NEWS REPORT

ADVANCE BORINGS FOR SEIKAN UNDERSEA TUNNEL

Mr. Hayao Kasuya, Chief of the Planning Department, Japan Railway Construction Corporation, reports the progress of the Seikan Tunnel Project and a unique feature employed to safeguard construction of the undersea tunnel.

SEIKAN TUNNEL PROJECT

After completing two undersea tunnels, the Kanmon Railway Tunnel (1944) and Vehicular Tunnel (1958), 3.6 km long, which connect the southern island of Kyushu with the main central island of Honshu, Japanese tunnel engineers have been hard at work on an ambitious plan to link Honshu with the northernmost island of Hokkaido by a 36.4 km undersea railway tunnel (Fig. 1).

The proposed tunnel is to cross the western end of the Tsugaru Strait, 22 km wide with depths up to 140 m, where the tidal current rushes through between the Pacific Ocean and the Sea of Japan at the maximum speed of 10 knots and at 3 to 4 knots even at the bottom of the channel.

The geology of the area (Fig. 2) where the tunnel is to be constructed is roughly as follows: The southern third of the proposed tunnel will run through andesitic rock strata which are a continuation of the volcanic geology of the Honshu side. The northern third will pass complex sedimentary rocks, essentially the same as those encountered on the southwestern tip of Hokkaido. The middle third will penetrate a younger geologic structure of sedimentary origin. Two of the major faults in the area will have to be crossed as well as many minor ones existing particularly in the volcanic structures. This suggests serious difficulties such as considerable seepage and even water blowouts unless proper precautions are taken during tunnel construction.

A preliminary exploratory work started in 1946 immediately after the World War II. With the results of extensive investigations on the project area, an inclined pilot tunnel on a 1 on 4 down-slope, 5.2 m high, 6.6 m wide, was commenced in 1963 from the Hokkaido side and another in 1965 from the Honshu side. The former reached the bottom in March, 1967 after drilling 1,200 m, where preparation is currently under way for horizontal drilling by a tunnel boring machine. In spite of considerable difficulties experienced, the latter has been driven 790 m as of July, more than half of its inclined length, 1,335 m.

These tunnels will be connected with a 3.6 m diameter near-horizontal (3% upslope) tunnel across the Tsugaru Strait, 240 m below the sea level. If everything goes well as scheduled, the pilot tunnel will be completed in spring, 1972, and will be utilized as a service and drainage-tunnel for the proposed Seikan Railway Tunnel.

Fig. 2.

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It is considered of utmost importance in this project to predict in advance the detailed geologic conditions and the behavior of water flows as accurately as possible.

Uncontrollable flows of water into an underwater tunnel as such could be disastrous. Even during tunnel work on land, a flow of ground-water often triggered by explosives could lead to a serious rockfall accident. Although seepage through hard rock usually does not endanger tunnel excavation, the seepage exceeding pump capacities would make it impossible to continue the work. Even if seepage is drainable, it is a difficult task to stop completely seepage through the excavated face once it starts. Since seepage through weak zones usually leads to a serious situation, the water has to be stopped and the zone stabilized before starting excavation. This is of particular importance when the use of a tunnel boring machine is planned.

The proposed Seikan tunnel will be driven at depths ranging from 240 to 270 m below the sea level. The flow of water, if encountered during construction, could be under a tremendous pressure. It was decided, therefore, to advance horizontal exploratory borings well ahead of the tunnel to check the details of geologic conditions and, in particular, to pinpoint any weak spots in terms of seepage and possible rockfalls. For such weak zones, appropriate precautionary measures will be taken before a full face tunnelling is made.

In driving the pilot tunnel, the borings were made in advance from transverse headings provided on both sides of the tunnel, approximately parallel with the alignment to reach 400 to 500 m ahead of the headings. These borings were made by a Crelius XH-80 with continuous sampling accomplished by the wire-line method. The direc-

Table 1. Typical records of advance borings on the Honshu side.

Number	Location (m)	Period	Length (m)	Inclination (degrees)
T ₁₃	-6.20	Apr. 2 to Jun. 14, 1965	601.35	-14
T ₁₄	2.84	Apr. 6 to Jun. , 1965	600.00	-14
B ₁₋₁	443.00	Dec. 9, 1966 to Jan. 23, 1967	246.90	-10--20
B ₁₋₂	443.00	Jan. 27 to Apr. 2, 1967	363.800	-6--18

Table 2. Typical records of advance borings on the Hokkaido side.

Number	Location (m)	Period	Length (m)	Inclination (degrees)
B ₁₋₂	334.67	Feb. 1 to Mar. 17, 1965	200.00	-13--19
B ₂₋₃	448.94	Aug. 17 to Oct. 8, 1965	303.00	-14--22
B ₃₋₄	548.40	May 23 to Jun. 15, 1966	500.00	-10--27
B ₄₋₂	756.29	Oct. 5 to Nov. 26, 1966	583.65	-5--27
B ₅₋₂	1,044.20	Jan. 26 to Apr. 20, 1967	497.30	0--23
B ₆₋₂	1,150.00	Mar. 9 to Apr. 13, 1967	399.30	0--5

tion and inclination of the hole were measured by an instrument called Tolopalli.

When borings hit water, the rate and pressure of the flow were measured and water samples chemically analyzed. The boring was continued only after the seepage was completely stopped by cement grouting. These advance borings tilted downwards mostly at a rate of 1 to 2 degrees per 50 m of horizontal drilling and progressed at an average rate of about 20 m a day (Tables 1 and 2). The maximum hole length so far achieved is 601.35 m. The engineers are trying to develop a new drilling technique to renew this record in order to enhance the safety and efficiency of the tunnel construction of this very challenging project. [T.A.]