Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

Kanto Regional Development Bureau

Tokyo Ring Road Highway Office

TE Bldg. 7th floor, 4-5-16 Yoga, Setagaya-ku, Tokyo 158-8580
Tel: 0120-34-1491
(Specific toll-free telephone number for Tokyo Ring Road Construction Work accessible from 9:15 to 18:00 on weekdays)

East Nippon Expressway Company Limited (NEXCO EAST)

Kanto Regional Head Office

Tokyo Ring Road Construction Office

4-1-23 Takanodai, Nerima-ku, Tokyo 177-0033
Tel: 0120-861-305
(Specific toll-free telephone number for Tokyo Ring Road Construction Work accessible from 9:00 to 17:25 on weekdays)

Central Nippon Expressway Company Limited (NEXCO CENTRAL)

Tokyo Branch

Tokyo Construction Office

Cross Air Tower, 7th floor
1-5-1 Ohashi, Meguro-ku, Tokyo 153-0044
Tel: 0120-016-285
(Specific toll-free telephone number for Tokyo Ring Road Construction Work accessible from 9:00 to 17:30 on weekdays)

Tomei JCT side Launching Section

■ Main Line Tunnel (South Bound) Tomei North Construction Project

Special Construction Work Joint Venture of Kajima Corporation, Maeda Corporation, Sumitomo Mitsui Construction Co., Ltd., Tekken Corporation, and Seibu Construction Co., Ltd. for Tokyo Ring Road Main Line Tunnel (South Bound) Tomei North Construction

3-12 Kitami, Setagaya-ku, Tokyo 157-0067
Tel: 03-6411-8723, Fax: 03-6411-8724

■ Main Line Tunnel (North Bound) Tomei North Construction Project

Special Construction Work Joint Venture of Obayashi Corporation, Nishimatsu Construction Co., Ltd., Toda Corporation, Sato Kogyo Co., Ltd., and The Zenitaka Corporation for Tokyo Ring Road Main Line Tunnel (North Bound) Tomei North Construction

6-17-2 Okura, Setagaya-ku, Tokyo 157-0074
Tel: 03-5727-8511, Fax: 03-5727-8521

Oizumi JCT side Launching Section

■ Main Line Tunnel (South Bound) Oizumi South Construction Project

Special Construction Work Joint Venture of Shimizu Corporation, Kumagaigumi Co., Ltd., Tokyu Construction, Takenaka Civil Engineering & Construction Co., Ltd., and Konoike Construction Co., Ltd. for Tokyo Ring Road Main Line Tunnel (South Bound) Oizumi South Construction

3-3 Oizumi-machi, Nerima-ku, Tokyo 178-0062
Tel: 03-5947-5256, Fax: 03-3925-0160

■ Main Line Tunnel (North Bound) Oizumi South Construction Project

Special Construction Work Joint Venture of Taisei Corporation, Hazama Ando Corporation, Penta-Ocean Construction Co., Ltd., Tobishima Corporation, and Daiho Corporation for Tokyo Ring Road Main Line Tunnel (North Bound) Oizumi South Construction

NTT Shakujii Bldg. 2nd floor, 2-14-13 Shakujii-machi, Nerima-ku, Tokyo 177-0041
Tel: 03-6913-3602, Fax: 03-6913-3672

4th Ed. issued August 2019

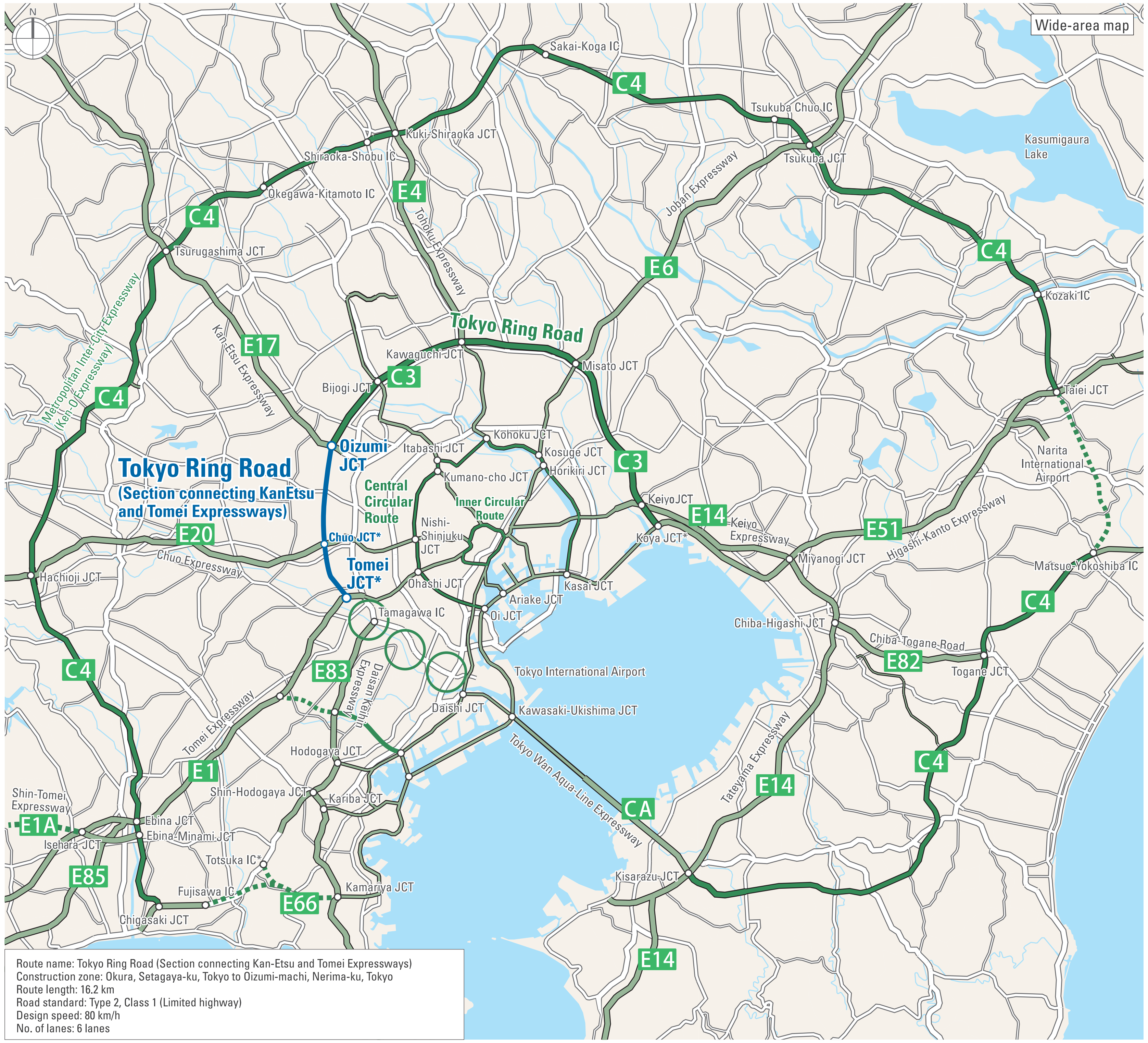
Shield Tunnel

Construction Project Brochure

01 Project Overview

Developing Expressway Network in the Tokyo Metropolitan Area

Tokyo Ring Road is a part of the expressway network composed of three (3) ring roads and nine (9) radial roads projected originally in 1963 as a framework for road transportation in the greater Tokyo area.
Tokyo Ring Road will finally extend about 85 km in total length, which passes through the area about 15 km from central Tokyo, and become a critical road for relieving congestion, improving the environment, and realizing a smooth transportation network.
Tokyo Ring Road (section from Kan-Etsu Expressway to Tomei Expressway) is about 16 km in length as tunnel, thereby contributing to a more comfortable environment and less environmental impact in Tokyo.



