High-Speed Railway In Japan

Railway Bureau, MLIT

5.December, 2011

MLIT

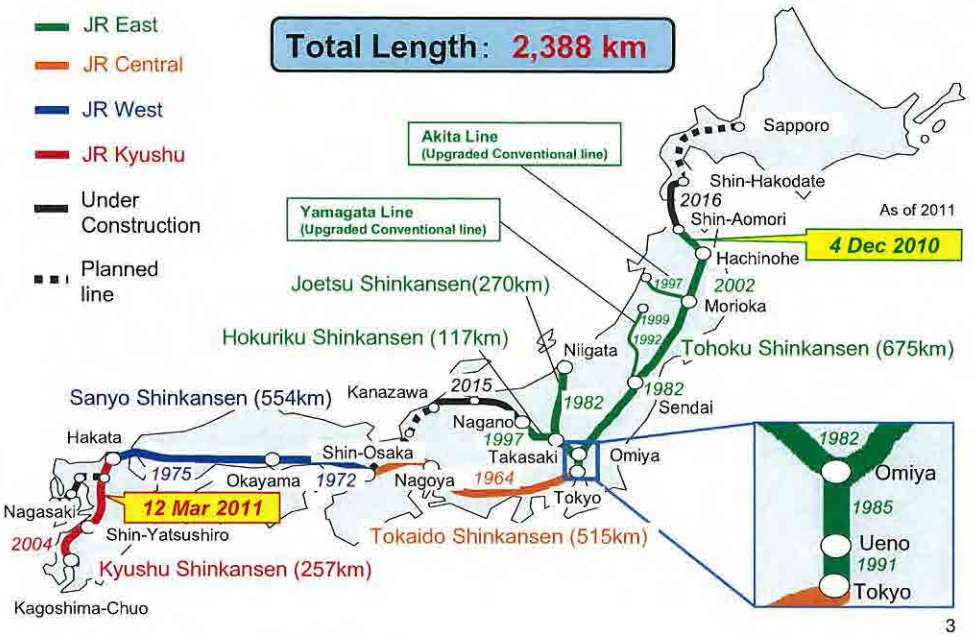
Today's Contents

1. Japan's Current HSR Network

2. The Development of the Construction of Shinkansen

3. The earthquake-proof Shinkansen

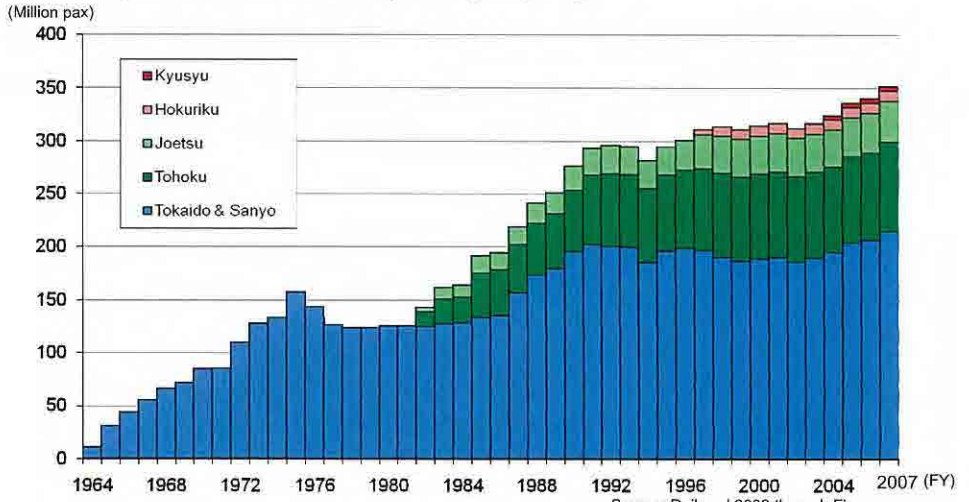
1. Japan's Current HSR Network



1. Japan's Current HSR Network
No. of Shinkansen Passengers

Annual No. of Shinkansen passengers has been steadily growing since its opening in 1964.

