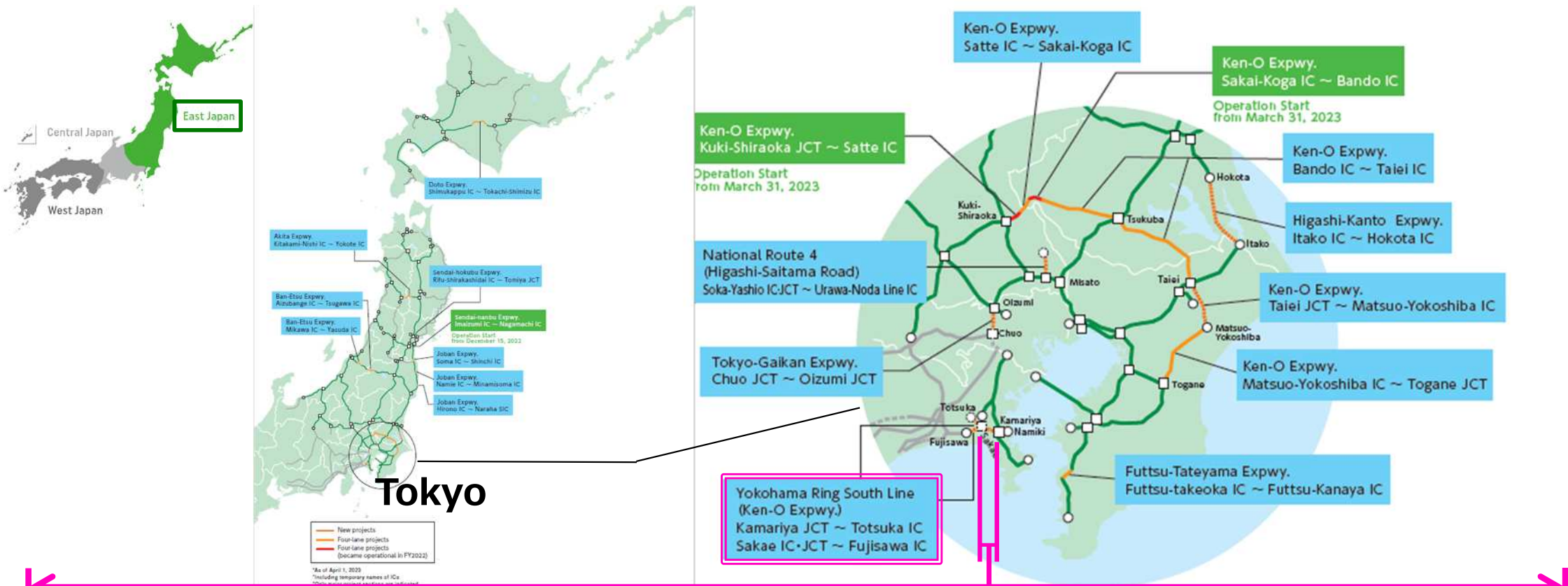


Construction of NATM Tunnel with the largest cross-section in Japan (Kamariya-Shodo Tunnel)

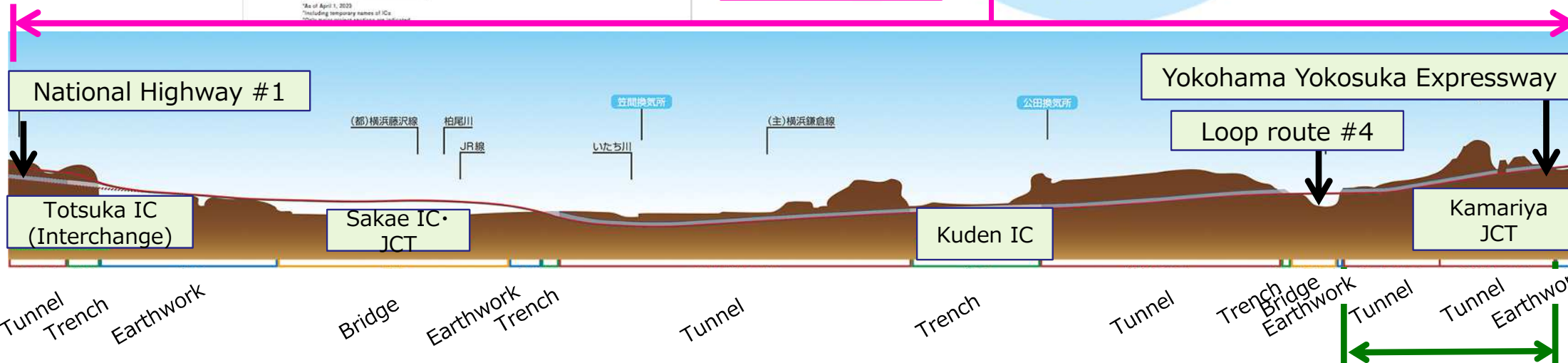
World Tunnel Congress
2024 @Shenzhen, China



