

Excavating the Shield Tunnels with the Largest Cross Section in Japan

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Introduction

Tokyo Outer Ring Road (Kan-Etsu-Tomei) is the first expressway project in Japan to fully utilize the great-depth underground area. The total length is approximately 16.2 km, and the two main tunnels with three lanes each side are to be constructed by the shield machines of about 16 m diameter, the largest cross section in Japan.

Since the construction conditions are tough — large cross section, long distance and high speed — the excavation started from both the north and south sides of the tunnels, to extend the drilling distance as long as possible to prepare for the failure of shield machine. Of the two tunnels, Central Nippon Expressway Co., Ltd., is responsible for the north-bound and East Nippon Expressway Co., Ltd. for the south-bound. Each divided the tunnels into two parts (starting from north / south) and ordered the construction to builders. Thus, four shield machines are now in operation. This paper introduces the features of the machines of the north side and the current state of the construction.

1. Characteristics of The Machines

The shield machines, equipped with single-pressure method long jacks, simultaneously excavate the tunnels and assemble the segments to speed up the construction and prevent the segments from being damaged by eccentric load. To dig through underground obstacles in the shallow depth of the north side, the machines have following features: The northbound machine is equipped with a slanting cutter head and special reinforcing type preceding bits (Fig. 1). The head with a 5° angle slant enables intermittent cutting, reducing the load when cutting through obstacles. The bits are fan-shaped for excellent resistance against abrasion and shock, enabling direct drilling through obstacles and long-distance excavation without exchanging bits.



Fig. 1 Northbound shield machine

The southbound machine is also equipped with a slanted cutter head (5°) as well as with the “long-life bits” (Fig. 2), designed to protect super-hard chips of high wear resistance with high impact-resistant chips, enabling long distance excavation without exchanging bits.



Fig. 2 Southbound shield machine

Moreover, for the northbound machine, three screw conveyors are arranged in series (approx. 50 m) as well as three barrier gates to reduce the risk of spouting the earth and sand, etc. For the southbound machine, two screw conveyors (approx. 40 m) are arranged independently to improve water resistance and prevent the halt of excavation.

2. Current State of The Construction

On the north side, the tunnel's starting shaft has been constructed, the machine assembly completed, and the initial excavation began from Jan. 2019. (Fig. 3). The drilling on the southern side started earlier on Feb. 2017 and as of Sept. 2019, the total excavated length is about 1.9 km.



Fig. 3 Oizumi JCT, Feb. 2019

The drilling will be carried out with the highest priority on safety, while confirming the volume of excavated soil — using a belt scale for the weight and a laser scanner for the volume — and conducting monitoring such as measurements of underground and ground surface.