○ Changes in No. of Shinkansen passengers yearly



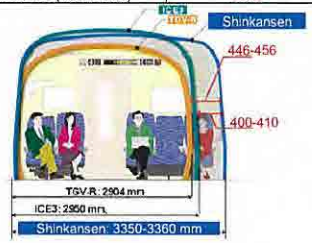
Source: Railroad 2009 through Figures, Shinkansen (Sankaido)

Shinkansen's car body is wider and lighter than other high speed rail trains

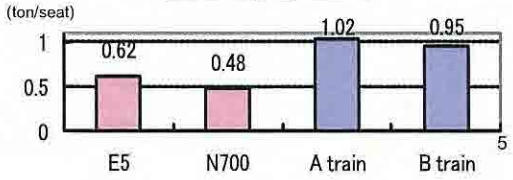
O Wide and lightweight car body

	Shinkansen Series E5	Shinkansen Series N700	A train	B train
Maximum Speed (km/h)	320	300	320	320
Width (mm)	3,350	3,360	2,904	2,950
Seat Pitch (mm)	1,040	1,040	900	920
Trainset(cars)	10	16	20	16
Seats (No.)	731	1,323	750	858
Train Weight (ton) *	454	635	766	818
Train Weight/Seat (ton/seat)	0.62	0.48	1.02	0.95

*Unloaded train data



Train weight per seat



5

O What are the benefits reaped from these strengths?

- **High Energy Efficiency & Less CO_2 Emission**
  Lightweight
- **Low Noise Levels**
  World's strictest trackside-noise regulation applied
- **Passenger Comfort**
  Wider car body & longer seat pitch
- **Large Capacity**
  More passengers per train
- **Low Construction Cost**
  Smaller tunnel cross-section & lane sizes
- **Low Maintenance Cost**
  Lightweight

Established Record of Outstanding Safety & Reliability Over 46 Years

- Passenger casualties to date: **ZERO**
- Average delay time: less than **1 min**

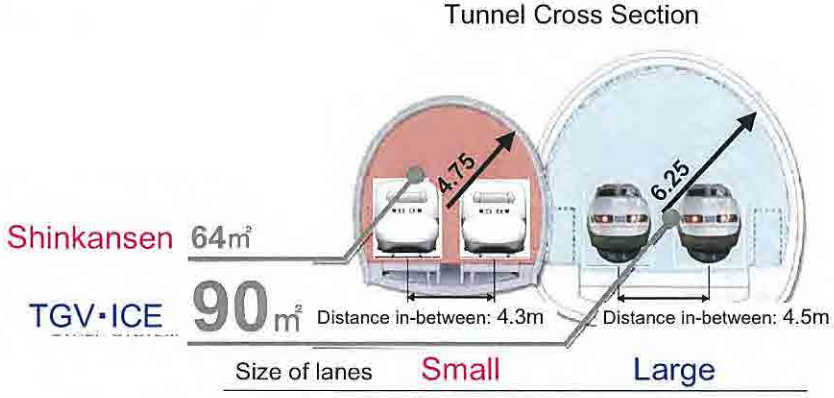
7

A3-31

Shinkansen allows for smaller tunnel cross sectioning thanks to its excellent car body air tightness.

O Small infrastructure

Tunnel Cross Section



6

1959 ~

Tokaido, Sanyo, Tohoku (Tokyo-Morioka), and Joetsu Shinkansen were mainly financed by **loans** with interest.

Privatization and division into six private companies of the Japanese National Railways (JNR) in 1987

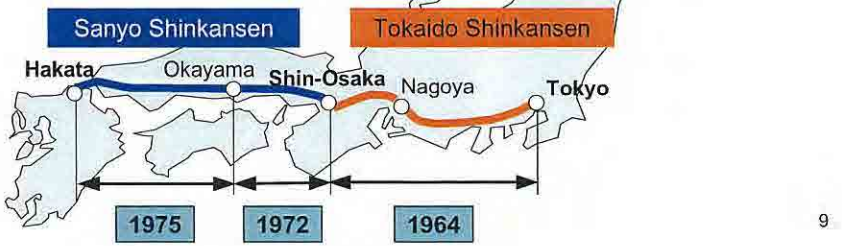
~ Today

Other Shinkansens have been constructed in the form of public works projects with **subsidies from the national government and local governments involved.**

8

O Construction schemes for the Tokaido and Sanyo Shinkansen

- **No special scheme** existed for Shinkansen construction.
- The construction costs were fully covered by **loans** with interest.
- For the Tokaido Shinkansen, a **World Bank (IBRD) loan** of $320 million was provided, which accounted for 8.6% of the total construction cost of $3.7 billion.