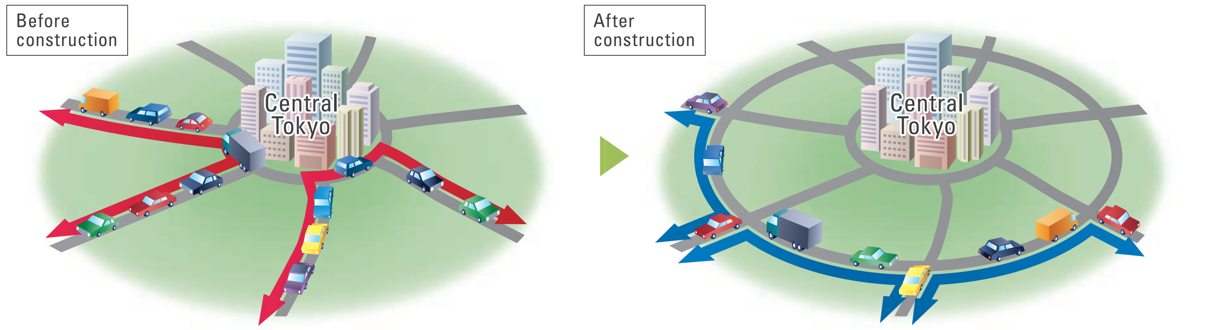
Route name: Tokyo Ring Road (Section connecting Kan-Etsu and Tomei Expressways)
Construction zone: Okura, Setagaya-ku, Tokyo to Oizumi-machi, Nerima-ku, Tokyo
Route length: 16.2 km
Road standard: Type 2, Class 1 (Limited highway)
Design speed: 80 km/h
No. of lanes: 6 lanes

*JCT and IC names are tentative.
The trunk road network map shown above is as of March 2019.
Dotted lines indicate the route section under construction in this project.

Expected Benefits from this Project

Relieving Congestion

Development of Tokyo Ring Road will control the inflow of through-traffic to central Tokyo.



Reducing Travel Time and Improving Environment

Tokyo Ring Road make the traffic flow smoother.Shorter travel time contributes to reduced CO_2 emissions.

Section connecting Kan-Etsu and Tomei Expressways

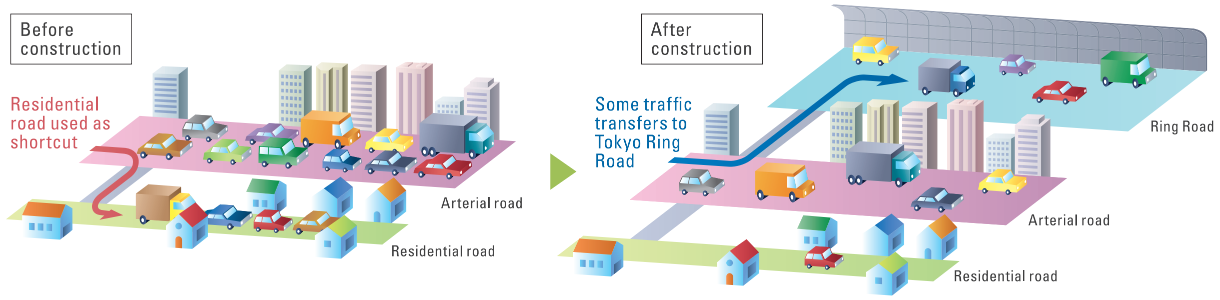
Before construction — Local Ring Road No. 8 — About 60 min

After construction — Tokyo Ring Road — Only About 12 min

Source: The time of 12 minutes is based on the design speed of Tokyo Ring Road.
The time of 60 minutes is based on the average travel speed during congestion as determined from 2010 Traffic Census.

Improving Safety of Residential Roads

The number of vehicles that use residential roads as shortcuts for arterial roads will decrease.

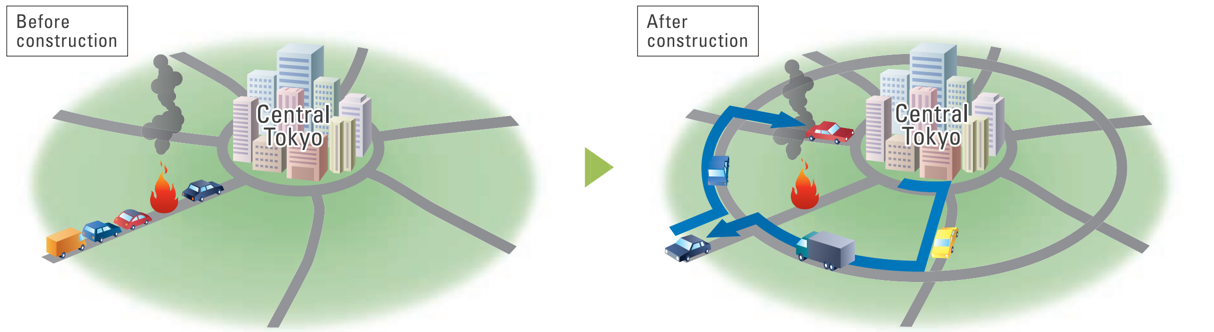


Residential roads used as shortcuts to avoid traffic jam

Traffic on residential road is reduced

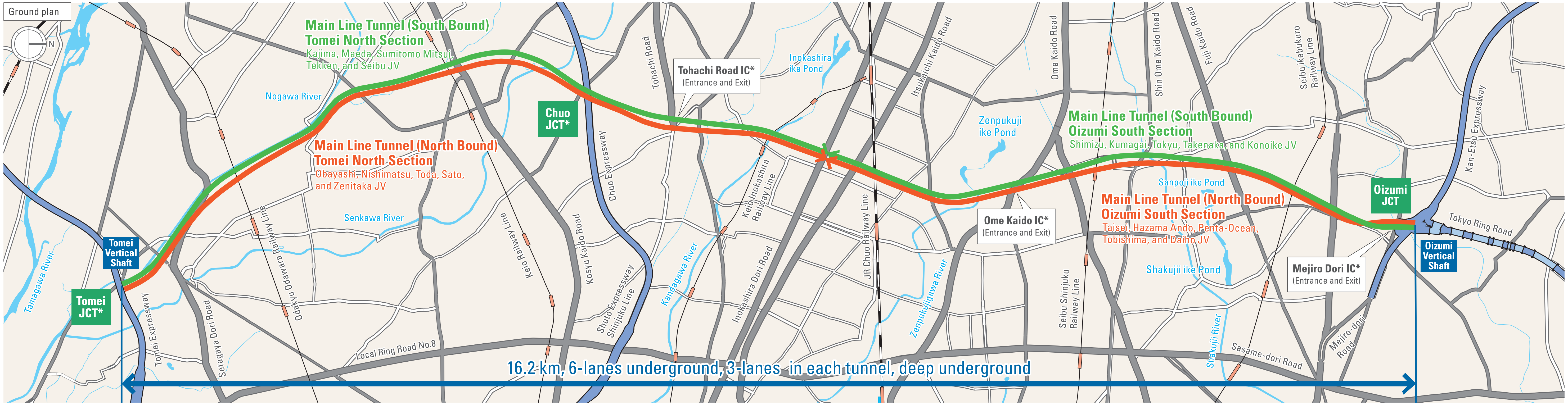
Disaster-resistant City

A ring road secures a detour to any destination with rapid movement even in the event of discontinuity in any section due to disaster, accident or other reasons.