Outline of Yokohama Ring South Line



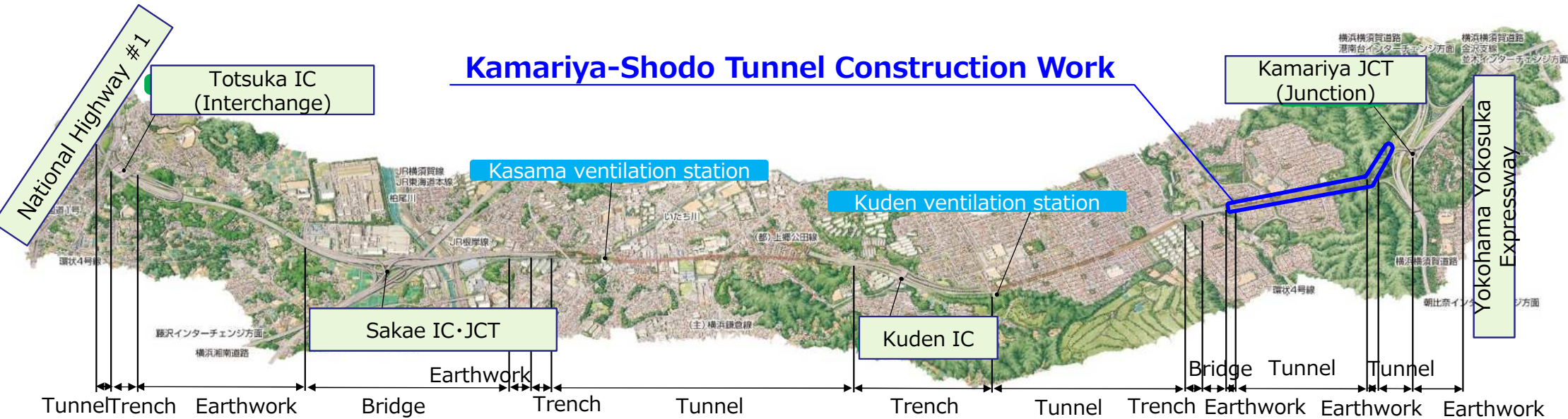
Tokyo



*The names of interchanges and junctions are tentative and may change in the future.

Overview of the construction site

- The construction section is approx. 1,200m length and planned as a tunnel structure.
- Shodo district is a quiet residential area where attentions are to be paid to the preservation of the living environment.



*The names of interchanges and junctions are tentative and may change in the future.



Junction Section
(As of December 2023)



Shallow Section
(As of December 2023)



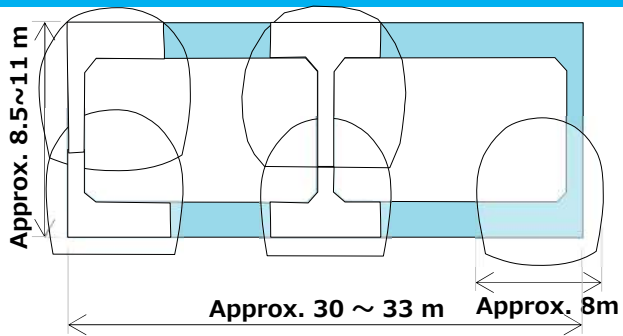
H-Rampway Section
(As of December 2023)

Overview of tunnel construction in Shodo district (Kamariya-Shodo Tunnel)

- The section closest to Kamariya JCT has 4 tunnels which are in proximity or in parallel to each other.
- The Junction section, where the two tunnels merge, has the largest cross section in Japan.
- Non-open cut method was adopted to the shallow section.

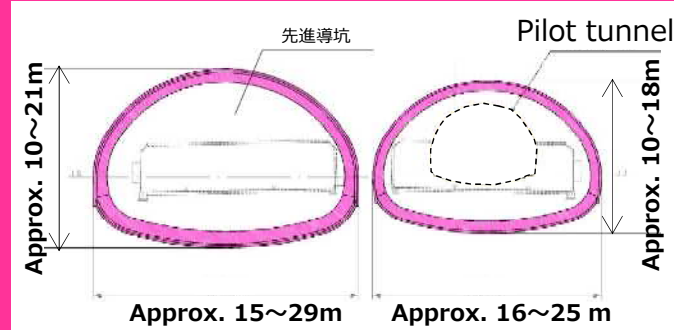
Shallow section (Section A-A)