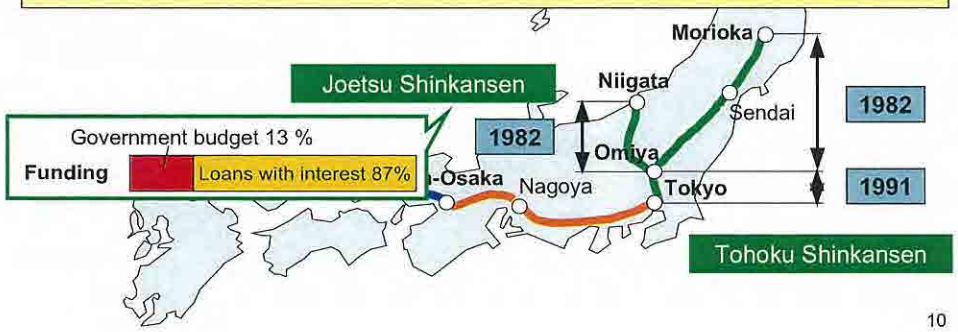
O Shinkansen Construction Costs(Before the reform JNR)

	Tokaido	Sanyo	Tohoku	Joetsu
Section	Tokyo～Shin-Osaka	Shin-Osaka～Hakata	Tokyo～Morioka	Omiya～Niigata
Route length	515km	554km	497km	270km
Construction period	1956～1964	1967～1975	1971～1991 ※1	1971～1982
Construction Costs	$3.7 billion	$10.1 billion	$29.6 billion	$18.1 billion
Cost per km	$7.2 million	$18.2 million	$59.6 million	$67.0 million
(Reference)				
Passengers per year	149.2 million	62.9 million	82.2 million	37.4 million
Passengers per day	409 thousand	172 thousand	225 thousand	102 thousand

※1 Ueno Tokyo during construction since the reform of JNR

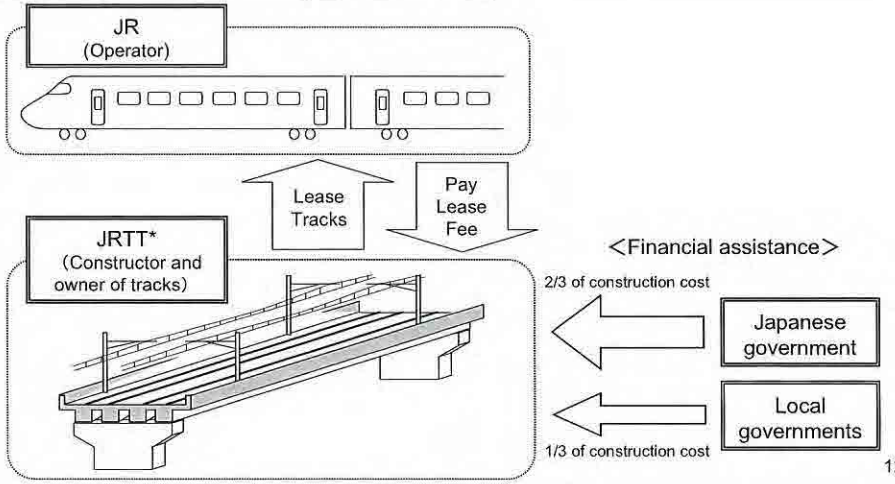
O Construction scheme for the Tohoku and Joetsu Shinkansen

- Tohoku Shinkansen (Tokyo-Morioka) & Joetsu Shinkansen (Omiya-Niigata) were constructed by the **JNR & Japan Railway Construction Public Corporation (JRCC) under the Nationwide Shinkansen Railway Development Law, enforced in 1970**.
- Government funding was partially used for the construction costs; however, a large part of the costs were still covered by **loans with interest**.



