Current Status of Hokkaido Shinkansen

Junichi Yorita

Introduction

The Hokkaido Shinkansen is being developed in accordance with the Nationwide Shinkansen Railway Development Act and will have some 360 km of tracks from Shin Aomori Station (the new terminus of the Tohoku Shinkansen since 4 December 2010) to Sapporo through Hakodate, Yakumo, Oshamambe, Kutchan, and Otaru. It will also incorporate a line between Sapporo and Asahikawa, and a line from Oshamambe through the vicinity of Muroran as a southern route.

The Japan Railway Construction, Transport and Technology Agency (JRTT) applied for approval of the first 149 km of line between Shin Aomori and Shin-Hakodate in April 2005 and construction started subsequently with completion scheduled for fiscal 2015. Along with the Shin Aomori to Shin-Hakodate (provisional name) approval, JRTT also applied for development of about 211 km of line between Shin-Hakodate and Sapporo including Shin Aomori Station to Sapporo Station, but some sections (where construction had not started) are not approved yet.

Although part of the broad master plan for the Hokkaido Shinkansen, some sections between Sapporo and Asahikawa and the southern route (Oshamambe through Muroran to Sapporo) have not yet materialized.

Background to Hokkaido Shinkansen Development Plan

In March 1967, the Sato Cabinet approved an economic and social development plan that included a shinkansen construction initiative, marking the *de facto* start of the current projected shinkansen lines. Two years later in May

Figure 1 Shinkansen Railway Network (Master Plan/Development Plan)

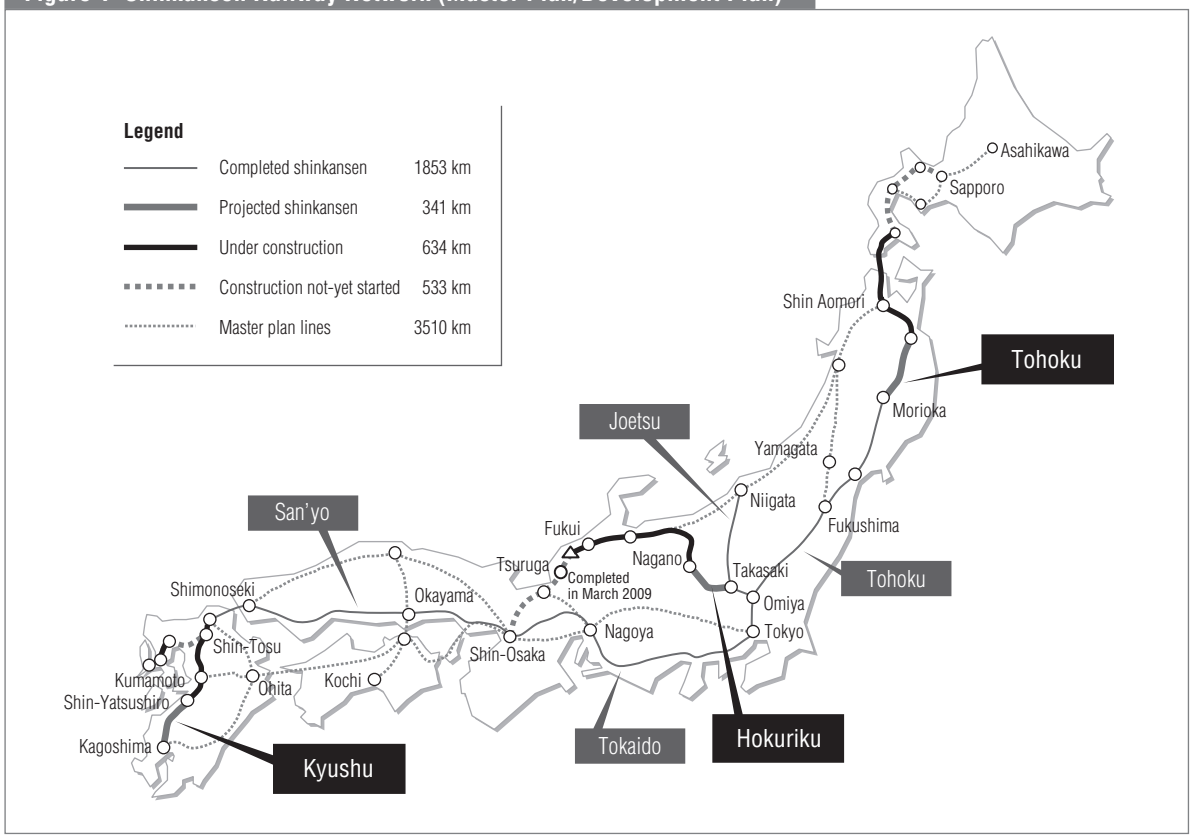


Figure 2 Hokkaido Shinkansen Map (Development Plan)

