Taiwan High Speed Rail

Takashi Shima

Prologue

The Taiwan High Speed Rail Corporation (THSRC) began trial revenue operation of its 700T high-speed train with half-price fares starting 5 January 2007 and then kicked off official operation with regular fares from 1 February. Although the first open section was between Banciao and Zuoying, service has been from Taipei Main Station in the north to Zuoying Station in the south since 2 March, making the entire 345-km system fully open to passengers. The travel time between the two cities by rail has been cut from 4.5 hours to 90 minutes. Starting with 19 round trips per day, six more daily round trips were added from 31 March. Furthermore, the THSRC increased the daily number of round trip to 31 from 1 June. The THSRC is committed to operating more than 61 daily round trips within 6 months after the inauguration when the system is fully stabilized. Meanwhile, the THSRC launched a ticket hotline on 20 March, allowing customers to purchase tickets by telephone.

Zuoying Station in Kaohsiung is like an international airport terminal

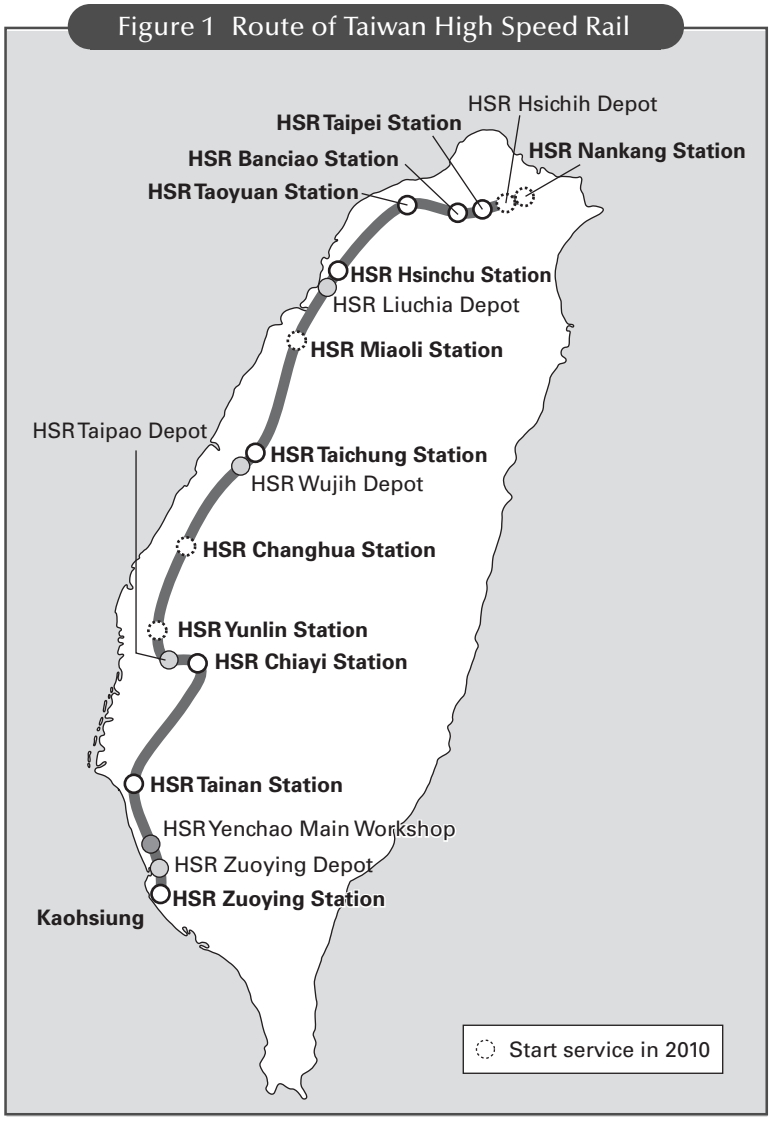
700T trains standing at Zuoying Depot

Historical Background

Plans for Taiwan's first high-speed rail line emerged in 1989 to tackle the continuing growth in traffic along the heavily travelled western corridor between Taipei and Kaohsiung, Taiwan's two largest cities. The first plans were proposed in a Ministry of Transportation study in 1990. They were then approved by the Executive Yuan in 1992 and the Legislative Yuan in 1993.

