Widening Work on Existing Tunnel Incorporating Consideration for Impact on Nearby Residents' Living Environment

Two protectors were used in the tunnel widening work, which involved the conversion of a one-lane road into a two-lane road.

Photo 1 Before construction

Width:5.7m, height:4.6m
Cross-sectional area:22.7m^2

Photo 2 During construction

Width:11.5m, height:6.5m
Cross-sectional area:60.7m^2

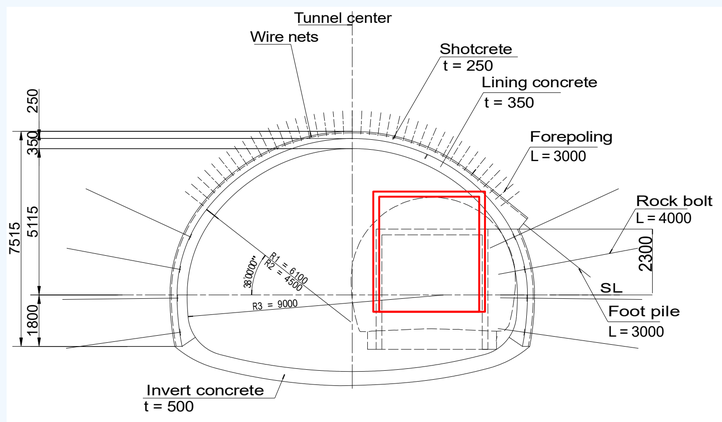


Image 1 Support patterns

Photo 3 Lighting inside protector

Project construction issues

Issue 1: The tunnel is part of a major route designated as both a primary transportation route and an emergency route. Accordingly, the tunnel could not be closed for long periods, whether for excavation or to move protectors.

Issue 2: A standing requirement was to minimize impact on the living environment of a residential area near the portal at the end of the tunnel. Accordingly, environmental protection measures were planned and implemented to avoid construction noise and vibrations.

Construction outline & Solutions for Issues

Project name	Improvement of single-lane prefectural road (trunkline), construction work to widen Kuradama Tunnel Road
Builders	Tobishima and Ito, a special joint building and engineering enterprise
Construction site	National Route 465 in Kuradama, Kimitsu City
Construction period	December 23. 2020 – March 24, 2023
Tunnel length	152.0m
Construction method	NATM (mechanical excavation)
Mucking out method	Road haulage
Earth covering	Maximum covering 24m
Soil characteristics	Alternate layers of predominantly mudstone, then sandstone rock