For the sustainable operation of Shinkansen, the operator, JR, does not shoulder an excessive burden of railway construction costs. The tailored construction-operation separation scheme was introduced in 1997, which is subsidized by the Japanese government and local governments involved.

O Construction-operation separation schemes



*JRTT: The Japan Railway Construction, Transport and Technology Agency

Criteria for starting construction

- ●Stable financial resources
- ●Profitability
  - Annual profit of operator >0
  - (average over the next 30 years after opening)
- ●Investment effect
  - Benefit/Cost > 1
  - (Effect of saving travel time, etc.)
- ●Consent of JR
- ●Consent of the local government for terminating JR operation of the current conventional line

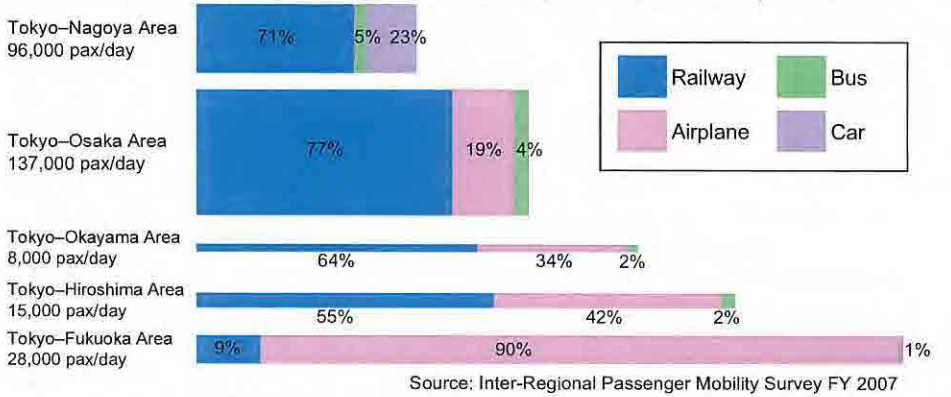
* Based on the basic policy on construction of new Shinkansen lines

○ Shinkansen Construction Costs(After the reform JNR)

	Tohoku	Hokuriku	Kyushu
Section	Morioka～Hachinohe	Takasaki～Nagano	Shin-yatsushiro～Kagoshima-chuo
Route length	97km	117km	127km
Construction period	1991～2002	1989～1997	1971～1991
Construction Costs	$5.1 billion	$9.2 billion	$7.0 billion
Cost per km	$52.6 million	$78.6 million	$55.1 million
(Reference)			
Passengers per year	82.2 million ※1	10.0 million	4 million
Passengers per day	225 thousand ※1	27 thousand	11 thousand

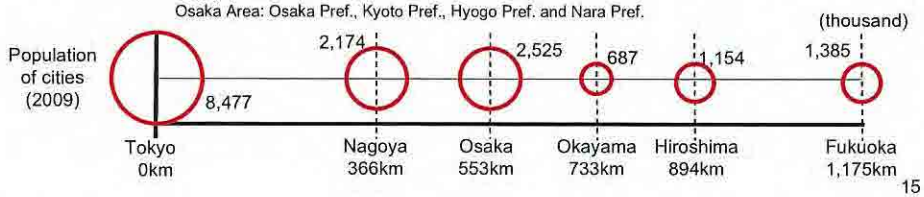
※1 Tokyo～Hachinohe data

○ Comparison of shares among modes of passenger transport for Tokyo–Fukuoka



Source: Inter-Regional Passenger Mobility Survey FY 2007

Note: Tokyo Area: Tokyo Metropolis, Kanagawa Pref., Chiba Pref., Saitama Pref. and Ibaraki Pref.
Nagoya Area: Aichi Pref., Gifu Pref. and Mie Pref.
Osaka Area: Osaka Pref., Kyoto Pref., Hyogo Pref. and Nara Pref.



Great East Japan Earthquake

<Date and time of occurrence>
March 11, 2011

<Strength of the earthquake>
Magnitude 9.0 on the Richter scale
(The strongest in the history of Japan)

<Number of casualties>
22,943 (As of June 20, 2011)

No casualties among passengers

・None of the Shinkansen trains were derailed. (27 Shinkansen trains were in operation, 19 of which were moving then.)
・No critical destruction to major structures such as viaducts, bridges, station installations and tunnels by this earthquake.