The decision to pursue a Build–Operate–Transfer (BOT) method was approved in 1996 and a tender was invited. Two groups, each supported by financial agencies as the central enterprise, stood as candidates: China Development Corporation, led by The China Development Bank (CDB), was a group of civil engineering and building contractors, Japanese core system suppliers, and trading companies; and the Taiwan High Speed Rail Consortium, which subsequently became the THSRC, composed of the Fubon group, four other local groups, and European core system suppliers. In 1997, the government announced that the THSRC was the 'best applicant', and the THSRC was awarded priority in the project negotiations. The THSRC then entered into simultaneous negotiations with the government and the European suppliers about procuring the core systems. However, because the negotiations did not run smoothly and a contract could not be agreed, the THSRC brought the Japanese suppliers and trading companies into the bidding too. Finally, the Japanese core system was selected, because the conditions proposed by the Japanese suppliers were best.

Figure 1 Route of Taiwan High Speed Rail



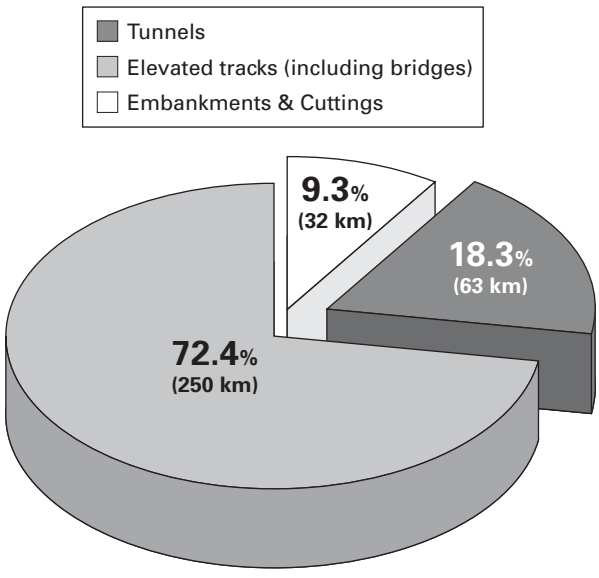
High-Speed Rail General Characteristics

Route and track

The Taiwan High Speed Rail (THSR) runs approximately 345 km from Taipei in the north to Kaohsiung in the south as shown in Figure 1. The line uses the international standard gauge of 1435 mm with continuously welded 60-kg rails on concrete slab track. Figure 2 shows the ratio of structure type by length.

In normal double-track operations, the left, north-to-south track is down. However, for operation flexibility, the signalling system also supports operation on both tracks in each direction (single-line, bi-directional operation).

Figure 2 Ratio of Structure Type by Length



Stations

Initially, the route has 8 stations but three additional stations in cities outside Taipei are planned for the future, with two additional possibilities—one in Taipei and the other on an extension to Kaohsiung City. The station specifications are shown in Table 1.

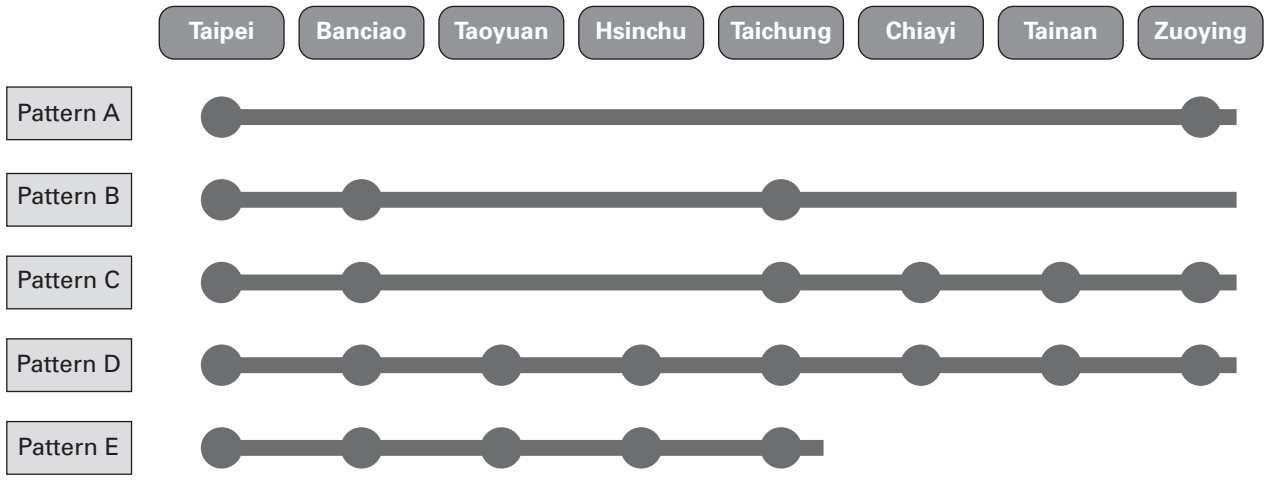
Major stopping patterns

As shown in Figure 3, five train stopping patterns, combining non-stop, express, and local trains have been selected for passenger convenience and to eliminate complexity in train diagrams. At of 1 June, seven Pattern B, six Pattern C, fourteen Pattern D and four Pattern E trains are operating daily in both the up and down directions.