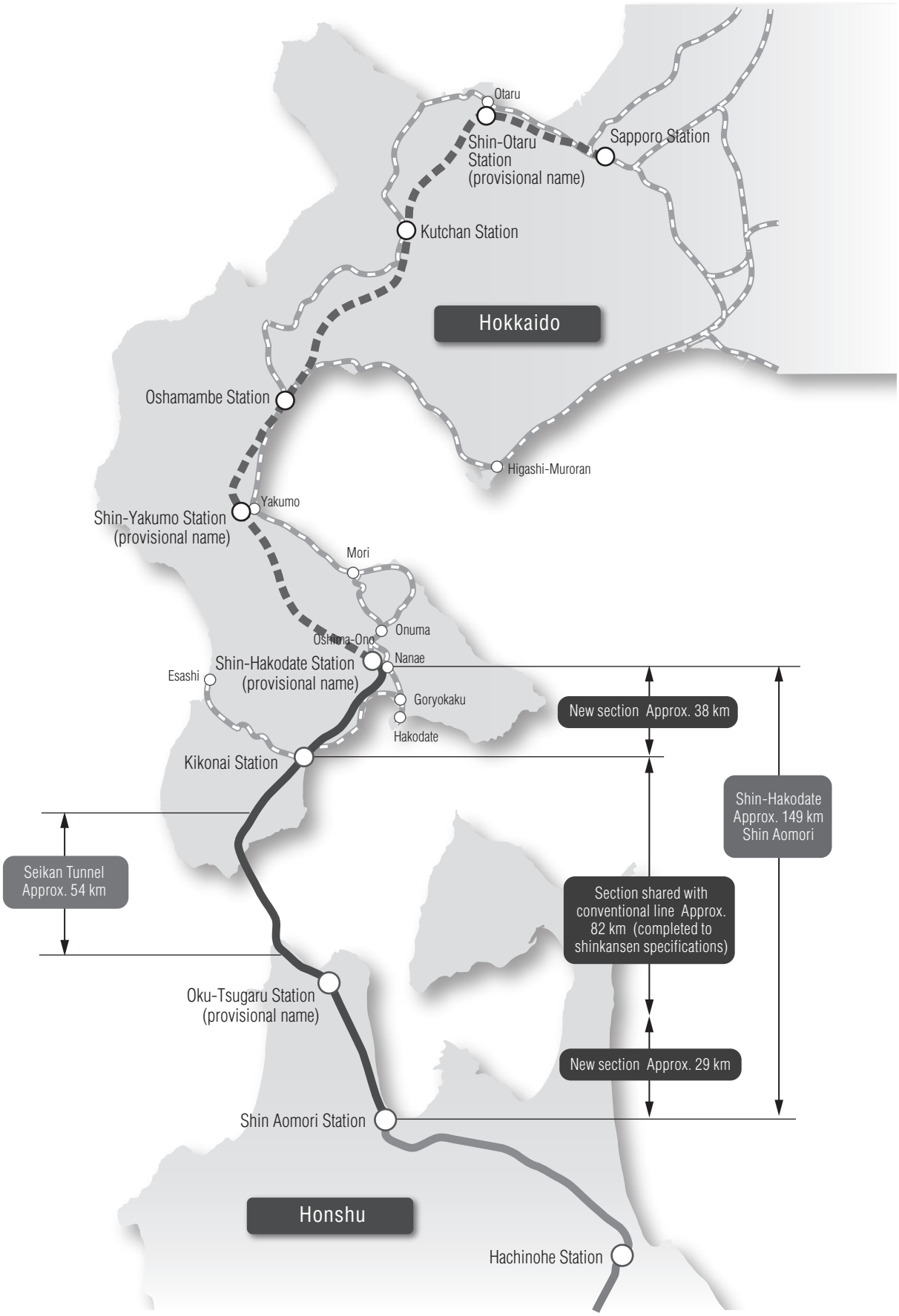
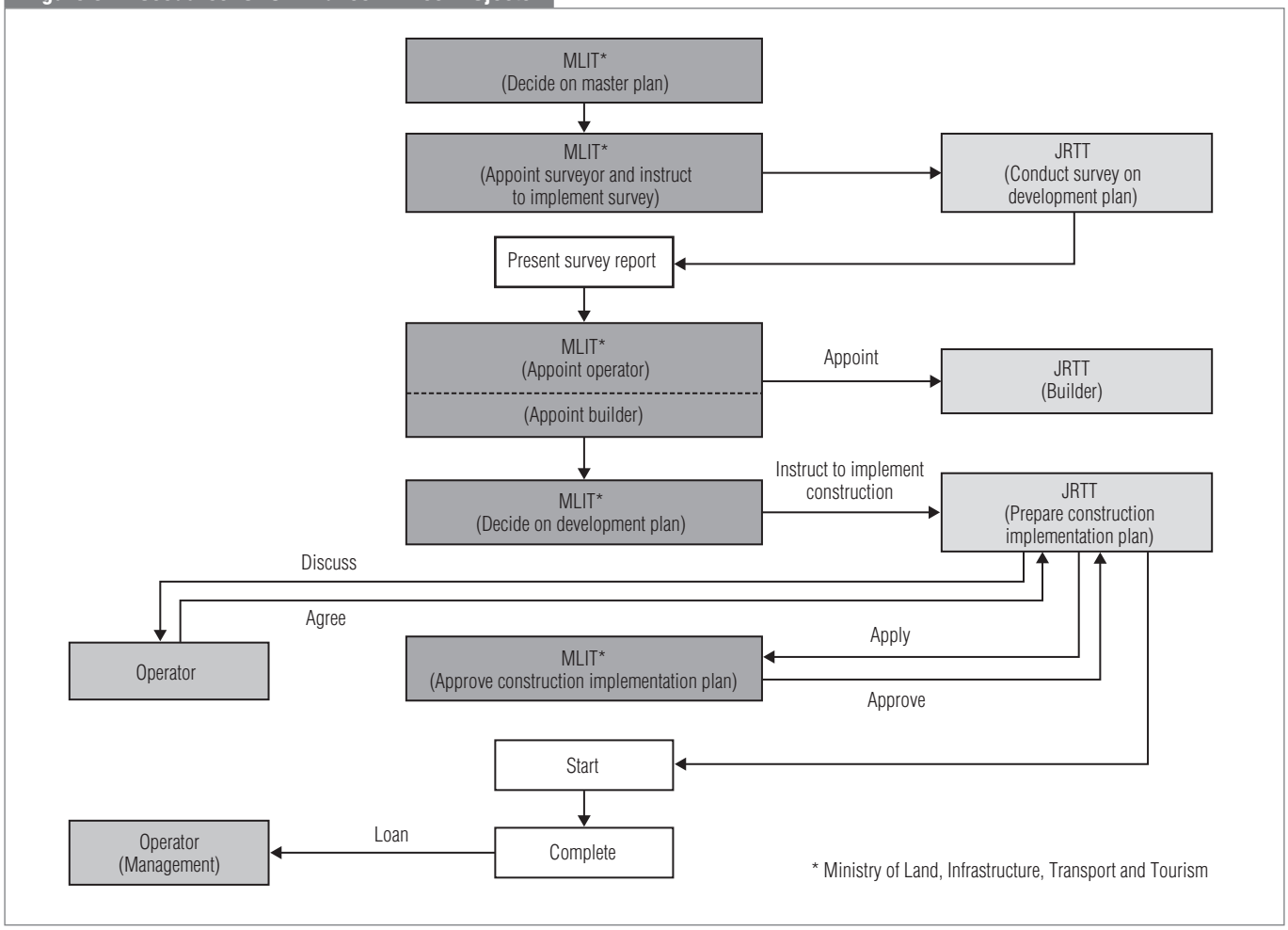