1 Double box culvert



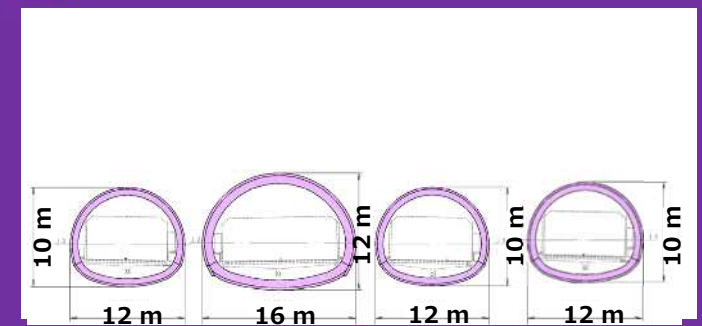
Junction Section (Section B-B)

- 2 Shodo Tunnel (Up line)
- 3 Shodo Tunnel (Down line)

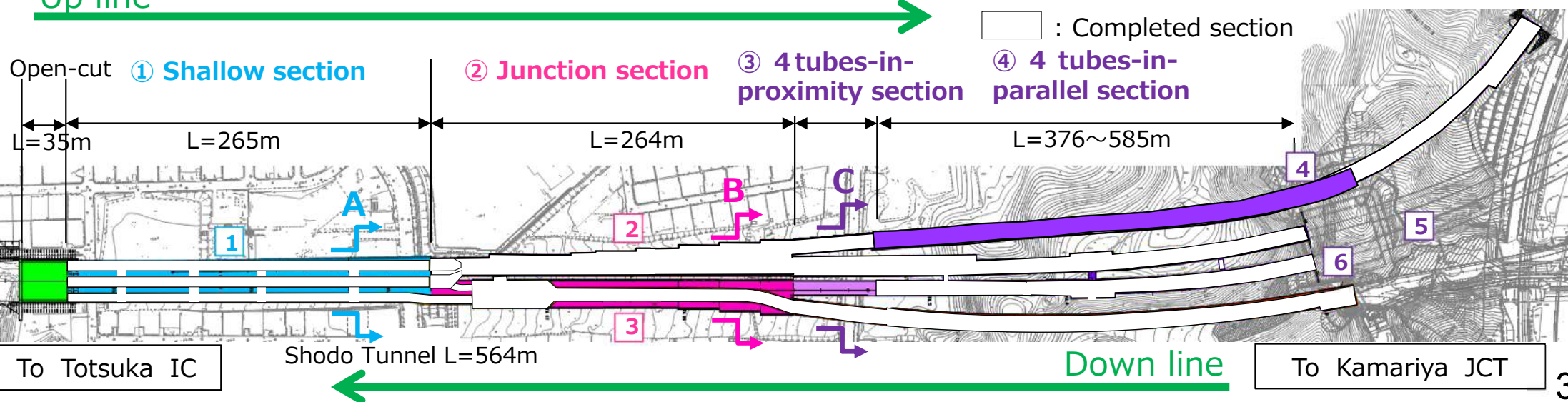


4 tubes-in-proximity (or 4 tubes-in-parallel) section (Section C-C)

- 4 H-Rampway tunnel
- 5 Kamariya-Nishi tunnel (Up line)
- 6 Kamariya-Nishi tunnel (Down line)