Table 1 General Characteristics of Stations

Station	Distance (km)	Type	Connection	Status
HSR Nankang	–3.27	Underground	TRA, MRT	Optional
HSR Taipei	5.904	Underground	TRA, MRT	
HSR Banciao	13.12	Underground	TRA, MRT	
HSR Taoyuan	42.285	Underground	MRT (future)	
HSR Hsinchu	72.179	Above ground	MRT (future)	
HSR Miaoli	104.865	Above ground	TRA	Provided later
HSR Taichung	165.733	Above ground	TRA (future), MRT (future)	
HSR Changhua	193.886	Above ground		Provided later
HSR Yunlin	218.48	Above ground		Provided later
HSR Chiayi	251.585	Above ground		
HSR Tainan	313.86	Above ground	MRT (future)	
HSR Zuoying	345.187	At grade	TRA (future), MRT (future)	
HSR Kaohsiung		Above ground	TRA (future), MRT (future)	Future possibility

Figure 3 Stopping Patterns



700T Trainsets

A total 30 trainsets have been supplied based on the 700 series shinkansen, currently operating on Japan's Tokaido and San'yo shinkansen, but modified to meet THSR requirements (Figure 4).

Each Electrical Multiple Unit (EMU) trainset consists of 12 vehicles (11 Standard class and one Business class) with 9 motored cars and three trailer cars. The train speed (300 km/h max.) and route are protected by an Automatic Train Control (ATC) system. Currently all 989 seats are reserved seats.

Maintenance depots

There are maintenance depots at locations along the route as shown in Table 2. Table 3 shows the preventive maintenance categories and intervals.