Table 1 Events Leading to Hokkaido Shinkansen

Year	Month	Item
1967	3	Economic and social development plan approved by the Cabinet (Shinkansen initiative)
1969	5	Comprehensive National Development Plan approved by the Cabinet (develop 7200 km nationwide shinkansen network)
1970	5	Act for Construction of Shinkansen Railway Across the Country promulgated
	6	Act for Construction of Shinkansen Railway Across the Country put into force
1971	1	Master plan decided on and instruction issued for surveys • Three shinkansen lines: Tohoku (Tokyo–Morioka), Joetsu (Tokyo–Niigata), and Narita (Tokyo–Narita)
	2	Development plan for three shinkansen lines decided on
	4	Instruction issued for construction of three shinkansen lines Tsugaru-Kaikyo Line changed from survey line to construction line (design considerations to handle shinkansen)
	9	Approval of construction implementation plan applied for and received for Tsugaru-Kaikyo Line, and construction started
1972	6	Instruction issued to change and add master plans and survey for the additional (incl. extension) shinkansen lines • Tohoku Shinkansen terminus change (Morioka changed to Aomori) • Three shinkansen lines: Hokkaido (Aomori–Sapporo), Hokuriku (Tokyo–Osaka), and Kyushu (Fukuoka–Kagoshima)
1973	11	Master plan changed, development plan decided on, and instruction for construction issued • Hokkaido Shinkansen master plan terminus change (Sapporo changed to Asahikawa) • Hokkaido southern route shinkansen added to master plan (Oshamambe–Muroran–Sapporo) • Development plans decided on and instruction for construction issued for three shinkansen lines (Hokkaido, Hokuriku, Kyushu)
1973		(Floating exchange rate system introduced) (First oil shock)
1979		(Second oil shock)
1982		Provisional Commission recommendation to put the Hokkaido Shinkansen on hold approved by the Cabinet
1988	8	Government and ruling parties talks • Study on order of priority for starting construction (Hokuriku Shinkansen (Takasaki–Karuizawa) top priority) • Past development plan to be maintained
1989	1	Construction of Hokuriku Shinkansen started (Takasaki–Karuizawa)
1990	2	Government and ruling parties talks • Start of construction decided on for Hokuriku (Karuizawa–Nagano), Tohoku (Morioka–Aomori), and Kyushu (Yatsushiro–Nishi Kagoshima) Shinkansen
1994	2	Three minister talks • Surveying to announce route promoted; environmental assessment promoted for sections that had yet to be completed
1997	10	Hokuriku Shinkansen (Takasaki–Nagano) opened (first projected shinkansen line)
1998	2	Stations and routes of Hokkaido Shinkansen (Shin Aomori–Sapporo) announced for environmental assessment
2000	12	Government and ruling parties talks • Approval of application for construction implementation plan decided on for Hokkaido Shinkansen (Shin Aomori–Sapporo) upon completion of environmental assessment
2002	1	Results of Hokkaido Shinkansen (Shin Aomori to Sapporo) environmental assessment announced and details disclosed
2005	4	Hokkaido Shinkansen (Shin Aomori and Shin-Hakodate) first phase construction implementation plan applied for and approved, and construction started
2010	5	Hokkaido Shinkansen (Shin Aomori and Shin-Hakodate) second phase construction implementation plan applied for and approved and construction started
2015		Hokkaido Shinkansen (Shin Aomori and Shin-Hakodate) scheduled to be completed

Figure 3 Procedures for Shinkansen Lines Projects



1969, the Cabinet approved the new Comprehensive National Development Plan forming the foundation of the current master plan. The Nationwide Shinkansen Railway Development Act was promulgated in May 1970 and came into force in June 1970, finally putting laws for shinkansen development in place. Based on this law, shinkansen development followed seven stages: (1) decision on master plan; (2) instruction for surveys; (3) decision on development plan; (4) instruction for construction under development plan; (5) approval of construction implementation plan; (6) start of construction; and (7) completion.

In January 1971, the master plans for the Tohoku (Tokyo–Morioka), Joetsu (Tokyo–Niigata), and Narita (Tokyo–Narita) shinkansen were settled on, excluding the Hokkaido Shinkansen. In April 1971, the master plan was modified to include the Tsugaru-Kaikyo Line as a construction line, and the Ministry of Transport (MOT) notified the Japan Railway Construction Public Corporation (JRCC, now JRTT) to consider planning for future passage of shinkansen. As a result, the double track through the Seikan Tunnel was built to shinkansen specification and the grade was lowered from 20‰ to 12‰, so that speed restrictions would not apply. In September 1971, JRCC applied to the MOT for approval of construction (roadbed) between Hamana and Imabetsu in Aomori Prefecture and Yunosato and Shiriuchi in Hokkaido (Seikan Tunnel) for the Tsugaru-Kaikyo Line. It can be said that the approval in the same month marks the *de facto* start of construction on the Hokkaido Shinkansen.

In June 1972, the Tohoku Shinkansen terminus was changed from Morioka to Aomori, and the master plans for the Hokkaido (Aomori–Sapporo), Hokuriku (Tokyo–Osaka), and Kyushu (Fukuoka–Kagoshima) shinkansen were added. At the same time, the MOT issued survey instructions.

The Hokkaido Shinkansen development plan was decided in November 1973 along with plans for the Tohoku, Hokuriku, and Kyushu shinkansen; the MOT instructed JRCC to start construction.

In November 1973, the Hokkaido Shinkansen terminus was changed from Sapporo to Asahikawa and a southern route was announced to run from Oshamambe through Muroran to Sapporo. These development and master plans are still the active plans today.

