Building a Crossing under Railway Using HEP&JES Method at a Terminal Station

Makoto ARAI ► Construction Office Section Chief, Engineering Department, Railway Headquarters, Seibu Railway Co., Ltd.

1. Introduction

The project was to build an underground crossing under a railway while constructing a new building after the old one was torn down. High speed Element Pull and Jointed Element Structure (HEP & JES) construction methods was used in this non-drilling project under multiple railroads including signal sytems at one of the major terminal stations in Tokyo where around 490,000 travelers go in and out of. A launching shaft was established in the basement levels of the building under construction and the project was done simultaneously in an extremely small space under many severe conditions. The following will report on the challenges of constructing an underground crossing under the railway and the conditions of a launching shaft and arrival shaft, and the measures taken to resolve those challenges, as well as the results of the construction.

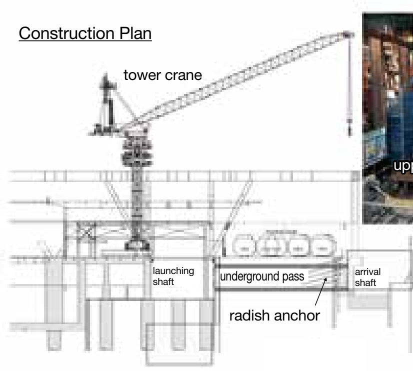

Photo 1 Launching Shaft (one leg portal crane)

2. Conditions of Construction and Challenges

There were five crossing railways, with about 650 trains coming and going in one day. As the site was a terminal station, there were a scissors crossing and other switches. The space is very small compared to usual shafts. The arrival point had a radish anchor for the earth retaining wall left from the previous construction.

3. Resolutions

(1)Drilling by Hand

Excavation was done by hand driller to repress any impact on track displacement while drilling. Any underground obstacles or radish anchors known to exist were taken away from inside the cutting edge, as it was impossible to remove. So machine drilling was not appropriate.

(2)Construction time

Upper floor and first level side wall elements were constructed after operation hours of the subway, to eliminate any impact to track displacement. The hours were from 1:00 to 4:00 am, after the last train went away and before the first train arrived. The second level side wall and lower floor elements were constructed through day and night, regardless of the train operation, as there would be little impact on track displacement by the drilling.

(3)Using Friction Cut Sheet while Drilling the Upper Floor Element

Friction cut sheet was used during the drilling of the upper floor element to repress horizontal displacement and reduce friction with the ground.

(4)Management of Tractive Force, etc.

Estimated tractive force by drilling area, which was calculated from the ground and other conditions, was set over against realtime tractive forces for management. The realtime tractive force came out around 70% during the actual drilling, and there were no instances to make an

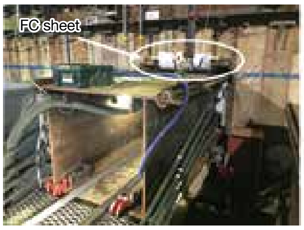

Photo 2 FC sheet (standard element 1080mm×850mm)

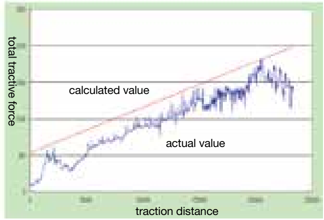

Fig. 1 Graph plotting the relevance of actual tractive force to distance (upper floor element)

emergency stop. (Fig.-1) The actuals are a result of using the friction cut sheet, the high precision of hand-drilling, the strong support from the natural ground consisting mainly of clay.

(5)Measuring Track Displacement

A measurement system (Digital Camera Rail Watcher) was used to measure track displacement all times during construction. Regular measurement was made as well. In addition to automatic tracking, level measurements and a 10m string was used to check the alignment of the tracks. These measurements were used to check the automatic tracking.

The trackings showed that the ground was gradually sinking (about 8mm), with no signs of rapid movement. Horizontal displacement was repressed by reducing friction between the upper side of the element using friction cut sheet. So the displacement was almost non (about 1-2mm), and with track maintenance the operations of the subway was not disturbed. There were no malfunctions of the signal systems during construction. Even though there was a small track displacement of 8mm, malfunctions were prevented during the construction with meticulous planning and measurements. Safety of train operation was ensured and the construction concluded as planned with no accidents and hazards.

Photo 3 launching shaft (lower floor element drilling)

Photo 4 Arrival shaft (drilling the side wall element)

4. Conclusion

The construction of the station building ended in spring 2019, and is now in business. I hope this report contributes in future non-drilling tunnel design and construction projects in urban areas.

References

Seibu Properties Inc. web site: http://www.seibupros.jp/about/develop/ikebukuro/Rail-ACT Research Group: HEP&JES Technical Material

Photo 5 Bird's eye view of DaiyaGate Ikebukuro (October 2018)