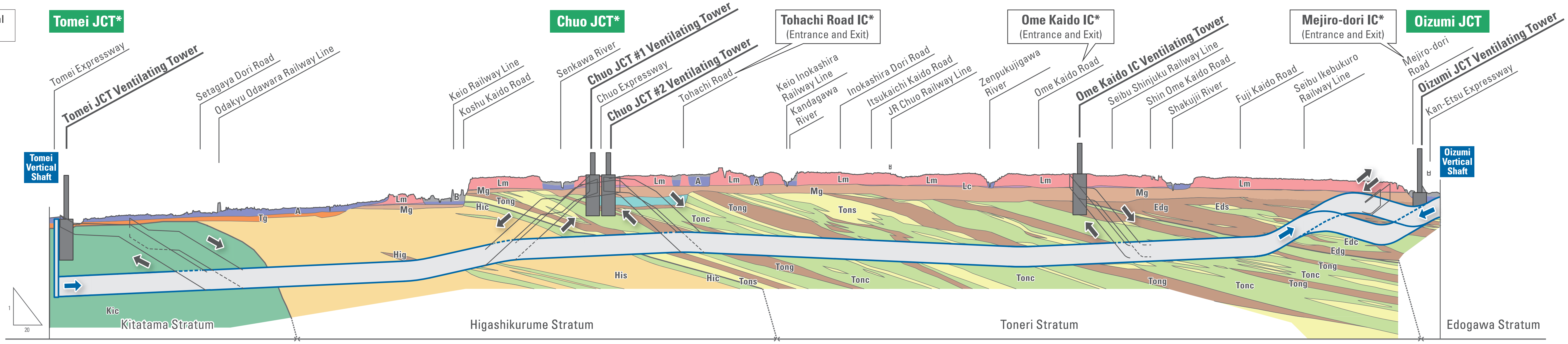


02 Abstract of Construction

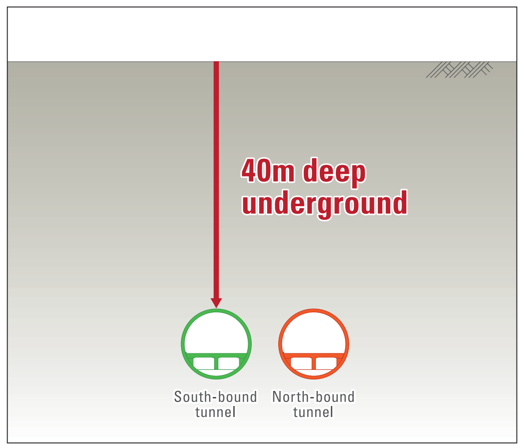
Ground plan



Longitudinal section



Typical cross-section



Outline of Main Line Tunnel

Length: About 16.2 km
Tunnel specs: Outer diameter 15.8 m
Inner diameter 14.5 m
Lining thickness 650 mm

Main Line Tunnel (South Bound) Tomei North Section
Main Line Tunnel (North Bound) Tomei North Section
About 9.2km

Main Line Tunnel (South Bound) Oizumi South Section
Main Line Tunnel (North Bound) Oizumi South Section
About 7.0km

Image of Completed Tunnel Section

Legend

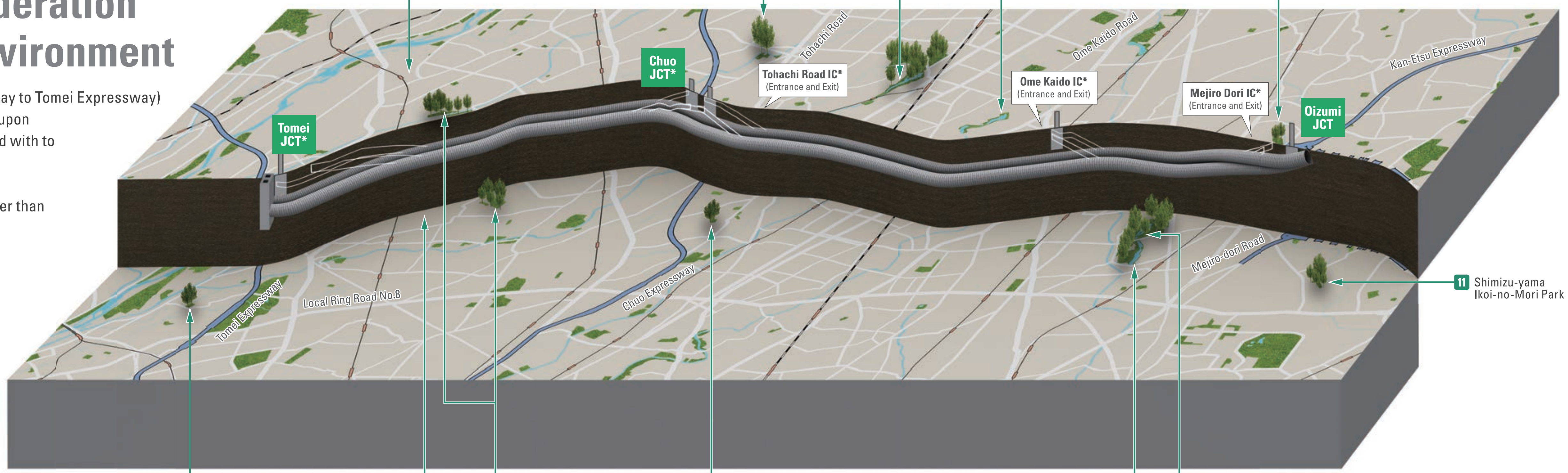
Geological age		Formation		Code	Facies	
Quaternary	Holocene	Bank, buried soil		B	Composed mainly of gravelly soils.	
		Alluvium		A	Soft cohesive soil, Humus soil	
	Pleistocene	Kanto loam		Lm	Volcanic cohesive soil	
		Loamy clay		Lc	Argillizated Kanto loam	
		Tachikawa gravel		Tg	Sand gravel	
		Musashino gravel		Mg	Sand gravel	
		Setagaya		Setc	Cohesive soils rich with fine particles	
				Setg	Sand gravel	
		Kazusa Group	Edogawa	Edc	Clay	Composed mainly of compact sandy gravels, including compact sand and hard cohesive soil layers between the sandy gravels.
				Eds	Sand	
				Edg	Gravel	
			Toneri	Tonc	Clay	Composed of repeated layers of compact sandy gravel, sand, and hard cohesive soil
				Tons	Sand	
				Tong	Gravel	
			Higashi kurume	Hic	Clay	Composed mainly of compact sand, including thin layer of hard cohesive soil between the compact sand layersPartly including the sandy gravel layers between the compact sand layers.
				His	Sand	
				Hig	Gravel	
			Kitatama	Kic	Clay	Composed mainly of hard cohesive soils

*JCT and IC names are tentative.

03 Environmental Effect

Adoption of the Tunnel Structure in Consideration of the Roadside Environment

Tokyo Ring Road (Section from Kan-Etsu Expressway to Tomei Expressway) has adopted a tunnel structure having less impact upon the natural environment on the ground as compared with to the elevated road design.
In the construction of Main Line tunnels, the shield tunneling method has been adopted rather than the method of excavation from the ground surface.
Thus, it contributes to suppressed influence on the groundwater compared to the open-cut method.



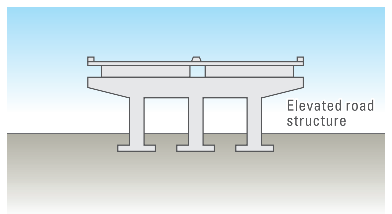
*JCT and IC names are tentative.

Protecting the Living Environment in the Roadside Areas

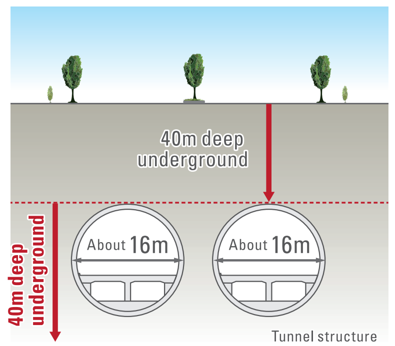
Adoption of the tunnel structure minimizes the effects of vehicle emission, noise and vibration upon the roadside areas.

Typical Cross-section

Initial Plan (July 1966)



Revised Plan (April 2007)



Inokashira-Ike Pond

The source of Kandagawa River. In Inokashira Onshi Park, Japan's first suburban park, there is a thickly wooded area, reminding us of the traces of the old Musashino.

Zenpukuji-Ike Pond

One of the three (3) major spring ponds in the old Musashino area, which had been utilized as a supplementary water source for Kanda Josui (Kanda water supply).

Yanokama-no-Wakimizu Spring

One of the springs in the basin of Shirakogawa River. Reportedly it was once a place visited by those who wanted to purify themselves before climbing Mt. Fuji or Mt. Ontake for worship.

Kokubunji Gaisen Cliff Line Green Conservation Area

A terrace cliff formed by Tamagawa River which had scraped off Musashino Upland over 100,000 years, still having a rich natural environment, including forests and springs.

Seijo Mitsu-Ike Pond

A place preserved in Setagaya Ward, especially featuring a rich natural environment, including thickly wooded area, springs, and precious flora and fauna.

Komae Benzaiten Pond Special Green Space Conservation District

Tradition records that, when drought struck in the Nara period, Ryujin, the dragon king in Japanese mythology, appeared and sent rain and then the water sprung up.

Karasuyama Benten-Ike Pond (Spring)

A pond supplied from the source of very shallow perched ground water. Lily communities, and kingfishers and ducks have relaxed the hearts of people.

Katsubuchi Jinja Shrine Special Green Space Conservation District

A precious green space adjacent to Senkawa River and Maruike Park, enclosed with a thickly wooded area.

