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Excavation of a Large-Section, Deep Shaft Using a Diaphragm Wall and Chemical Grouting

— Chuo Shinkansen Meijo Emergency Exit —

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The Chuo Shinkansen is a line built to create a dual transportation system of Japan's main arteries, which has long been carried by the Tokaido Shinkansen (Tokyo to Osaka). (Fig. 1) It is planned to construct the shield tunnels deep underground (depth of 40m+) in urban areas that are already highly urbanized. The launch shaft for shield tunnel nearest to Nagoya Station is the Meijo Emergency Exit. (Photo 1)
The emergency exit is used for ventilation and maintenance work in the tunnel in normal operation, and as an evacuation route for passengers in case of emergency.
The Meijo Emergency Exit is a cylindrical shaft with a depth of approximately 89m and a diameter of approximately 38m. The construction was carried out using the open-cut method with a RC diaphragm wall of approximately 130m in length. After excavating to a depth of approximately 50m, water inflow occurred from around a blocked observation well, but the excavation was successfully completed by carrying out water sealing work. This paper is an outline of the water inflow and the processes to complete the excavation by implementing water sealing work.

Fig. 1 Chuo Shinkansen planned route

Photo 1 Meijo Emergency Exit

Countermeasures for ground heaving

It was planned that the groundwater level was lowered by pumping out the pore water in the aquifer just below the diaphragm wall. In order to reduce the amount of pumping, a single row of injection holes with a spacing of 0.8m was placed into the aquifer just below the diaphragm wall. And chemical grounting was carried out.

Water inflow

When the excavation proceeded to approximately 50m, water inflow occurred around the observation well, which had already been blocked. In order to estimate the cause of the water inflow, an acoustic tomography survey was conducted. As a result, it was found that the unevenness and inclination of the stratum were larger than expected, which led to the disagreement of the watertight packing of the well closure. It ended in forming the water path.

Countermeasures for water inflow

As a result of acoustic tomography, it was decided to construct a cutoff wall inside the diaphragm wall by chemical grouting, because the water path was considered to exist just below the diaphragm wall due to the unevenness of the stratum. (Fig. 2)
The purpose of chemical grouting is not to “reduce” the water inflow into the shaft, but to “stop” it. The volume per step was increased compared to that of normal chemical grouting because of the large depth and high artesian water pressure. In addition, thorough construction management was carried out by “(1) drilling of the injection hole by two-stage excavation and confirmation of the drilling position by gyroscopic survey” to accurately inject the chemical solution into the deep area and “(2) confirming the injection effect via check injections to maximize the effectiveness of the chemical grouting”.
In particular, in (2), the injection pressure of all the holes located in the middle of the three rows was checked(ref. Row C in Fig. 2), and check injections were carried out in the steps where no pressure increase was observed.
The check injections ware able to compensate for the lack of improvement, and the upward trend of pressure was confirmed in all of the injection areas.
As a result of the pumping test, the amount of pumping required for drawdown was 1.2 L/min on average, which was very small, and it was considered that a good quality cutoff wall could be constructed by chemical grouting.
After the excavation was resumed, the excavation was completed to approximately 89m without any water inflow.

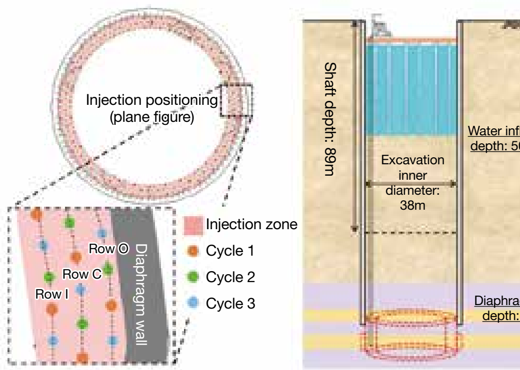

Fig. 2 Chemical grouting schematic diagram