Road To Start of Construction

Although the Hokkaido Shinkansen (Aomori–Sapporo) development plan was approved in November 1973, the road to the start of construction has been long. The 1973 floating exchange rate for the yen resulted in a stronger yen followed by the oil shocks of 1973 and 1979 and led to a worsening of Japan's financial situation. Administrative reforms, the 1987 JNR privatization and division, and other tight circumstances delayed funding for shinkansen construction. Finally, in 1982, the Cabinet decided to delay the projected shinkansen lines based on a report submitted by the Second Provisional Commission on Administrative Reform, putting the Hokkaido Shinkansen on hold. However, later talks by the government and ruling parties in August 1988 led to a study on the construction order of priority and the overall plan was maintained. The top priority was the Hokuriku Shinkansen (Takasaki–Karuizawa) and a decision on the section between Karuizawa and Nagano was to be made within 3 years taking into account the issue of Nagano as the venue for the 1998 Winter Olympics. The start of construction between Karuizawa and Nagano was decided in February 1990 and the Hokuriku Shinkansen (Takasaki–Nagano) opened in October 1997 as the first of the planned shinkansen lines.

A 1994 revision of the projected shinkansen lines decided by talks between the ministries of Home Affairs, Finance, and Transport promoted route surveying for the Hokkaido Shinkansen, 8.5 years after studies on the Hokuriku Shinkansen between Takasaki and Karuizawa had started.

In January 1998, the Government New Shinkansen Line Examination Commission decided to announce the locations of stations and routes between Shin Aomori and Sapporo and to start environmental assessments. An overview of routes and stations was announced in February 1998 to allow environmental assessments to start, and the government decided in December 2000 to approve the construction implementation plan between Shin Aomori and Sapporo upon completion of the environmental assessment.

At last, concrete action was underway. The results of the environmental assessment were announced in January 2002. A construction implementation plan centred on roadbed was approved in April 2005 as the first phase of construction between Shin Aomori and Shin-Hakodate, and construction finally started. May 2010 marked the approval for facilities related to opening the line, such as track, machinery, structures, and electrical installations. Construction is ongoing towards completion in 2015.

Overview of Section between Shin Aomori and Shin-Hakodate under Construction

The most prominent feature of the section between Shin Aomori and Shin-Hakodate where construction has started is the shared section where the conventional Tsugaru-Kaikyo Line and shinkansen run on the same roadbed for

Figure 4 Image of Shared Track

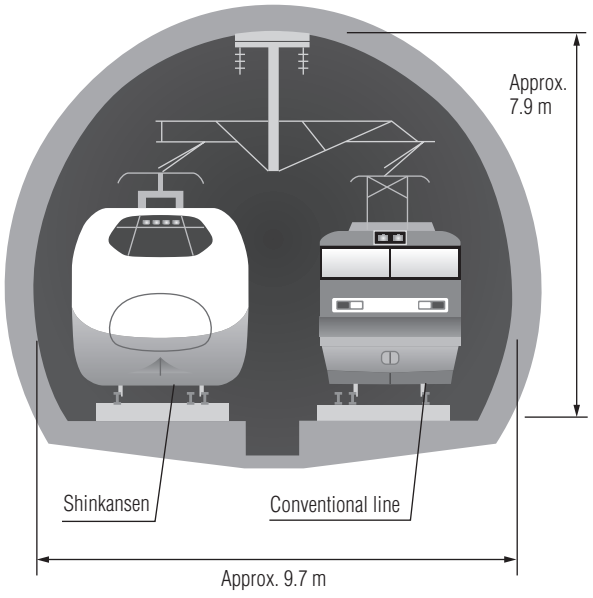


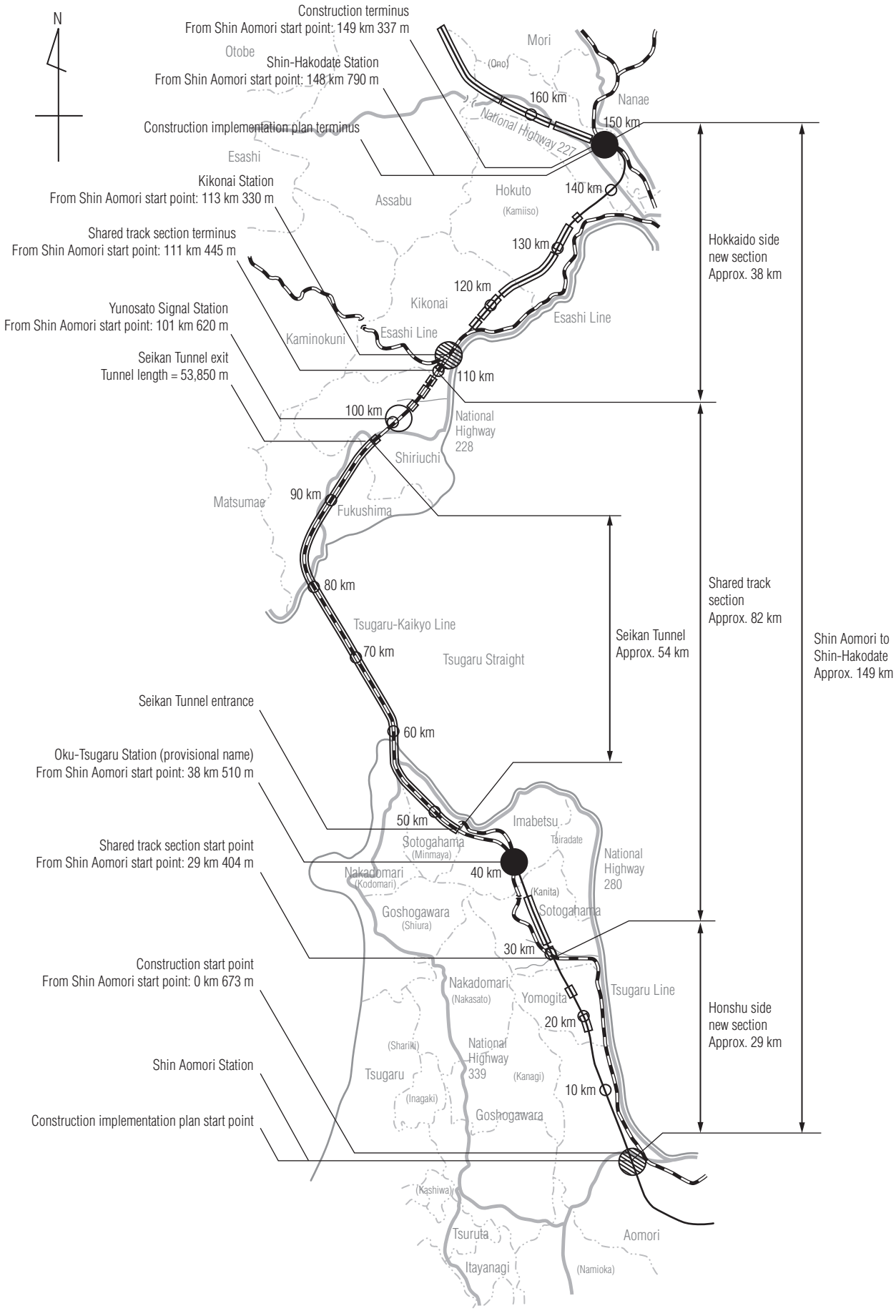
Table 2 Length of Structures (Including Shared Track Sections)