Okamoto Seikado Green Space

A wood land surrounding Seikado Bunko Art Museum. The former garden has been preserved, and the natural forest of Castanopsis sieboldii (species of chinquapin) and the evergreen woodland can be seen.

Sanpoji-Ike Pond (Marsh)

One of the three (3) major spring ponds in the old Musashino area. Reportedly the pond has never been exhausted even during long spells of dry weather in the Edo period.

Shimizu-yama Ikoi-no-Mori Park

As the name implies, fresh water has been springing out without exhaustion and trout lilies grow in profusion.

Shakujii-Ike Pond

From Sanpoji-Ike Pond, a waterway had been led and fields and paddies were spread out. In 1933, the waterway was ponded up to create this pond.

04 Characteristics of Main Line Tunnel Construction

Construction of 16 km Tunnels

Main Tunnel is composed of the North-Bound Tunnel extending the north from Tomei JCT* and the South-Bound Tunnel extending south from Oizumi JCT, forming the road of 3 lanes for each direction, and 6 lanes in total.
The two tunnels will be excavated from Tomei Vertical Shaft and Oizumi Vertical Shaft, and will join near the Inokashira-dori Road.
The construction work also includes assembling of slabs to form the road surfaces and construction of cross passages to connect between the North-Bound and the South-Bound Tunnels.

Shield Tunnel Method

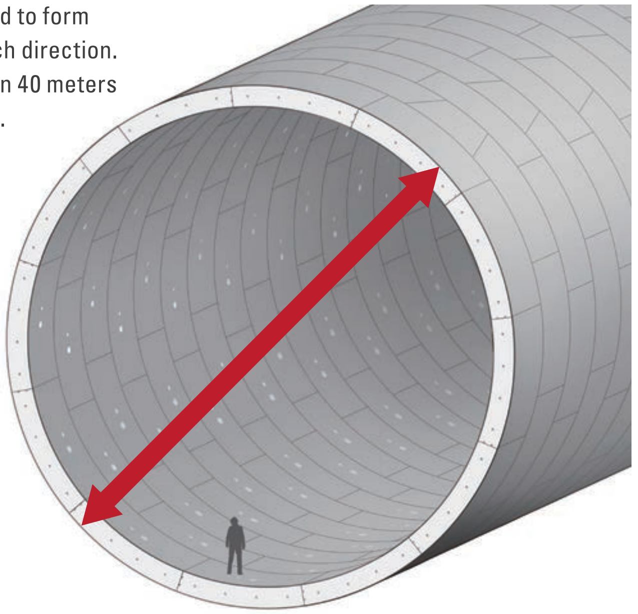
By the shield method, a tunnel with a diameter of 15.8 m is constructed to form a road tunnel of 3 lanes with each direction. Most of sections run deeper than 40 meters below the surface of the ground.

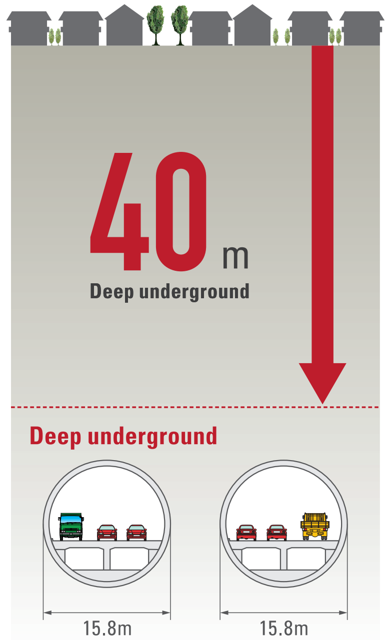
Tunnel outer diameter

15.8 m

Total tunnel length about

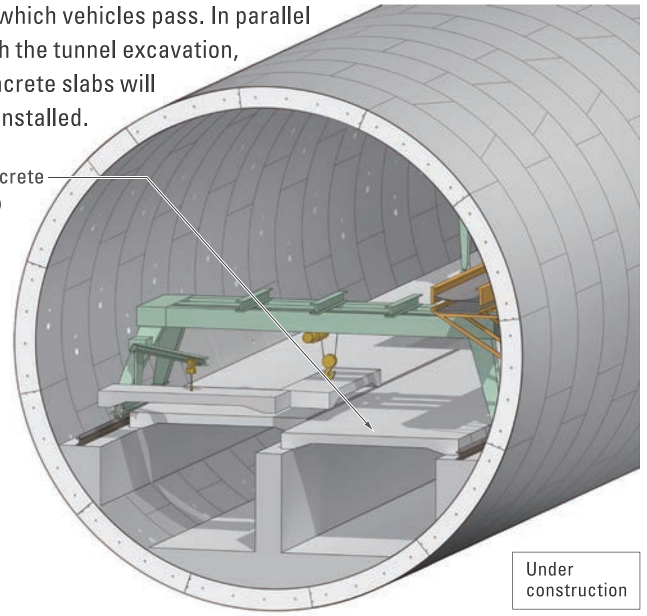
16.2 km

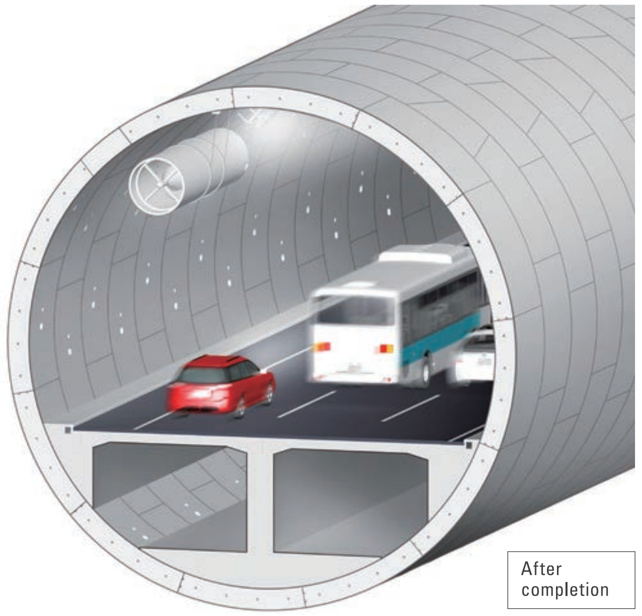


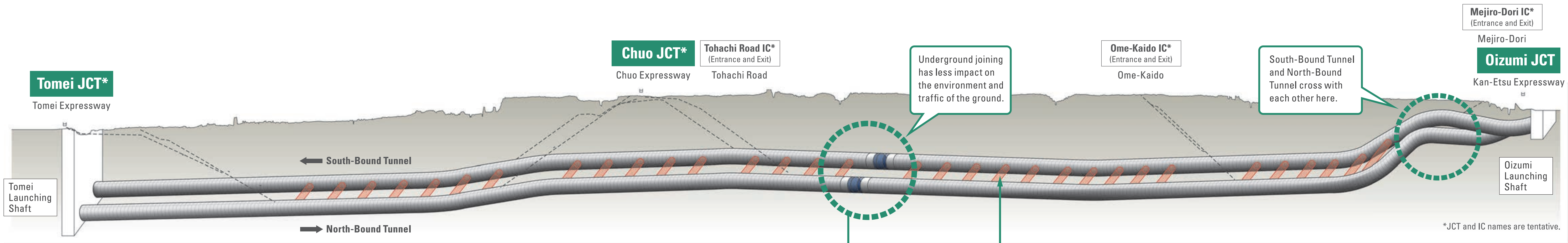


Concrete Slab Construction

Concrete slabs form the road surfaces on which vehicles pass. In parallel with the tunnel excavation, concrete slabs will be installed.



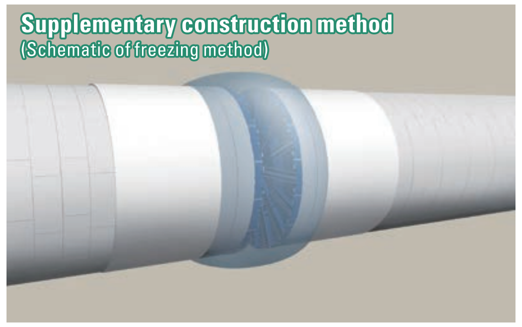




*JCT and IC names are tentative.