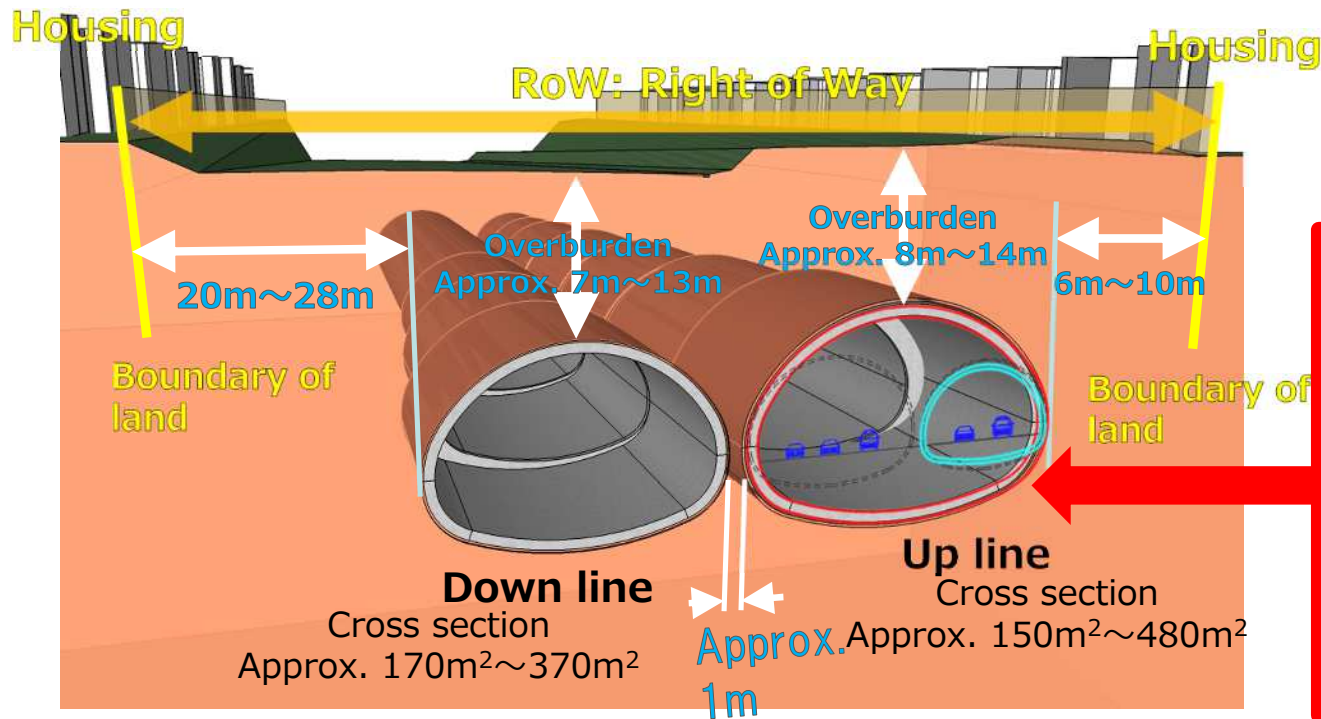
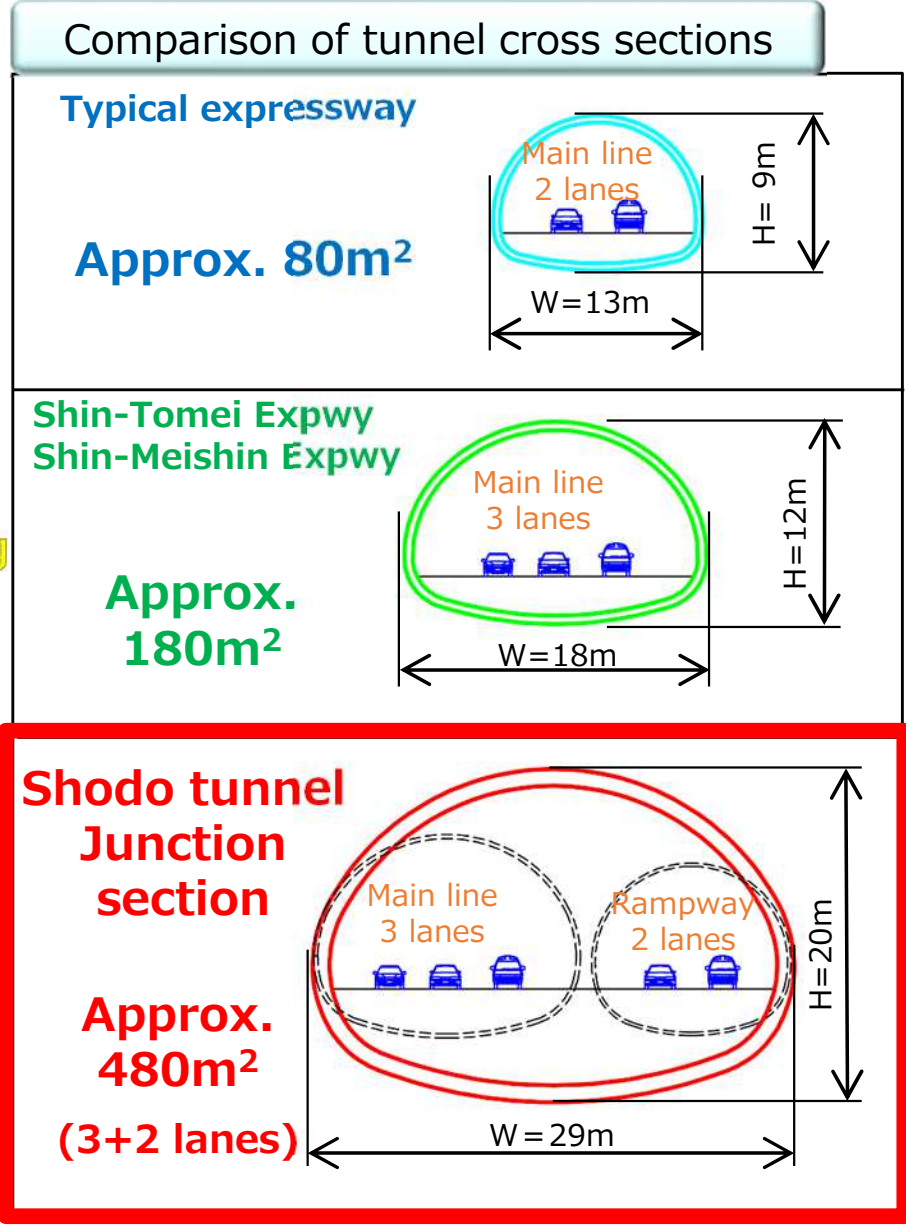