Structure	Length (approx.)	Ratio
Cuttings/Embankments	12 km	8%
Bridges	6 km	4%
Viaducts	34 km	23%
Tunnels	97 km	65%
Total	149 km	100%

Table 3 Lengths of Structures on Aomori Prefecture Side

Structure	Length (approx.)	Ratio
Cuttings/Embankments	2 km	10%
Bridges	2 km	7%
Viaducts	16 km	55%
Tunnels	8 km	28%
Total	29 km	100%

Figure 5 Hokkaido Shinkansen Construction



Tsugaru-Yomogita Tunnel Shield Borer (JRTT)

Table 4 Lengths of Structures on Hokkaido Side

Structure	Length (approx.)	Ratio
Cuttings/Embankments	6 km	15%
Bridges	2 km	6%
Viaducts	14 km	36%
Tunnels	16 km	43%
Total	38 km	100%

about 82 km. That shared track section has already been built to shinkansen specifications as the section between Naka-Oguni in Aomori Prefecture and Kikonai in Hokkaido, including the Seikan Tunnel, of the Tsugaru-Kaikyo Line. It opened in March 1985 and has been used as a conventional line.

The shared track section is being converted into three-rail track, and shinkansen, conventional line, and freight trains will run on the same roadbed. Land acquisition and roadbed construction and other work is ongoing for a new 67-km section.

Structures on shared sections, such as the Seikan Tunnel (approx. 54 km), are mostly complete and used by conventional lines, but work to operate shinkansen, such as conversion to three rails and stringing overhead catenary is still ongoing. The shared track section on the same roadbed for shinkansen, conventional trains, and freight trains with different systems, gauges, etc., is new operations territory and development of supporting technologies, such as three-rail digital ATC, three-rail turnouts, etc., is underway in earnest.

The lengths of structures, including the shared track section, are shown in Figure 5.

Construction of the Shinshiro River bridge at the junction with the Tohoku Shinkansen and all other civil engineering construction, such as open sections and tunnels, started in fiscal 2010. The 590-m Tatesawa Tunnel was broken through in December 2008, making it the first completed tunnel of the Hokkaido Shinkansen. The Tateshita Tunnel followed in December 2009.

The Tsugaru-Yomogita Tunnel (6190 m) runs through mostly unconsolidated sands, and construction is expected to be difficult. For safety, economy and work management, it is being constructed using a cast-in-place tunnel support system with a shield tunnel boring machine used successfully for the Sambongihara Tunnel on the Tohoku Shinkansen. The initial 162-m boring was completed in mid-February 2010, followed by full-scale tunnelling in March.

Overview of New Section in Hokkaido (Kikonai to Shin-Hakodate)

Figure 5 shows the new 38-km section between Kikonai and Shin-Hakodate and the lengths of individual structures. The Hakodate General Rolling Stock Yard (provisional name) is also in Hokkaido.

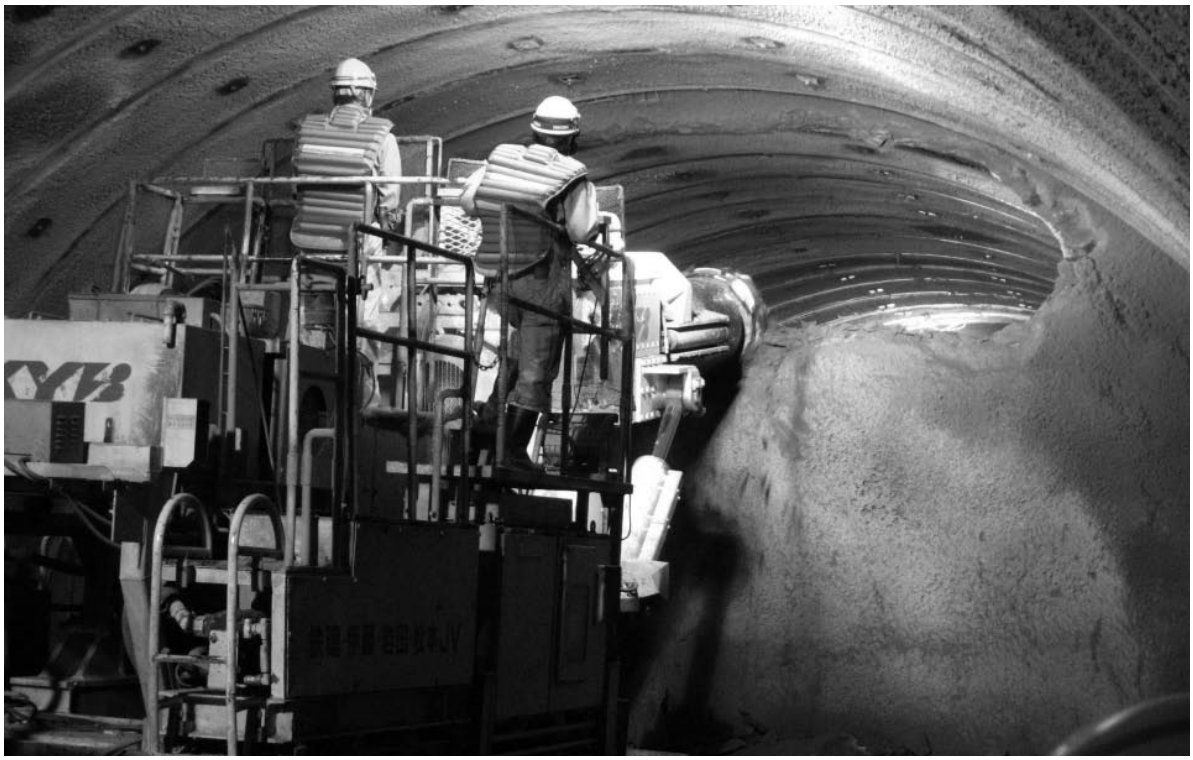
The new section on the Hokkaido side starts from the junction with the shared track section near Kikonai. From there, a two-platform, three-line, elevated station will be built north of Kikonai Station on the JR Hokkaido Esashi Line, through six long and short tunnels, across the Hakodate plain to Shin-Hakodate Station, an over-the-tracks structure at Oshima-ono Station on the JR Hokkaido Hakodate main line. Shin-Hakodate Station will be the terminal station for the time being, and is about 18 km from the city centre so the convenience of changing at Shin-Hakodate for Sapporo still needs to be improved.