Underground Joining Work

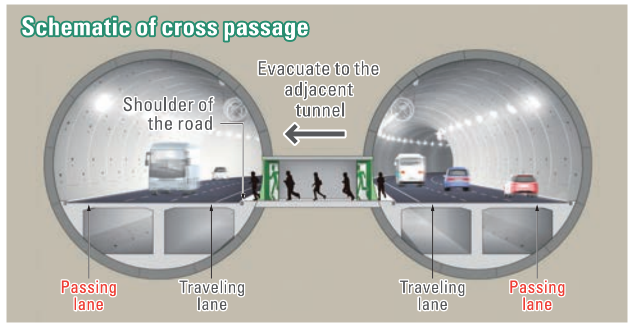
The shield machines, starting from Tomei Vertical Shaft and Oizumi Vertical Shaft, meet face-to face at the target point near underground of Inokashira dori Road. After freezing the surrounding soil by auxiliary method (freezing method), the shield machines are dismantled, and tunnel connecting work are completed.



Freezing method allows the underground tunnel connection while protecting inflow of groundwater.

Cross Passage

Cross passage is intended to facilitate the evacuation in case of an emergency to the tunnel on the other side.



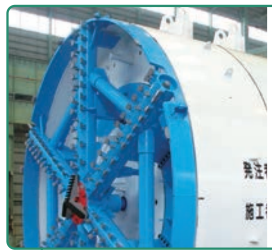
The South-Bound and North-Bound Tunnels starting from the Oizumi Vertical Shaft cross with each other. This design allows evacuation to the opposite side tunnel from the traveling lane without crossing the passing lane. In addition, evacuation is attained to the traveling lane where shoulder space is available, thus enhancing safety during evacuation.

05 Shield Tunneling Method

A Safe Construction Method Achieved by Building the Tunnel Walls during Excavation

Shield tunneling is a method of constructing a tunnel by digging the ground with an excavator known as a shield machine. The shield machine is a cylindrical excavator covered with a rugged steel shield to withstand the pressures of soil and water deep underground.
The inside of the machine is a sealed space, and the walls constructed as the machine digs through the ground are structured to prevent inflow of groundwater. Thus, shield tunneling has less impact on groundwater both during and after construction.

How the Shield Machine Works

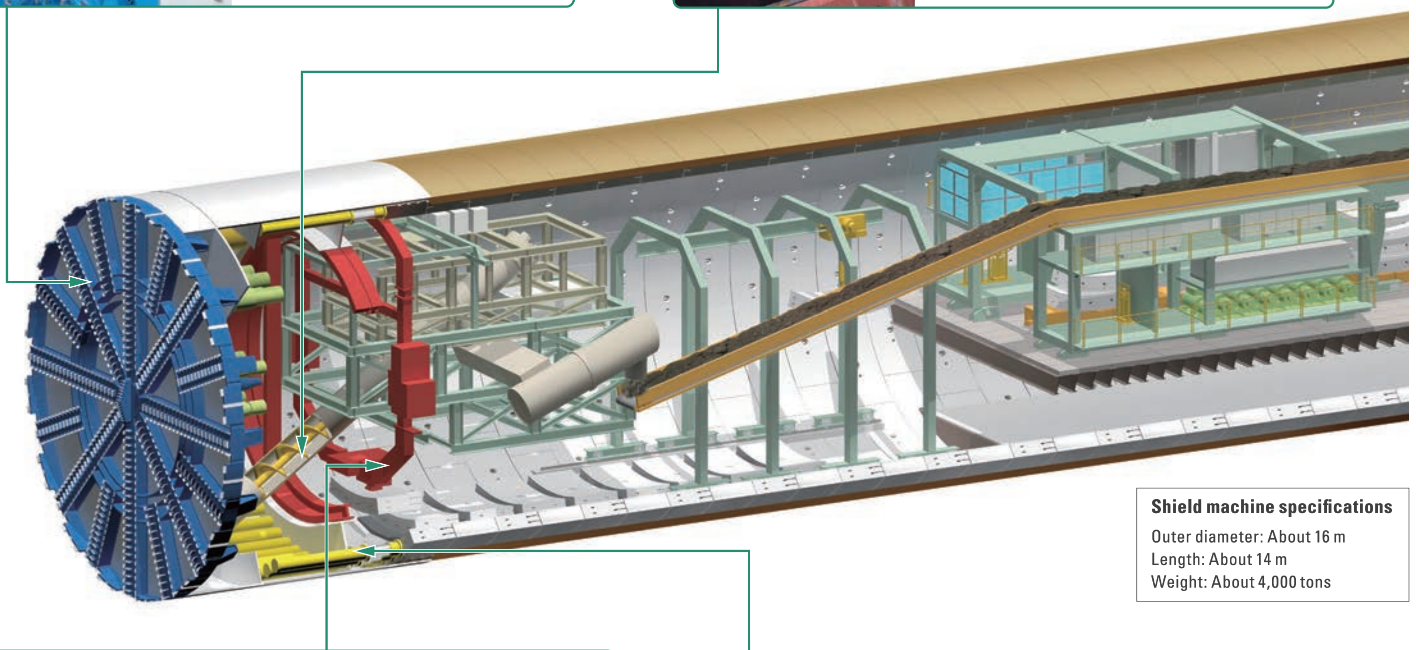


Cutter Head
[Shaving off the earth]

The cutter head contains the blades (cutting bits) of about 10 to 15 cm arranged in a radial pattern. It digs through the ground while shaving off the soil by rotating.

Screw Conveyor
[Conveying the excavated soil]

The screw conveyor works to take the soil excavated by the cutter head into the shield machine and carry it to the rear. It can adjust the volume of soil to be taken into the shield machine by controlling the rotation of the screw.



Shield machine specifications

Outer diameter: About 16 m
Length: About 14 m
Weight: About 4,000 tons

Erector
[Fabricating the tunnel wall]

To the sections from which the soil is shaved off, panels called segments (see Page 12) are fabricated to form the tunnel wall. Segments are fabricated by the erector.

Shield Jack
[Moving the shield machine forward]

The shield jack can expand and contract freely by hydraulic pressure and it works to push the shield machine forward while taking reaction force against the wall of the tunnel.

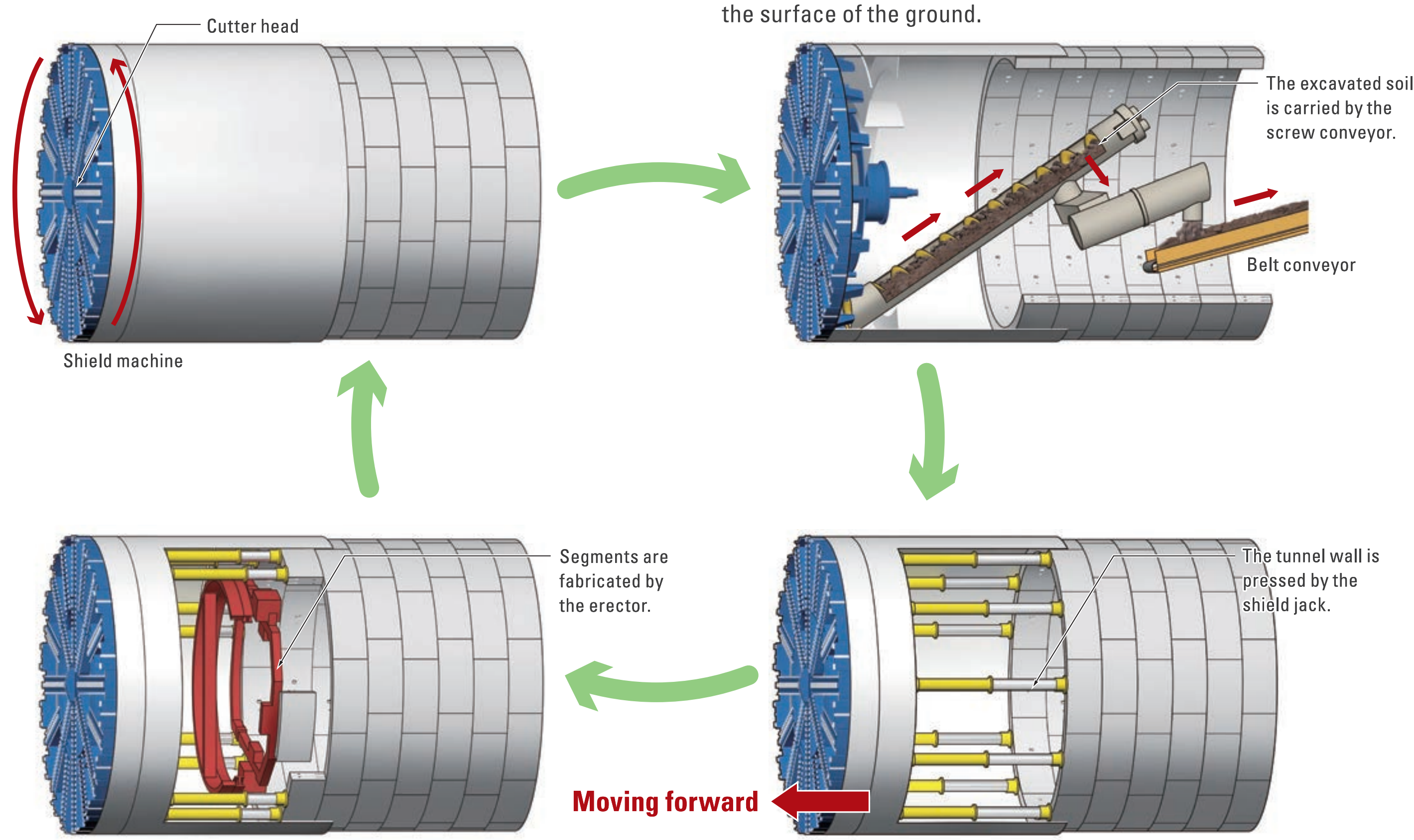
How the Shield Machine Excavates a Tunnel

