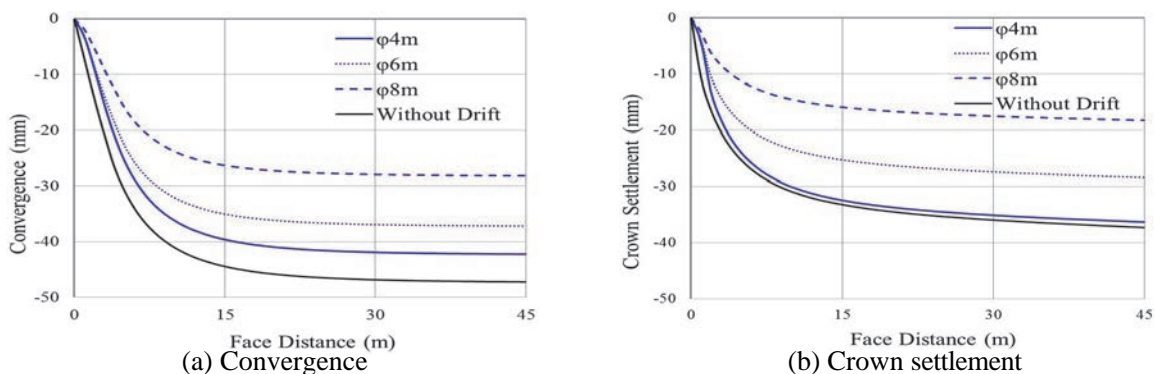


Fig.5 Convergence and crown settlement of main tunnel

**REFERENCES**

Baba, M., Sakurai, T., Ishikawa, S., Koide, T.: Break through the complicated ground along the Median Tectonic Line with 3D computerized construction, Tunnels and underground,51-10, 2020, pp.31-40.  
 Ohmori, S., Okabe, T., Gomi, A., Isago, N.: Consideration on main tunnel behavior and design index of drift when applying the center drift advancing method. Journal of JSCE (Tunnel Engineering F1), Vol.76, No.2, I\_1-I\_20, 2020.