The Hakodate General Rolling Stock Yard will be about 1 km in the Aomori direction from Shin-Hakodate Station between the Hakodate main line and shinkansen line. It will have depot and maintenance facilities for Hokkaido Shinkansen rolling stock.

Time-consuming tunnel construction started in advance of other work. Work started first on the longest 8-km Oshima-Tobetsu Tunnel in August 2005 and on all construction sections including tunnels in March 2010.

The Oshima-Tobetsu Tunnel was the first on the Hokkaido side to break through in August 2009, followed by the Koren Tunnel in December 2010.

Construction of open sections started in autumn 2009 with two sections including the Kikonai River bridge and Ono River bridge. Construction, such as driving cast-in-place piles, is proceeding on schedule. Preparation to start construction is underway in four sections at the Kikonai roadbed, Mantaro roadbed, Iida viaduct, and Inasato viaduct. Orders for all civil engineering construction will have been placed this fiscal year.



Breakthrough in Oshima-Tobetsu Tunnel (JRTT)

Hakodate General Rolling Stock Yard Embankment (Vertical Drain) (JRTT)

Other construction involves reforming land at the Hakodate General Rolling Stock Yard by bringing in 450,000 m^3 of soil for an area of 360,000 m^2. The geology near the yard is soft ground, so subsidence is expected. Construction started in February 2008 ahead of main line open section construction. A test embankment was cut in fiscal 2008 to determine the construction method, and construction of the main embankment started in fiscal 2009 based on the results.

Overview of Shared Track Section

The 82-km conventional Tsugaru-Kaikyo Line to be shared with the shinkansen requires both track and electrical construction.

Figure 6 Image of Three-Rail Track Conversion

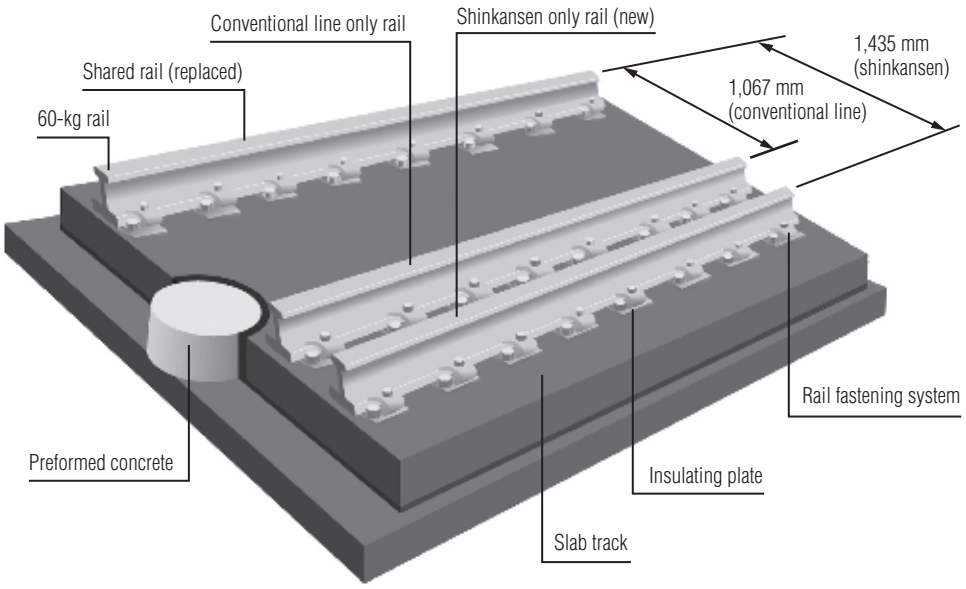
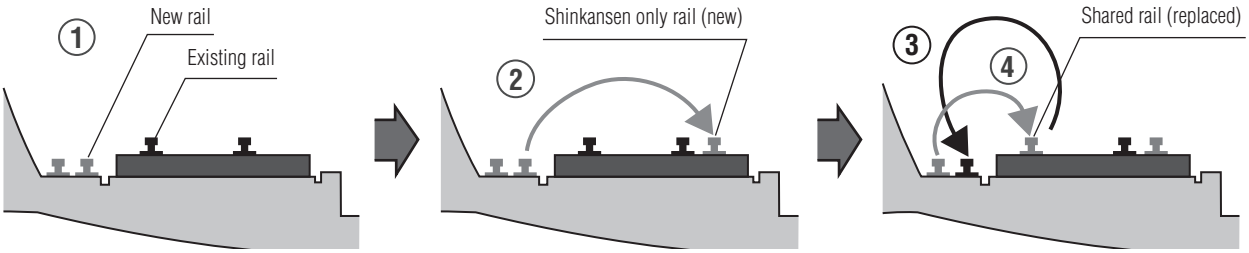