Step 1 Shaving off the Earth

The cutter head on the front face of the shield machine rotates to shave off the soil.

Step 2 Conveying the Excavated Soil

The screw conveyor carries the excavated soil to the rear of the shield machine and loads it onto the belt conveyor extending to the surface of the ground.



Step 4 Fabricating the Tunnel Wall

In the space created as the shield machine moves forward, segments are fabricated in an annular pattern by the erector.

Step 3 Moving forward

The shield jack is pressed against the fabricated tunnel wall and is expanded to allow the shield machine to move forward.

Comparison of Shield Machine Construction by Excavated Distance and Tunnel Cross Section per Machine

Applications of Shield Tunneling Method

Shield tunneling method has been applied for not only road tunnels but also railway tunnels and water supply and sewerage systems.

Road tunnels

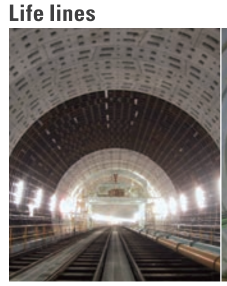
Central Circular Shinagawa Route

Tokyo Wan Aqua-Line

Railway tunnels

The tunnel between Kokuryo and Chofu stations on Keio Railway Line

Life lines



Otsu Floodway

Shirakogawa River Underground Flood Control Reservoir

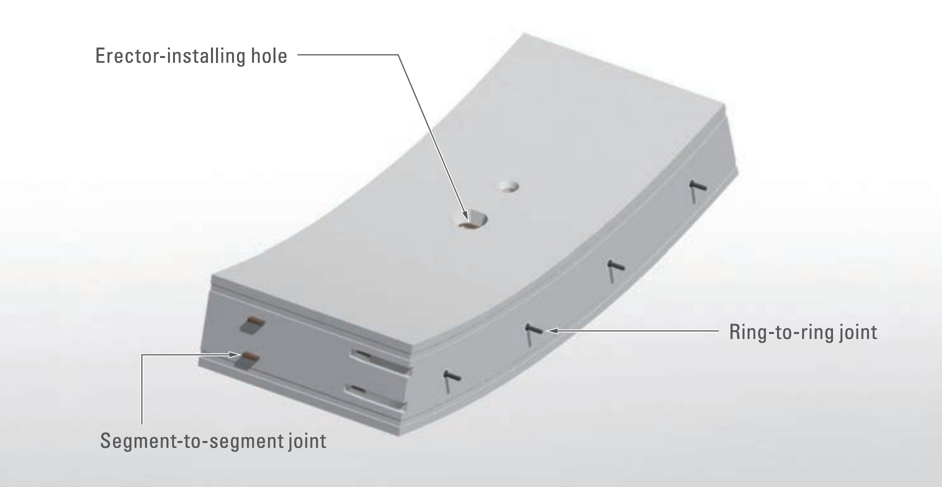
06 Shield Segments in Construction of Main Line Tunnel

Shield Segments for Tunnel Structure

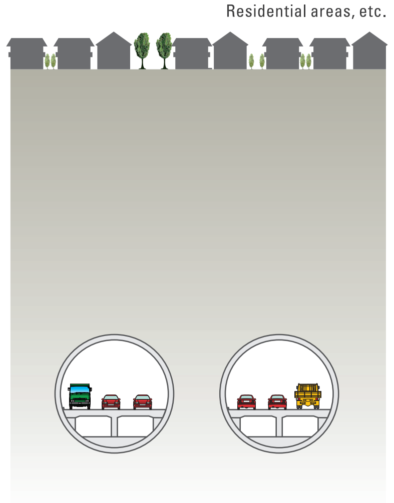
The tunnel structure is made of segments, which are annularly arranged precast concrete panels.
For the specific purpose and/or conditions of the place of construction, appropriate types of segments are applied.

For Normal Sections
RC (reinforced concrete) Segments

Girder height: 650 mm
Width: 1,600 mm
Arc length: 4,052 mm
Joint: Cone connector and pin joint system

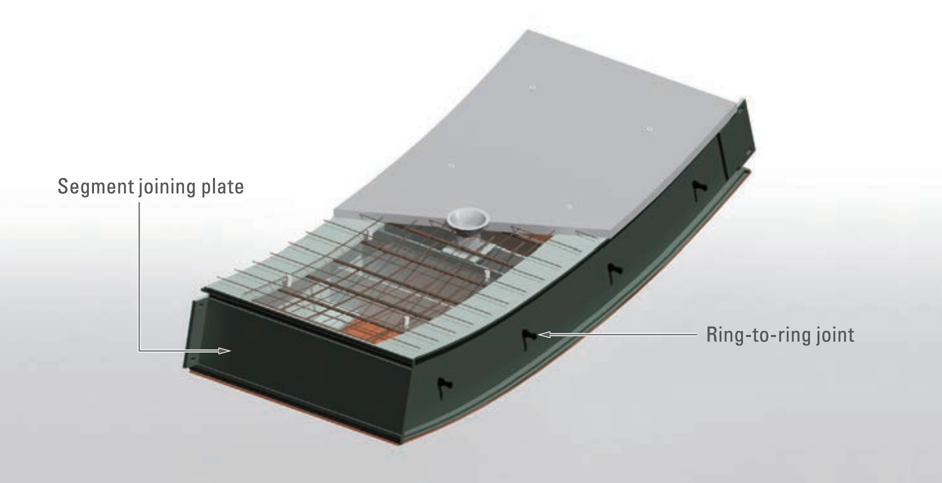


RC segments are made from reinforced concrete, featuring high rigidity and excellent compressive resistance and durability. They are applied to normal sections in the entire tunnel.