Up line



Construction of an ultra-large cross section NATM tunnel near residences

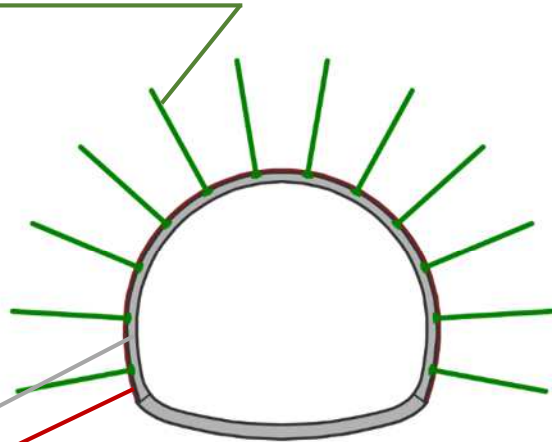
•An unprecedented ultra-large cross section tunnel (the largest cross section in Japan) was constructed.



Structural overview of the tunnel with the largest cross section

Typical expressway Approx. 80m²

Rock bolt : L=4.0m



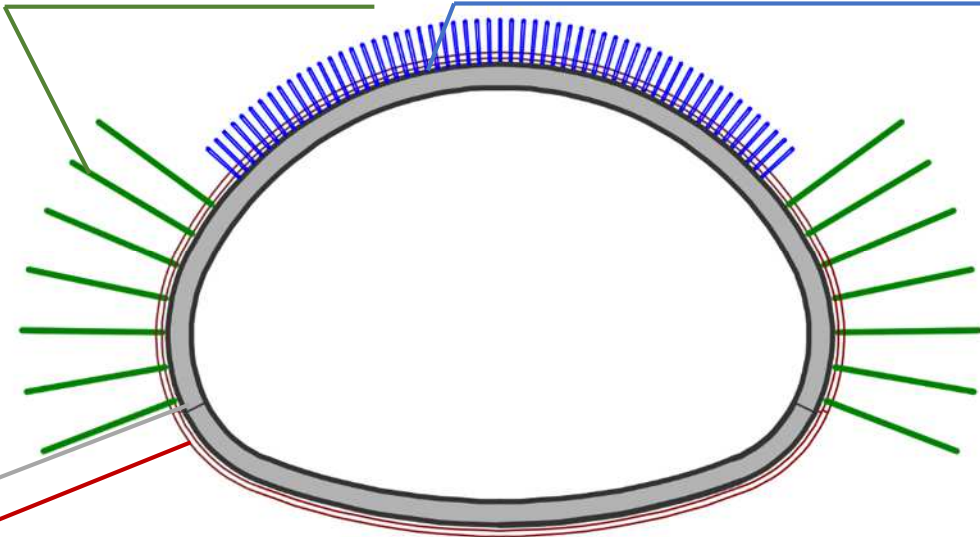
Steel arch support: HH100 (spacing: 1.0 m)
Shotcrete : t=100mm (36N/mm²)

Lining concrete : 300mm (24N/mm²)
Invert : 450mm (18N/mm²)

Shodo tunnel junction section Approx. 480m²

Rock bolt : L=6.0m

Auxiliary method
(All Ground Fasten method) : L=12m



Steel arch support : HH200×2 (double support) (spacing : 1.0m)
Shotcrete : t=250mm (36N/mm²)

Lining concrete : 1000mm (40N/mm²)
Invert : 1000mm (40N/mm²)

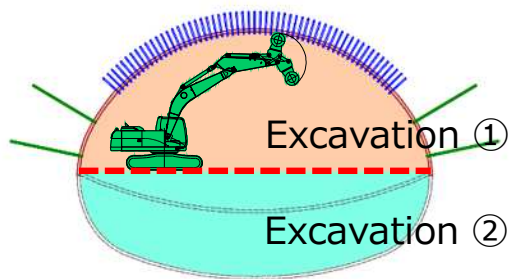
| | Length or Thickness | Strength |
|--------------------|---------------------|-------------------|
| Rock bolt | 1.5 times | - |
| Steel arch support | 4.0 times | - |
| Shotcrete | 2.5 times | 1.0 times |
| Lining concrete | Approx. 3.3times | Approx. 1.7 times |
| Invert | Approx. 2.2times | Approx. 2.2 times |

Efforts and Effects [Reducing displacement in the pit by using large machinery]

- The hydraulic cutting machine (construction height: 13.8m) is used to expand the excavation area, which makes it easier to ensure structural stability and reduce displacement in the pit.
- The installation with two hydraulic cutting machines shortens excavation time and suppresses downhole displacement.