Figure 7 Three-Rail Track Work



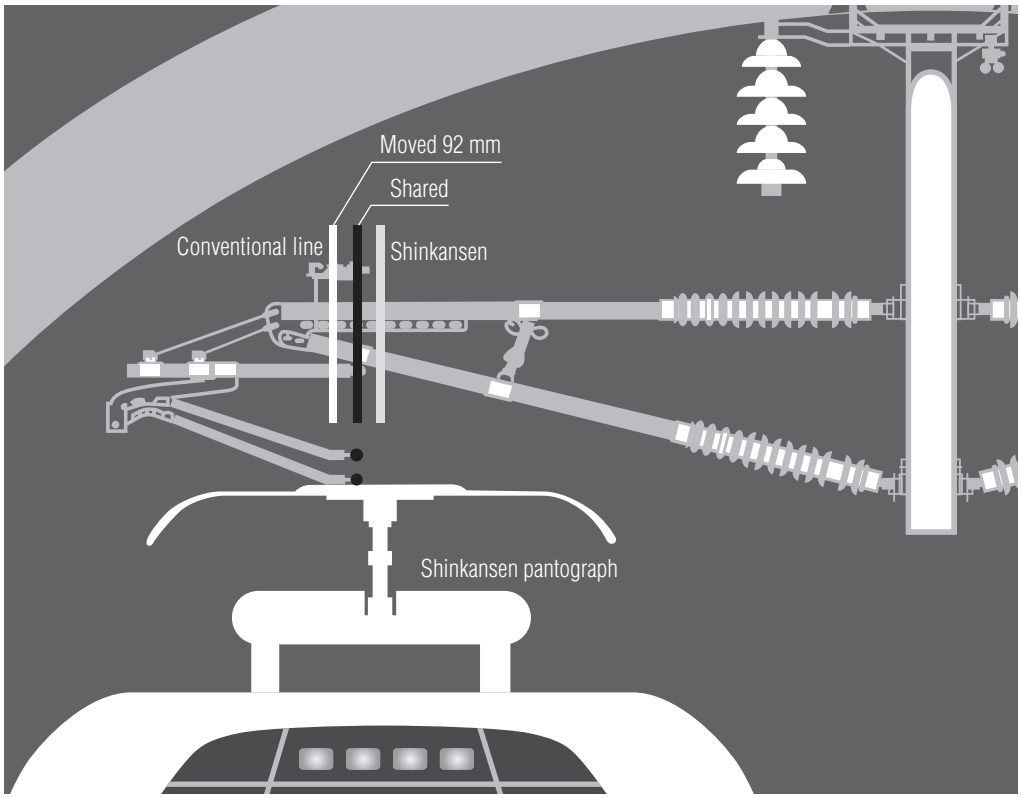
Three-Rail Track Laying (JRTT)

Surveying in Seikan Tunnel (JRTT)

Track construction involves adding a rail for the shinkansen. The existing slab track already has rail fastenings for the third rail. On ballasted sections, current narrow-gauge sleepers will be replaced with sleepers for three rails. Widening of embankments and other construction for Yunosato signal box (provisional name) at the current Shiriuchi Station was completed in November 2006. The signal box will be used as a base for the aforementioned track construction. Rail welding was underway there until March 2010; welded rails have been transported from there during the 4 hours of night when no trains are running for full-scale rail laying in sections such as the Seikan Tunnel since fiscal 2008.

Electrical construction for overhead catenary, transformers and signalling is still needed. Catenary in the Seikan Tunnel is heavy compound for shinkansen use, and

Figure 8 Image of Overhead Contact Line Position Change (in Seikan Tunnel)



automatic tensioners are being installed at approximately 1.5-km intervals since 2008 to prepare for shinkansen. Shared sections outside the Seikan Tunnel originally had simple catenary for conventional trains but this is being converted to simple catenary for shinkansen. The catenary is also being realigned for use by both shinkansen and conventional trains. The feed voltage is being changed from 20 to 25 kVac.

The current signalling system is ATC for conventional lines, but a system for three rails will be developed and feasibility tests have been conducted since fiscal 2007 on a three-rail section between Shiriuchi Station and Kikonai Station. These works must be done using a safe schedule while conventional trains are running.

Many other items currently under consideration for shinkansen operation include aseismic reinforcement of viaducts, addition of tunnel portal hoods as countermeasures to tunnel boom, cross-wind countermeasures for freight trains, and snow and noise pollution countermeasures.

Overview of Seikan Tunnel Survey and Function Maintenance/Renovation

The Seikan Tunnel between Honshu and Hokkaido opened in March 1985 is still the world's longest undersea tunnel. Facilities between Naka-Oguni and Kikonai including the tunnel approaches are owned by JRTT, and trains of JR Hokkaido and Japan Freight run on them. Tunnel maintenance and renovation are extremely important for reliably completing the Hokkaido Shinkansen and securing safe operation.

Operations-related tunnel maintenance is performed by JR Hokkaido but the tunnel itself is maintained by JRTT. JRTT understands the geologic and structural conditions affecting the tunnel. It performs work such as analysis of tunnel data, as well as comparison with construction data to survey and confirm the tunnel soundness.

The Seikan Tunnel is made up of track, catenary, and other equipment directly related to train operations, drainage and other equipment related to tunnel maintenance, and firefighting equipment related to disaster prevention in long tunnels. These equipment function together to secure safe transport in the Seikan Tunnel. They are in a very difficult environment characterized by high humidity and high airborne salinity and a 2008 survey showed some equipment had degraded. As a result, renovation has being ongoing since fiscal 2009, starting with equipment with high priority in terms of safe transport. Renovation of items such as structures and equipment is also needed to run shinkansen trains, so plans are currently being made for