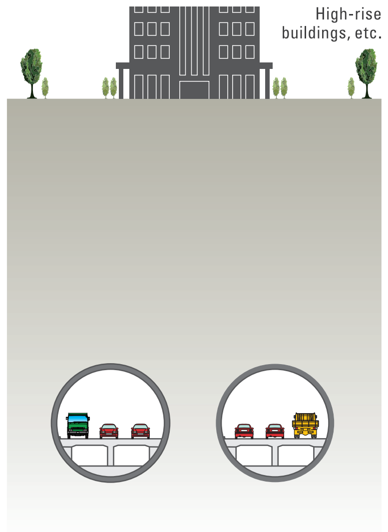


For Heavy Loaded Sections
Composite Segments

Girder height: 650 mm
Width: 1,600 mm
Arc length: 4,052 mm
Joint: Fitting system

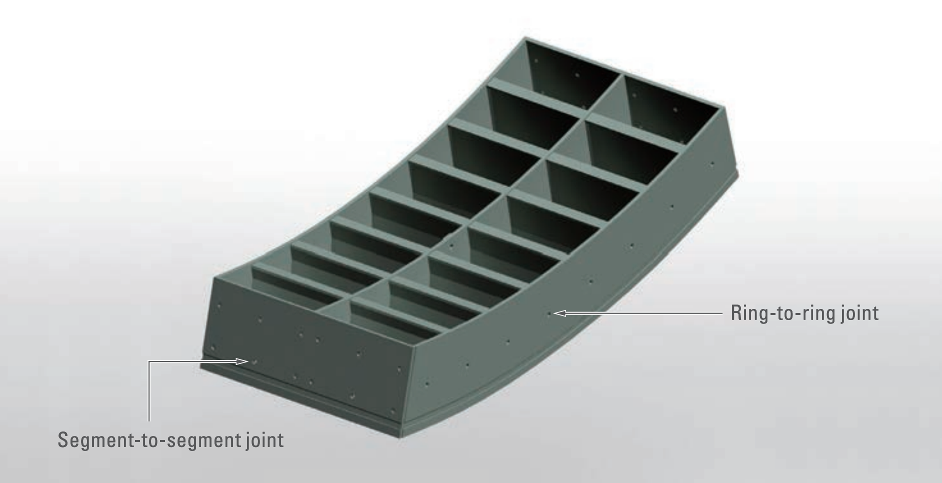


Composite segments are hybrid of steel and concrete. They are applied to those sections over which high-rise buildings or other heavy-duty structures could be constructed.

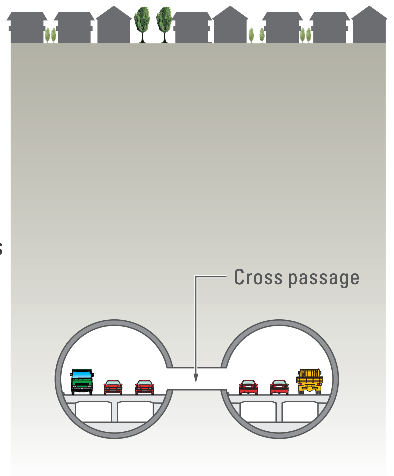


For Cross Passages and Widened Sections
Steel Segments

Girder height: 650 mm
Width: 1,000 mm to 1,800 mm
Arc length: 4,052 mm
Joint: Bolts



Steel segments are highly flexible in design, they are applied in the cross passages requiring openings and the underground widened sections requiring cutting and removal.

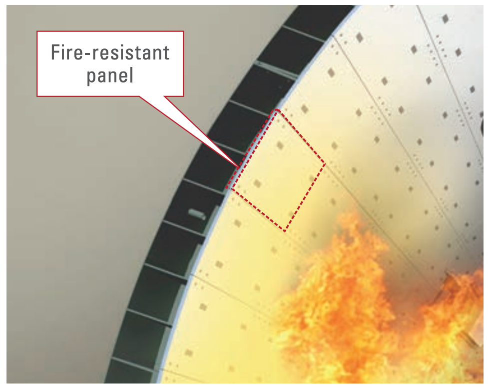


Countermeasures against Tunnel Fires

When a fire breaks out in the tunnel, the tunnel may collapse if the segments get damaged due to heat. Thus, the segments shall have proper fire-resistive performance, ensuring that the tunnel is resistant to fire.

RC Segments and Composite Segments

Steel Segments

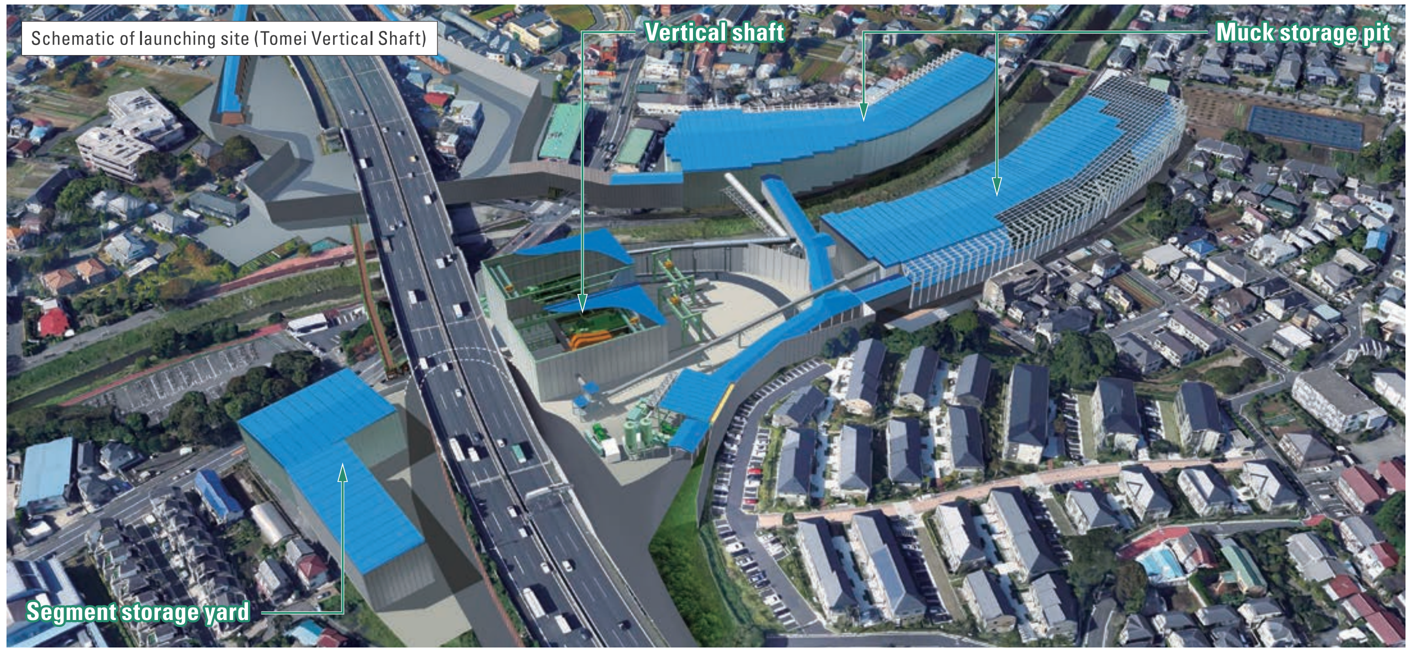


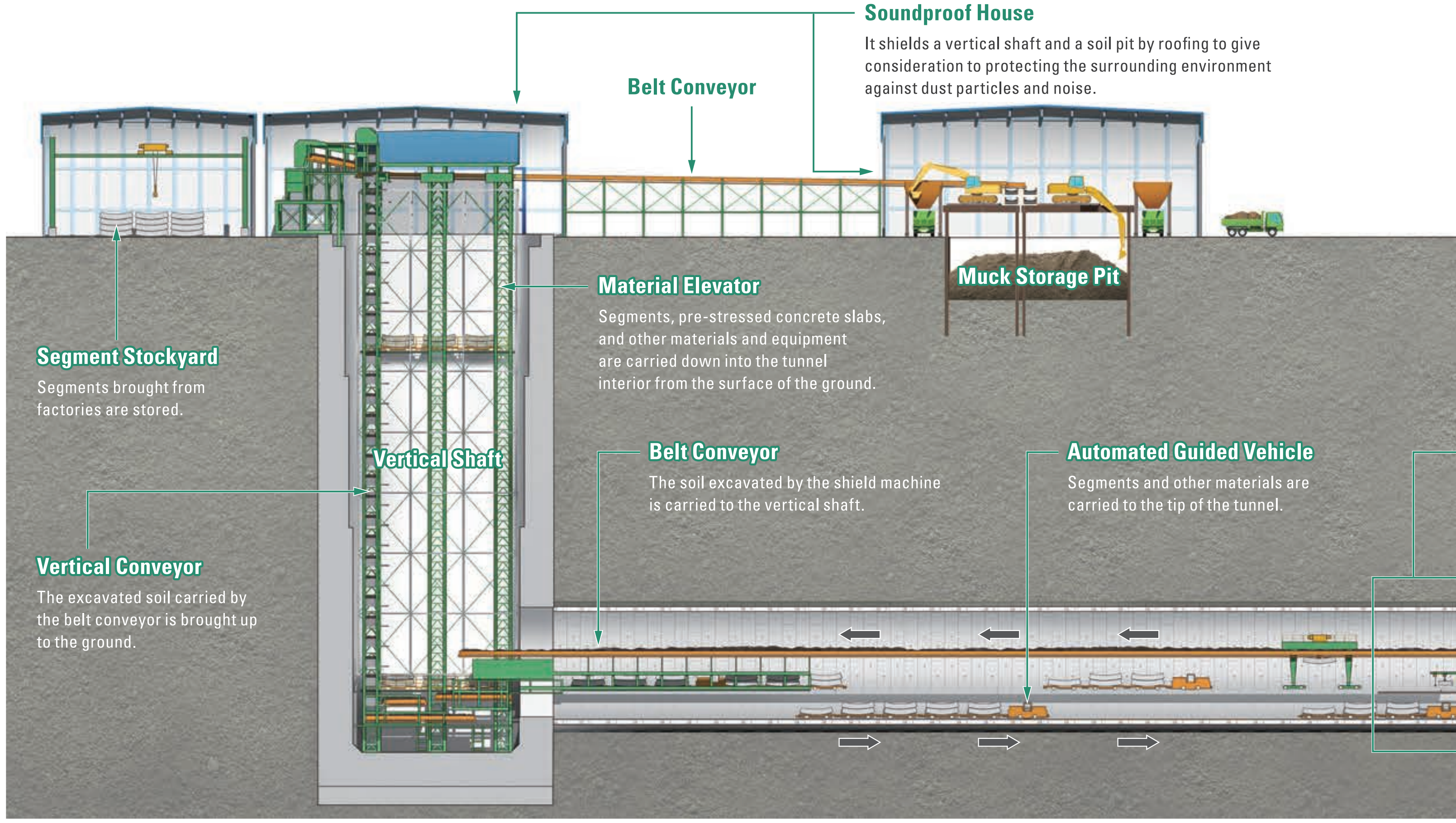
Fire-resistant panels are installed on the inner wall of the tunnel.