【 Standard construction method for tunnels with standard cross section 】

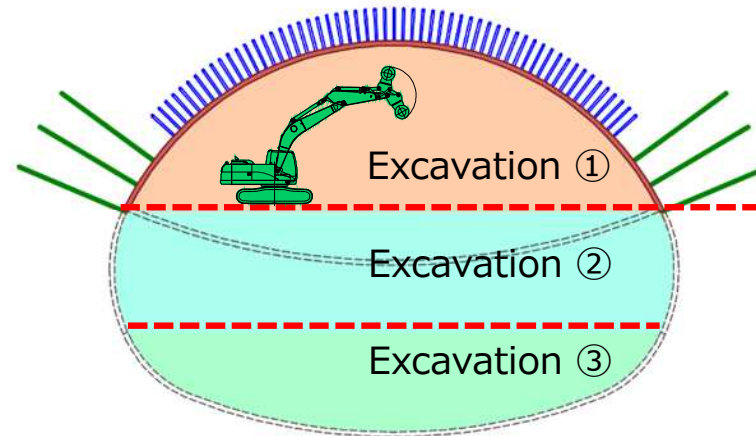
< 2 lanes >
Cross section : 80m²



- ▶ Hydraulic Cutting Machine (Possible construction height 8.8m)
- ▶ Excavation time : 3 hours/m

【 Standard construction method for Shodo tunnel 】 *Case study

< 3+ 2 lanes >
Cross section : 480m²

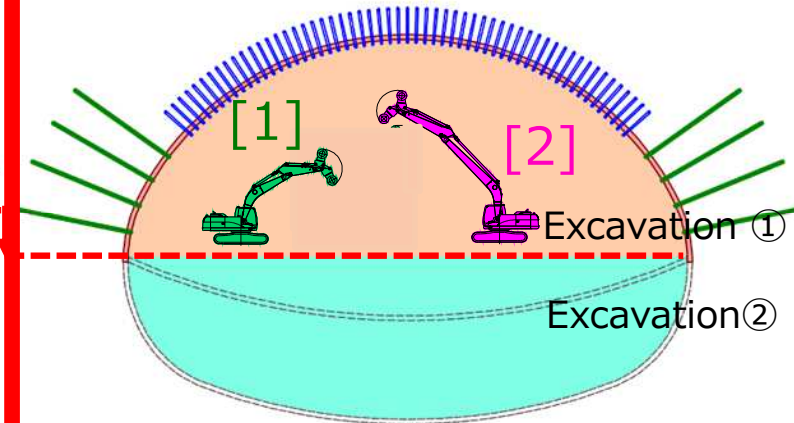


- ▶ Hydraulic Cutting Machine (Possible construction height 8.8m)
- ▶ Excavation time : 17 hours/m