Figure 4 700T Trainsets

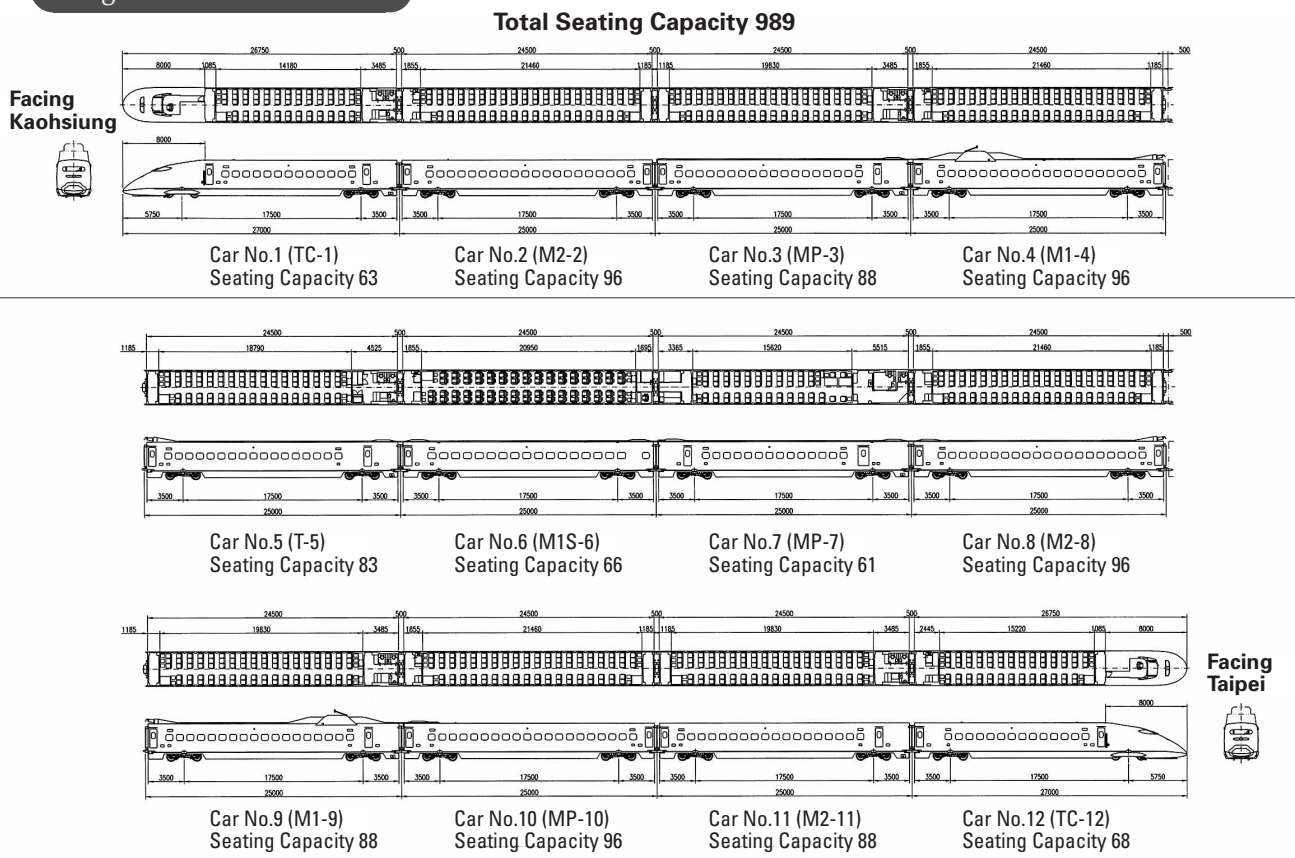


Table 2 Maintenance Facilities

Maintenance Facilities	Location	Purpose	Status
Yenchao Main Workshop	Kaohsiung	Trainset assembly/overhaul maintenance/repair of other rolling stock	Principal facility for heavy overhaul of all rolling stock
Zuoying Depot	Kaohsiung	Trainset maintenance, servicing, cleaning and stabling Permanent way maintenance Equipment storage	Principal facility for trainset maintenance
Wujih Depot	Taichung	Trainset stabling, maintenance, inspection, cleaning and catering Permanent way depot	Trainset maintenance Principal infrastructure depot
Sungshan Temporary Facility	Taipei	Trainset stabling and cleaning	Temporary facility
Hsichih Depot	Taipei	Trainset stabling, servicing	Future facility
Taipao Depot	Chiayi	Infrastructure maintenance Permanent way depot	Southern section infrastructure depot
Liuchia Depot	Hsinchu	Infrastructure maintenance Permanent way depot	Northern section infrastructure depot

Table 3 Preventive Maintenance Categories and Intervals

Maintenance Categories	Intervals
Turning around inspection	Turnaround
Terminal stabling inspection	Daily (can be superceded by DI or other higher level inspection)
Daily inspection (DI)	Every two days
Monthly inspection (MI)	Every month or every 30,000 km
Bogie inspection (BI)	Every 18 months or every 600,000 km
General inspection (GI)	Every 36 months or every 1,200,000 km
ATC Function inspection	Third MI or not more than 90 days
Wheel truing	Every 300,000 km

Table 4 Special Features (Some Differences from Japanese Reference System)

		THSRC	Reference System
Infrastructure			
Minimum curve radius		6,250 m	4,000 m, 2,500 m (Tokaido)
Turnout		Large (#33, #26, #20)	Small (#18, #16, #12)
Distance between tracks centres		4,500 mm	4,300 mm, 4,200 mm (Tokaido)
Tunnel cross section		90 m^2	64 m^2
Maximum gradient		3.5%	1.5%
Feeding system		Non-tie feeding system between adjacent tracks	Tie feeding system between adjacent tracks
Operation			
Train operation		Double track, bi-directional	Double track, single-directional
Advanced train automatic stop control at station		PSSC (Programmed Station Stopping Control)	None
Passenger door handling by train master		Door switch operable from any passenger door	Door switch operable from rear driver's cab
Operation at track circuit failure		STD (Secondary Train Detection)	Substitute protection system (manual)
Timetable in abnormality		Contingency timetable	None
Rolling Stock			
Train protection system		General alarm	EGS (Emergency Ground Switch)
Driver's cab	Side window	Fixed	Open sliding window
	Side door	None	Exclusively installed
Constant speed control		Cruise control	None
Deadman's handle		DVD (Driver Vigilance Device)	None
Emergency evacuation		Emergency windows, hammers	None
Stabling at depots		Parking brake	None
Fire protection device		Fire wire, smoke detector	None
Remote powering-up device		Pantograph remote controller	None
Pantograph emergency dropping device		Rear pantograph descends automatically if front pantograph damaged	None
Train radio		Space wave	LCX

Special features

As mentioned, although the core system is basically Japanese, a number of significant modifications have been made and some subsystems used in Europe have also been adopted. As a result, the THSR can be described as a mix of the world's best representative high-speed rail systems. Table 4 shows some of the differences between the THSRC and Japanese Reference System.

