

Full-Face Tunnel Boring Machine (TBM) Method

In the past, a steep tunnel with large diameter had been excavated by two processes, i.e., first drilling a small pilot tunnel from the bottom up and then drilling and enlarging the tunnel from the top down, by dropping rock laths into the pilot tunnel (see the diagram below as to the details of changes in drilling technology). This time, the "full-face tunnel boring machine" was introduced for the first time in Japan for the work to drill a penstock tunnel (48 degrees in an angle of inclination, 6.6 meters in diameter and about 1,000 meters in length), and the penstock tunnel was drilled from the bottom to the top as one process.

The "full-face tunnel boring machine" has a large drilling section, and it is improved to work in soft and shoftcrust geological conditions. In addition to the motor that can dig its way, supporting the machine weighing a total of about 600 tons, and the function to prevent the machine from sliding down, it is also equipped with a boring machine to survey the soil 30 meters ahead.

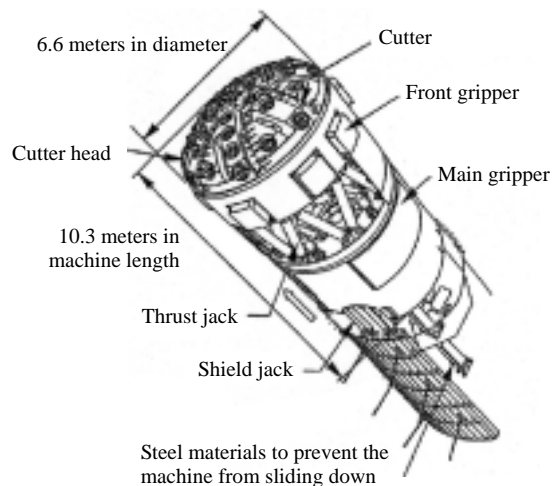
As a result of the introduction of this method, the construction period of the penstock tunnel could be reduced by about six months.



TBM (tunnel boring machine)

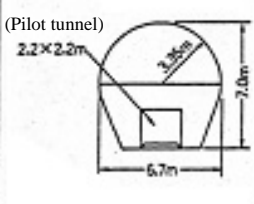
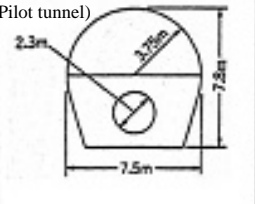
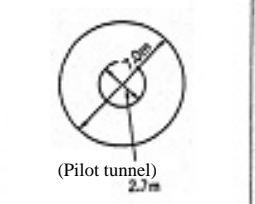

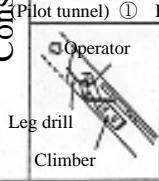
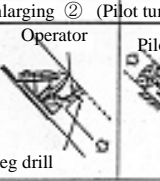
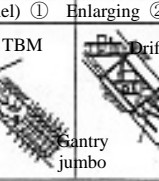
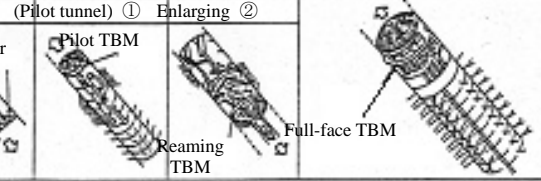
(6.6 meters in drilling diameter, about 50 meters in overall length and about 600 tons in total weight)

- * The machine presses a disc drill (cutter head) equipped with 44 hard cutters against a rock, rotates the disc drill, scrapes off the rock and excavates a tunnel.



Structural Drawing of Main Body of TBM

Changes in Drilling Technology

	Imaichi	Shiobara	Kazunogawa	Kannagawa
Construction method	Pilot tunnel and enlarged section	Pilot tunnel and enlarged section	Pilot tunnel and enlarged section	Full-face drilling section
				
	Pilot tunnel) ① Enlarging ②	Pilot tunnel) ① Enlarging ②	Pilot tunnel) ① Enlarging ②	
				

At Imaichi Power Plant, both the excavation of pilot tunnel and enlarging were done by blasting. At Shiobara Power Plant, a pilot TBM drilled the pilot tunnel and blasting did enlarging. At Kazunogawa Power Plant, the pilot tunnel was drilled by a pilot TBM and enlarging was done by a reaming TBM method.