Figure 9 Plan and Side View of Seikan Tunnel

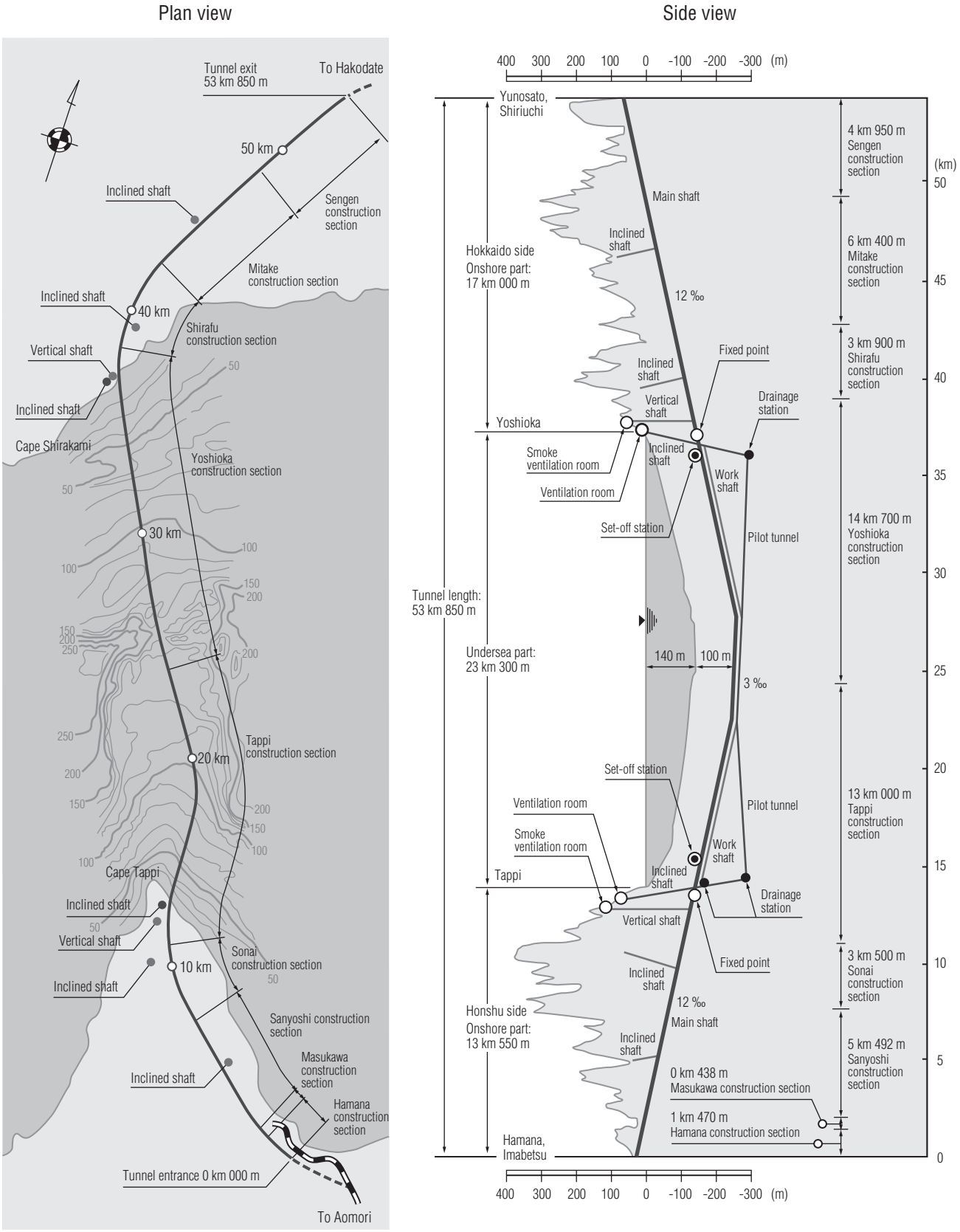


Table 5 Overview of Hokkaido Shinkansen between Shin-Hakodate and Sapporo

Length (approx.)	Open sections	Tunnels	Stations	Depots
211 km	50 km	160 km	5	1

that too. For the tunnel as a whole, the following changes and renovations need to be made.

- Earthquake disaster equipment
- Drainage equipment
- Fire detection equipment
- Firefighting equipment
- Power equipment
- Train control equipment
- Communications equipment
- Transformer equipment
- Others

Overview of Shin-Hakodate–Sapporo Section (construction not started)

The 211-km Shin-Hakodate–Sapporo section of the Hokkaido Shinkansen will start at Shin-Hakodate and pass through Yakumo, Oshamambe, Kutchan, and Otaru before reaching Sapporo.

Although an application to approve the construction has been made, it has yet to be approved. Surveys are continuing so construction can start as soon as possible after approval is received. Bore surveys for the Uchiura Tunnel, and station surveys for Shin-Yakumo (provisional name), Oshamambe, Kutchan, and Shin-Otaru stations (provisional name) were made in fiscal 2009.

A committee to study projected shinkansen line issues headed by the Minister of Land, Infrastructure, Transport and Tourism started consideration of this section as well as sections of the Hokuriku Shinkansen and Kyushu Shinkansen (West Kyushu route). The following five points are considered basic conditions for starting construction: prospect of stable funding; possibility of profitability; investment effect; acceptance by JR Hokkaido as operator; acceptance by local governments for managing parallel conventional lines.

In August 2010, this committee stated that more detailed studies are needed where construction has not yet started, including issues regarding sections currently under construction. The following issues were brought up regarding the Hokkaido Shinkansen: how operations will be handled on the shared track section in the Seikan Tunnel; how parallel conventional lines will be managed; a review of maximum design speed (development plan). Extension of the Hokkaido Shinkansen to Sapporo (start of construction) will be possible by overcoming these issues and proactive consideration and coordination by affected bodies will probably be very important.

Conclusion

Construction of the Hokkaido Shinkansen between Shin Aomori and Shin-Hakodate started thanks to long years of effort by those concerned and the enthusiasm of local communities. 2010 marks the sixth year of construction. Approval was received in May 2010 for facilities related to line opening, marking the start of the final run up to completion in fiscal 2015. Surveys between Shin-Hakodate and Sapporo and of the Seikan Tunnel along with tunnel maintenance are steadily going forward, and start of construction on sections where construction has not yet started is desired.

Local communities have high hopes for the Hokkaido Shinkansen in greatly contributing to the Tohoku and Hokkaido economies. The Hokkaido Shinkansen is also expected to contribute to ideal usage of Japanese land as a whole, and issues delaying extension to Sapporo must be solved as soon as possible. Unwavering efforts, cooperation, and partnership by those involved are extremely important to achieve this goal.

JRTT must continue to work diligently on quality, construction cost, and work schedule to assure on-time completion to Shin-Hakodate. The technical skills fostered by this work are sure to pay off with an extension to Sapporo. ■

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Dr Yorita is a Deputy Director of the Shinkansen Department of JRTT. He joined the organization in 1992, after earning a Masters' Degree from the graduate school of Tokyo Institute of Technology. He obtained his doctorate degree from Kyoto University in 2008.