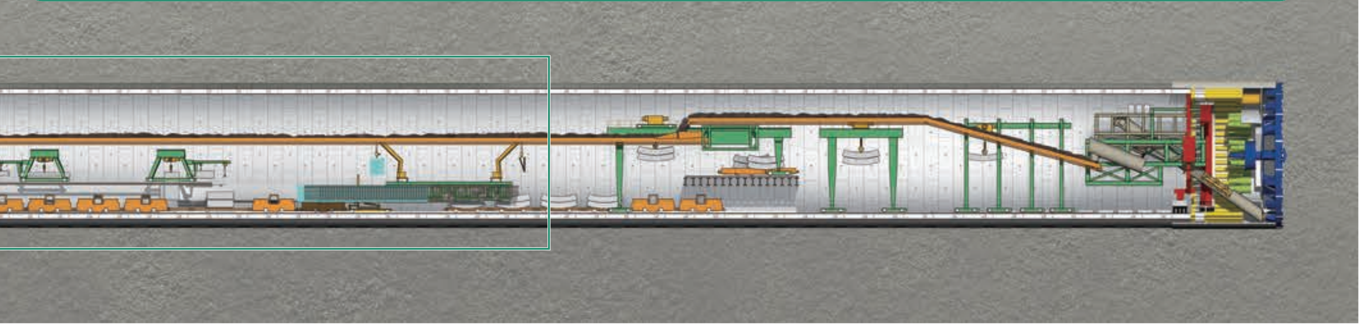
07 Logistic System

Carrying in Materials and Equipment and Carrying out Excavated Soil

The excavated soil is carried to the vertical shaft by a belt conveyor installed in the tunnel interior.
At the Tomei vertical shaft, the excavated soil is carried up to the surface by the vertical belt conveyor and accumulated at the soil pit, and then loaded in dump trucks. Meanwhile, the shield segments and other materials and equipment for tunneling are carried down from the surface to the tunnel interior by a lift and are then carried by an automated vehicle along the tunnel.





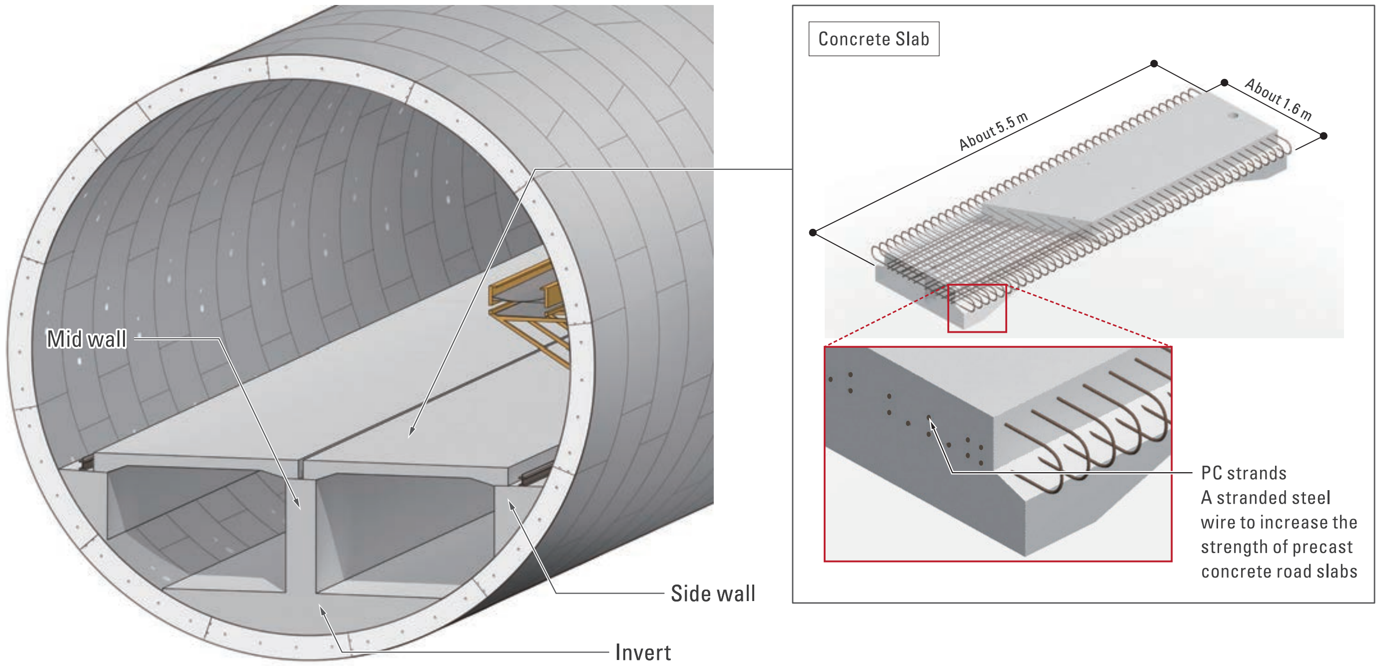


TOKYO RING ROAD

08 Concrete Slab Fabrication

Concrete Slab Work is Carried out in Parallel with Tunneling Work

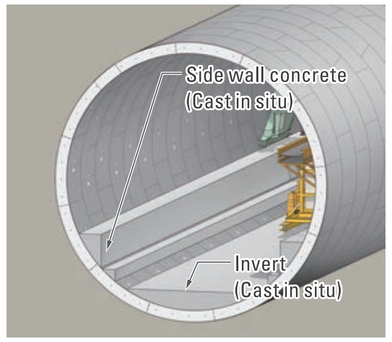
Concrete slabs, which form road surfaces, consist of concrete slab, mid wall, side wall, and RC invert. In the present tunneling work, precast concrete slab work is carried out in parallel with shield excavation work, and then the precast members (members prefabricated at factories) are adopted for concrete slab and mid wall.



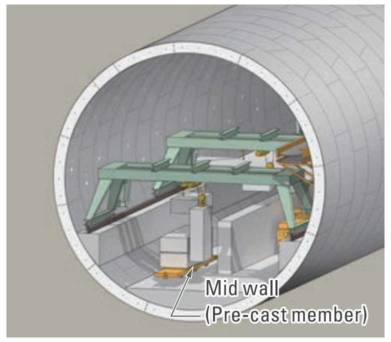
Concrete Slab Work is Carried out behind the Shield Machine.

Invert and side wall concrete are placed in situ and then precast members are installed in the order of mid wall and precast road slab.

1 Placing the invert and side wall concrete



2 Installing the mid wall



3 Installing the precast road slab