- ▶ Tunnel deformation (Settlement of leg portion) 4.4mm

【 Actual construction method applied to Shodo tunnel 】

< 3+ 2 lanes >
Cross section : 480m²



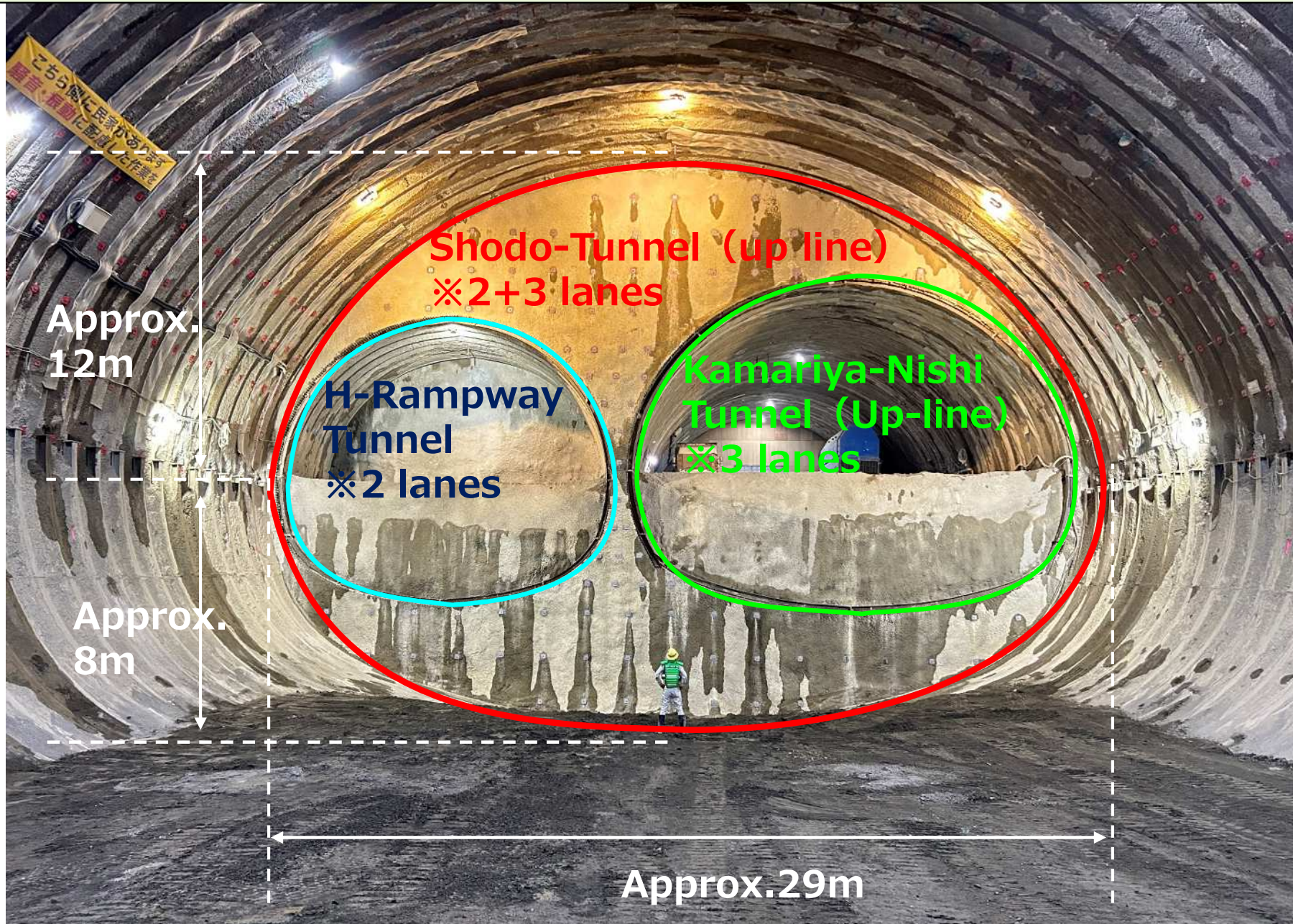
- ▶ Hydraulic Cutting Machine (Possible construction height 8.8m)
- ▶ Hydraulic Cutting Machine (Possible construction height 13.8m)
- ▶ Excavation time : 7.5 hours/m

➡ **60% time reduction**

➡ 1.7mm

【Junction section】 Excavation of the tunnel with the largest cross section

- At the end of March in 2023, excavation of the tunnel with the largest cross section in Japan as a NATM tunnel was completed.