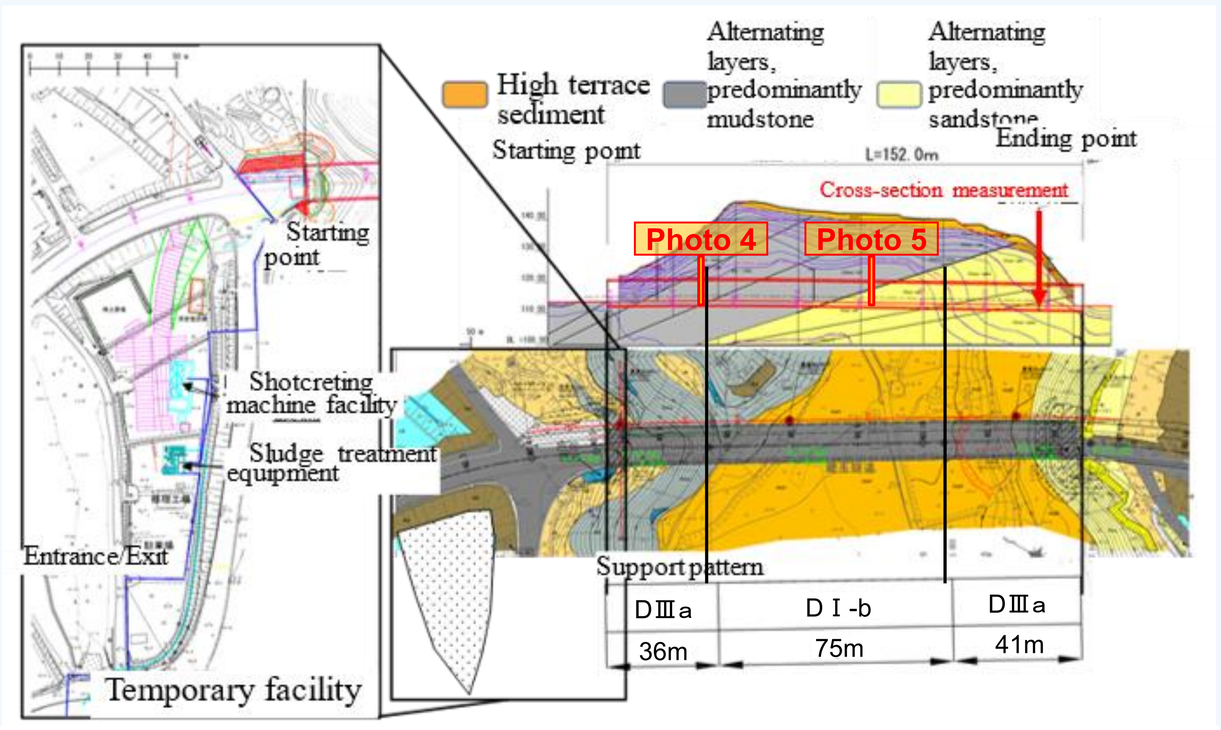


Image 2 Temporary yard (plan view); soil characteristics (vertical section)

Issue 1, Solution 1: Move all protectors in one night (8 hours).

- Protector units (1 unit, 2 meters) were connected to form 10-meter blocks.
- A chill tank was placed at the four corners of each block to allow efficient movement of the protectors.

Issue 1, Solution 2: Reduce heavy machinery relocations.

- A shotcreting machine with an erector attached was deployed when the steel supports were erected.
- ⇒ Effect: The number of times heavy machinery had to be moved in and out was reduced from the originally planned three times to one time.

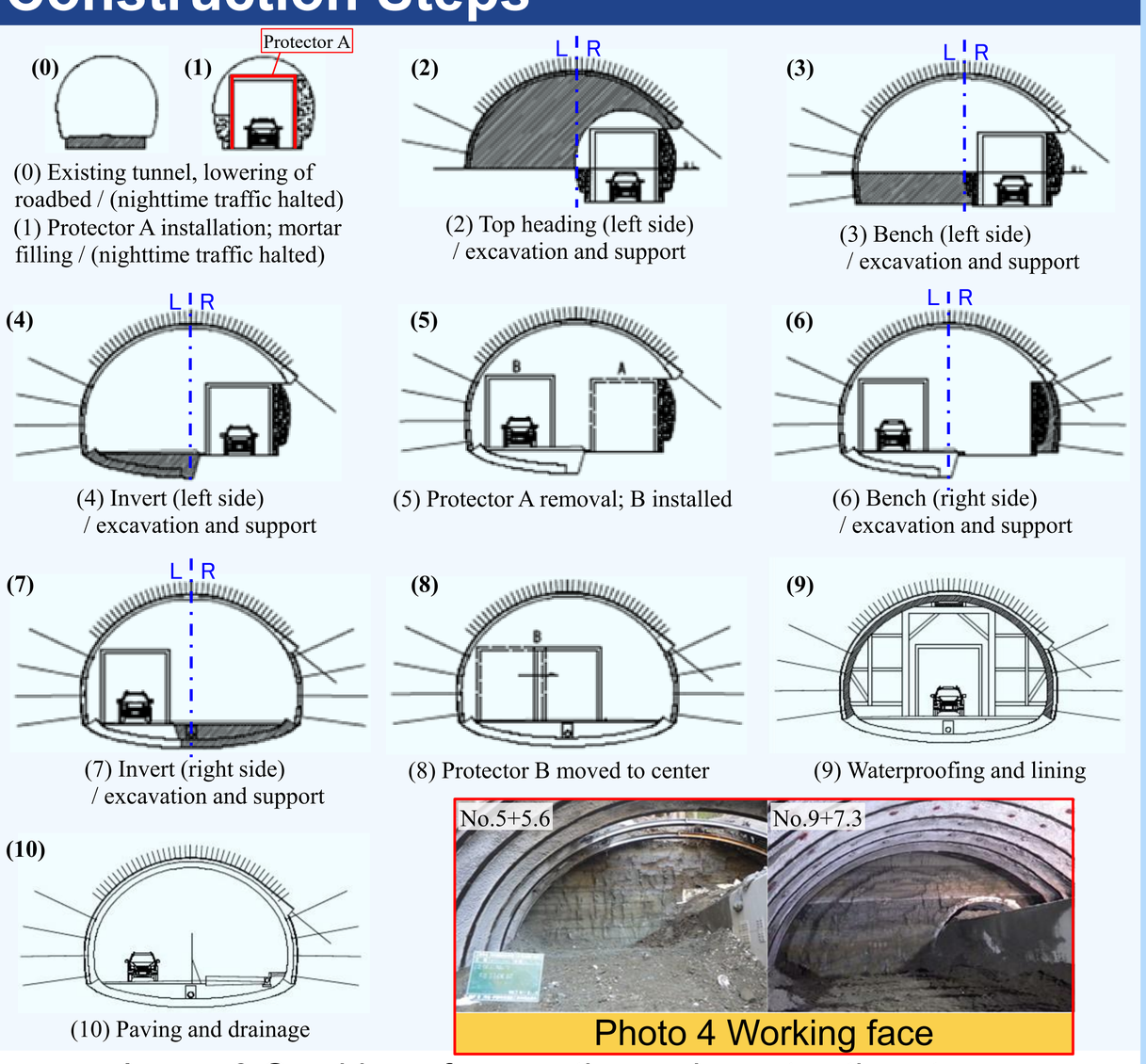
Issue 2, Solution 1: Reduce noise during excavation.

