

### 3. The Excavation of the Steeply Inclined Tunnel of the 6.6m Long Penstock by the Full Face TBM

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Okumura corporation has developed the Inclined TBM Method since at first it was applied as the Pilot TBM Method to the Pilot inclined tunnel of the penstock of Shiobara Power Plant. Afterwards it was improved as the Pilot-Reaming TBM Method at the penstock of Kazunogawa Power Plant. But it has been yet the two way system to excavate the reaming tunnel after excavating the pilot tunnel.

This time the Inclined TBM Method has been established as the one way system without excavating the reaming tunnel at the penstock of Kannagawa Power Plant. This penstock is one of largest and longest inclined tunnels.

The followings was developed to establish the Inclined TBM Method over the characteristics of the excavation of steeply inclined tunnels

- ① the face prediction system
- ② the preventing system from slipping
- ③ the transportation inclined system
- ④ the rock class evaluation system

**Key words** : pumped storage power station, inclined tunnel of penstock, TBM, cost down