Build–Operate–Transfer (BOT)

The THSR is one of the world's largest privately funded railway construction projects. The total project is valued at US$13 billion and is being funded by the THSRC under a concession agreement by which the consortium has a 35-year franchise to design, finance, build, and operate the THSR and will then hand back the entire project to the government or a third party nominated by the government.

Under the Station Zone Development Agreement, the government granted the THSRC a 50-year concession to develop land surrounding THSR stations for commercial, residential, and recreational purposes.

Passenger Forecast

The THSR passenger forecast was consistent with generally accepted transportation planning practice, and THSRC's initial forecast in the early 1990s was quite optimistic, because the annual growth in domestic airline passengers was then at its peak, doubling from 9 million in 1992 to 18 million in 1997. Based on the initial forecast, THSRC estimated up to 88 daily round-trip operations transporting over 200,000 passengers at the time of the inauguration.

However, these numbers dropped due to the 1997 Asian Currency Crisis, which drastically reduced business passenger numbers. In 2005, the number of domestic airline passengers fell to 9 million, which is the same level as in 1992. When National Highway No. 3 and several expressways were constructed, the number of domestic airline passengers dropped yet again.

In the wake this setback, the passenger forecast was revised several times, searching for potential HSR market share in the unfavourable circumstances.

THSR Impact in First 7 Months

After only 7 months of THSR operations (at the time of writing), it is too early to predict the future transportation picture but it seems clear that the airlines have suffered a big impact and lost many customers. According to the four major domestic airlines, the number of passengers on competing routes dropped significantly and the load factor in January was down by 24%–31%.

To be competitive with the THSR, most of the airlines reduced weekend fares for Internet bookings. For example, the Taipei–Kaohsiung airfare was NTD1490–

700T train on downline to Zuoying Station with Yenchao Main Workshop at top centre

1500 (US$1 = NTD34), which is the same level as the HSR. The reduced fares were a limited time offer, but if the airlines continue offering this kind of service, they will have business difficulties.

Despite some minor initial glitches and snags, so far there have been no serious problems in terms of rolling stock and train operations. During the peak Chinese New Year holidays (16–25 February), the THSR carried 343,637 passengers for a daily average of 34,000 and seat occupancy of 66%. The daily peak so far was 51,026 on 14 January.

Although the average daily passenger level of 47,000 at present is not what was first anticipated, this is due partly to Taiwan's economic downturn and mostly to the fact that THSRC is still only running a low number of daily trains with small seating capacities. Some of the performance statistics during the first 7 months are shown in Table 5.

Table 5 Performance Statistics during First 7 Months

	January (5–31)	February (1–28)	March (1–31)	April (1–30)	May (1-31)	June (1-30)	July (1-31)
Ridership	1,161,047	724,784	919,455	1,076,413	1,155,098	1,241,227	1,425,755
Load Factor (%)	79.36	49.44	55.82	51.87	53.29	49.19	52.69
Punctuality* (%)	99.6	99.8	99.9	99.93	99.94	99.03	99.39

* Punctuality means a delay at the terminal station of less than 10 minutes.

Space-age Hsinchu Station—third stop from Taipei Station

Epilogue

The THSR will contribute greatly to Taiwan's environmental and energy-saving policies. In terms of CO_2 footprint, a fully loaded 700T releases only 11% of the CO_2 released by private cars carrying the same number of passengers (25% for buses).

In a similar comparison, a 700T consumes only about 16% of the energy of private cars (50% for buses).

The THSR opening has brought a new era to Taiwan because the entire nation will be within 1-day's reach by rail, revolutionizing Taiwan's manufacturing industries, tourism, and the daily life of its citizens.

Takashi Shima

Mr Shima is Advisor to the Taiwan High Speed Rail Corporation. After graduating from the University of Tokyo, he joined JNR in 1955. He was seconded by the Ministry of Foreign Affairs to the Consulate General of Japan in New York for 8 years and to the World Bank for 5 years. In 1985, he transferred to Hitachi before becoming Managing Director of Hitachi Systems Technology and Executive Managing Director of the Japan Association of Rolling Stock Industries.