

## Development and application of automatic construction system for tunnel-secondary lining

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### Background

In the placement of tunnel lining concrete in Japan, a concrete with a slump of about 15 cm is placed into a narrow and closed space with a lining thickness of about 30 cm, and internal and formwork vibrators are manually operated for compaction work. On the other hand, the construction industry in Japan suffers a huge shortage of skilled workers due to aging, and to make up for these problems, encourages mechanization and automation of construction works. There is an urgent need to mechanize painful human efforts in lining concrete placing.

### Summary of the System

We have developed a new concrete placement pipeline system and an automatic concrete-placement system in combination with a concrete pumping truck utilizing interlinking technology. The automatic concrete-placement system for tunnel lining, as shown in Fig.1, is composed of four elements. A: high-fluidity lining concrete which requires no compaction, B: a new concrete-casting pipeline system to facilitate the recovery of waste concrete, C: high-speed pipeline switching system, and D: a placement control system which is designed to regulate the concrete height automatically.

By automatically controlling Systems B and C, System D is able to place concrete from the center of the lining formwork without human intervention and to automatically adjust the concrete height of the left and right linings. Furthermore, the casting situation was able to be delivered over the network, demonstrating the capability that placement can be monitored remotely and to be utilized as a model of actual lining work.

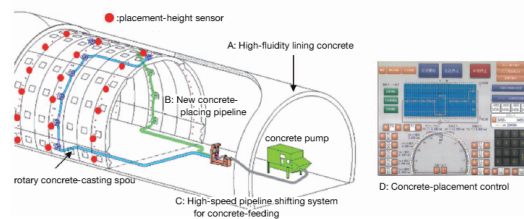


Fig. 1 Diagram of the automatic lining concrete-placement system

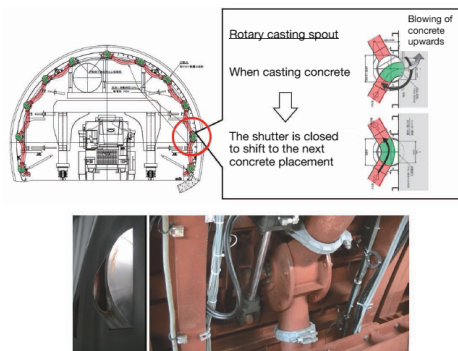


Fig. 2 New concrete placing pipeline