Underground Shield Docking for the Trans-Tokyo Bay Highway

T. Funasaki and Y. Izumi
Trans-Tokyo Bay Highway Corporation
Tokyo, Japan

K. Miki and T. Nakamura
Obayashi Corporation
Tokyo, Japan

ABSTRACT

The Trans-Tokyo Bay Highway has a length of 15.1 km, of which about 4.5 km is the bridge section and about 9.5 km is the tunnel section. The tunnel was excavated by the slurry shield method. After the completion of tunnelling, the two shields facing each other were docked together under a high water pressure at the depth of about 60 m under the sea level.

This paper reports the test boring, filling of high-concentration slurry, freezing and forced thawing, etc. carried out during underground shield docking.

KEY WORDS: shield tunnel, underground shield docking, test boring, freezing work, frost heaving

DOCKING METHOD

The seabed in the work section generally has a shape of a gently curved ship bottom. Relatively solid sandy layer is deposited below the seabed. At the depth of TP-80 to 90 m or more, the sandy soil (the upper layer of the Kazusa group) having an N value of 70 or larger exists as an engineering base for design. The ground to be excavated is an alternation of diluvial sandy soil/gravel and diluvial clay. The point of underground docking is about 26 m deep from the sea level and has an overburden of 15 m.

The center cutter draw-in method was selected for shield docking in view of the following points:

• The structure of the shield cutter face should be simple enough to avoid breakdown during excavation.
• Safety and reliability during docking should be ensured.

The freezing method was used as an auxiliary method.

DOCKING PROCEDURE

Underground docking was carried out in the procedure shown in Fig. 2.

A. First, the first-arriving shield continues excavation until it reaches the predetermined docking position, then halts. The slurry in its chamber is replaced with high-concentration slurry.

A device is attached to prevent the thrust of the late-coming shield from causing the first-arriving shield to retreat at docking time.

All through the above process, the late-coming shield continues excavation.

B. The primary dismantling of the first-arriving shield including the rear part of the bulkhead is carried out.

The first test boring is conducted when the late-coming shield arrives at the point 50 m to the docking point. Then the second test boring is conducted when the late-coming shield arrives at the point 30 m to the docking point. The both shields are finally made to come close to each other until the distance between the disk face plates reaches 30 cm.

C. For the first-arriving shield, freezing pipes and temperature measurement pipes are buried and erected in preparation for freezing works.

When the late-coming shield reaches the docking point, its slurry is replaced with high-concentration slurry, and a retreat-prevention device is attached to it as at the time when the first-arriving shield reaches the docking point.

D. The first-arriving shield starts soil-freezing operation using radial freezing pipes and attached freezing pipes.

The late-coming shield starts soil-freezing operation using only attached freezing pipes after the primary dismantling of the shield and the burying of temperature measurement pipes.

E. After the completion of soil-freezing, the high-concentration slurry is removed from the chambers, and unnecessary frozen soil is discarded.

A splice plate is welded in the space between the disc face plates of the two shields to cut off water in case of thawing of the frozen soil.

After complete attachment of the splice plate, secondary dismantling of the shields is carried out.

F. Steel segments are assembled at the docking point, and backfill grouting, side concrete lining and other docking works are completed. Freezing maintenance operation is discontinued. In order to prevent long-term settlement, the frozen soil at the bottom of the tunnel is forced to thaw and cement-bentonite (CB) is grouted. Now the underground docking is complete.

REPLACEMENT OF CHAMBER SLURRY WITH HIGH-CONCENTRATION SLURRY

This construction utilizes the freezing method as an auxiliary method for underground docking. Convection-prone slurry in the chamber would cause thermal convection during freezing, and the heat of