- A 12m sound insulation wall was set up at the portal of the tunnel endpoint.
- A pile of soil (2 m) was left at the end-point side of the tunnel as a sound insulating bulkhead to suppress sound propagation during invert excavation.

Other countermeasures and considerations:

- Need to prevent ordinary vehicles from striking the sides of protectors when passing through: Blue tube lights and LED lighting were attached to the sides of protectors to increase visibility.
- A shaft ventilation system was devised to achieve ventilation during excavation without blowing dust outside the tunnel.

Construction Steps



(0) Existing tunnel, lowering of roadbed / (nighttime traffic halted)
(1) Protector A installation; mortar filling / (nighttime traffic halted)

(2) Top heading (left side) / excavation and support

(3) Bench (left side) / excavation and support

(4) Invert (left side) / excavation and support

(5) Protector A removal; B installed

(6) Bench (right side) / excavation and support

(7) Invert (right side) / excavation and support

(8) Protector B moved to center

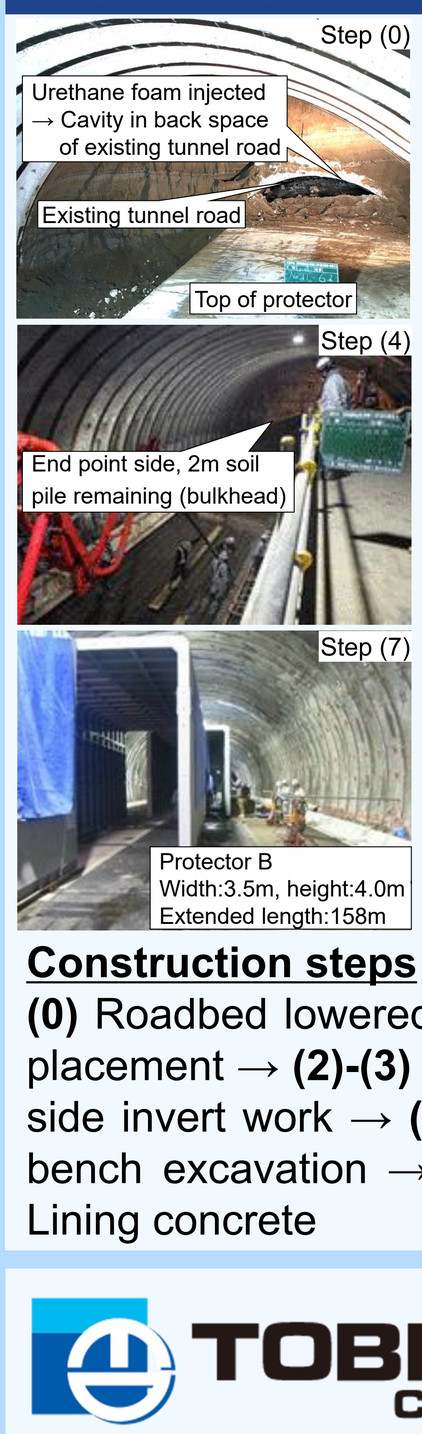
(9) Waterproofing and lining

(10) Paving and drainage

Photo 4 Working face

Image 3 Overbiew of excavation and construction steps

Photo of construction Steps



Construction steps

(0) Roadbed lowered; rear face cavity filled → **(1)** Protector A placement → **(2)-(3)** Top heading, bench excavation → **(4)** Left side invert work → **(5)** Protector B installed → **(6)** Right side, bench excavation → **(7)** Protector B moved to center → **(8)** Lining concrete

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