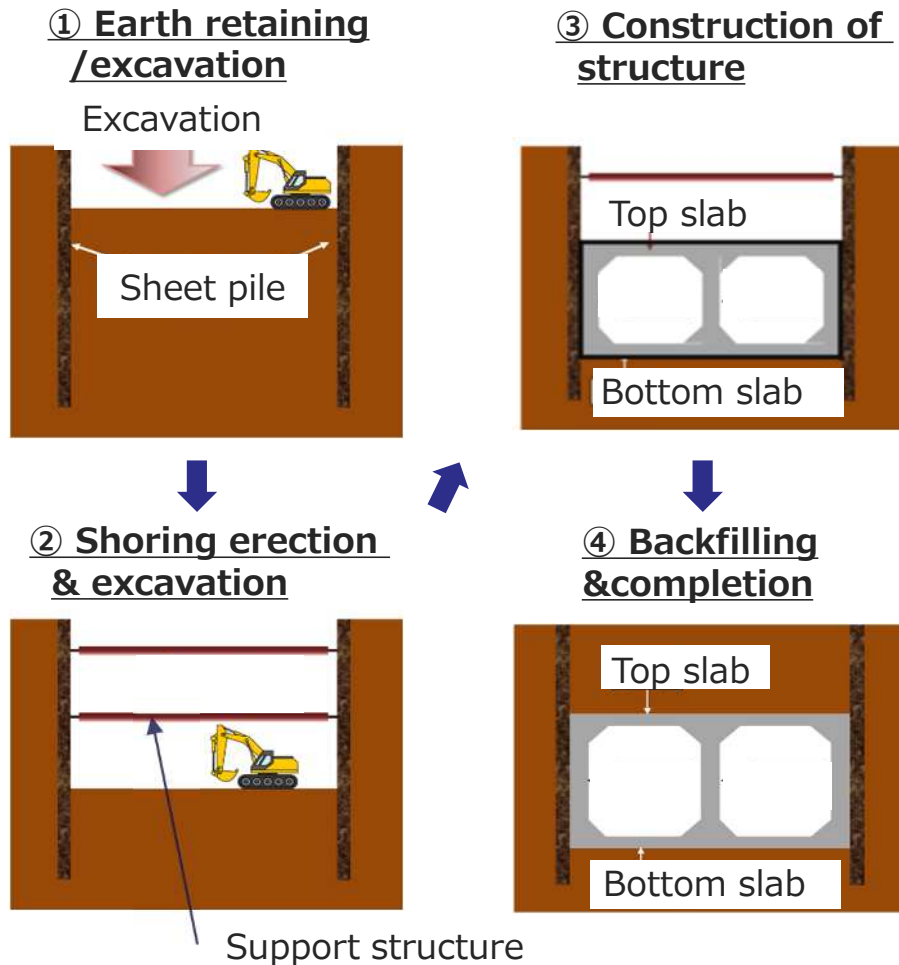


Efforts and effects in construction

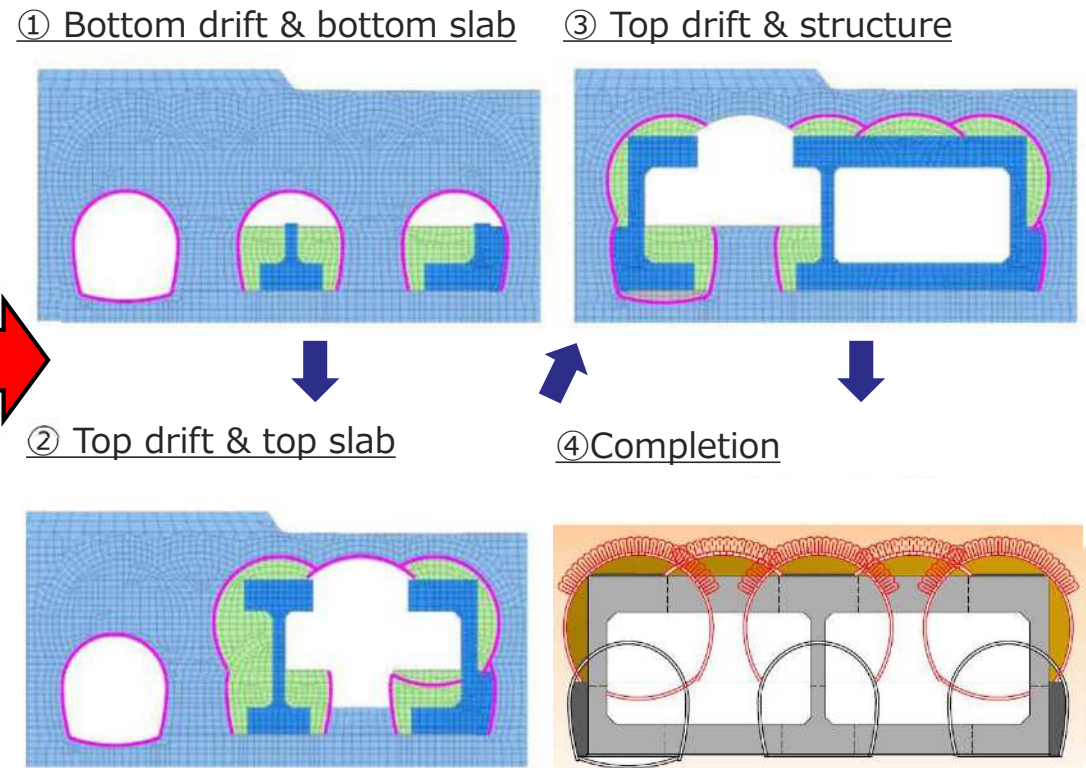
- Preservation of the surrounding environment using non-excavation methods -

- Non-open cut method was adopted to reduce noise, vibration and dust generation, etc. during construction, with considering environment preservation.
- Based on technical consideration, side and middle drift method was applied. (horseshoe-NATM at the bottom and circular-NATM at the top)

● Open-cut method (General construction method)



○ Non-open cut method (unprecedented method)



● Efforts and effects

- Shortening the construction process by using multiple shafts
- Reduction of ground displacement by circularization of shaft cross-sections



Thank you for visiting us.