○Damage caused by the earthquake
No. of damaged sites: Approx. 1,200
・Broken, leaning, or cracked electrification masts: Approx. 540
・Severed power lines: Approx. 470
No. of damaged sites caused by the aftershock on 7 April: Approx. 550


Broken, leaning, or cracked electrification masts

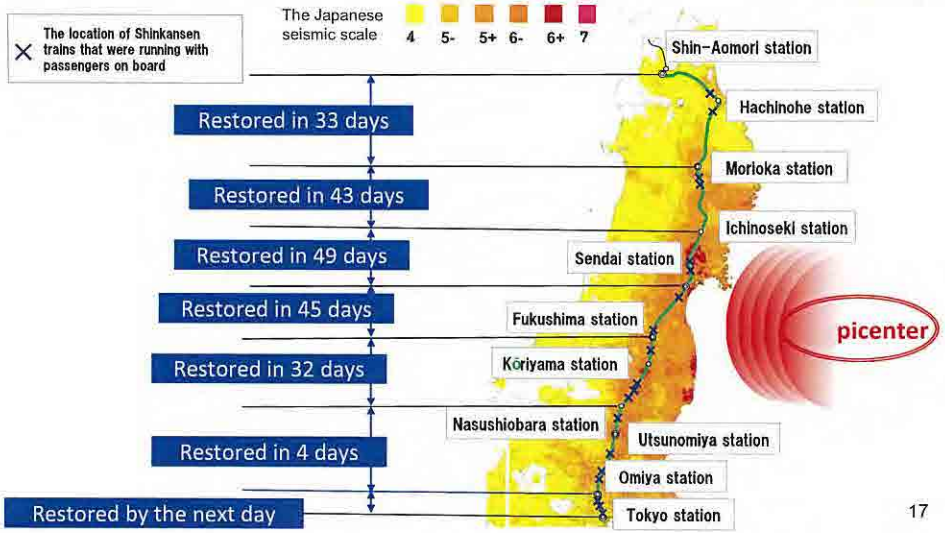

Severed power lines

3. The earthquake-proof Shinkansen

Ministry of Land, Infrastructure, Transport and Tourism

○The present status of Tohoku Shinkansen

Shinkansen services were completely restored 49 days after the earthquake occurred.



3. The earthquake-proof Shinkansen

Ministry of Land, Infrastructure, Transport and Tourism

○Anti-seismic reinforcement

Based on the experiences of past earthquakes, anti-seismic reinforcement to prevent shear failure of viaducts had been completed.
It prevented the viaducts from suffering critical damage; the restoration work was completed in a short time.

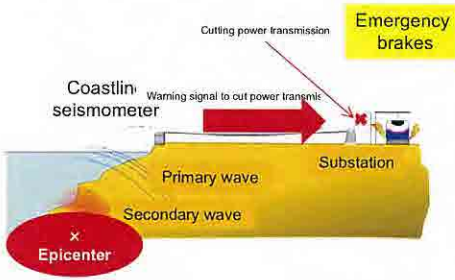
The damage to viaducts in Great Hanshin-Awaji Earthquake (occurred on 17 January 1997)	No damage to reinforced viaducts in Great East Japan Earthquake (occurred on 11 March 2011)

3. The earthquake-proof Shinkansen

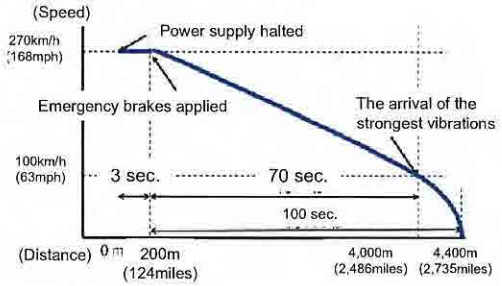
Ministry of Land, Infrastructure, Transport and Tourism

○Introducing "Early Earthquake Detection System"

・Before the arrival of the strongest vibrations, the "Early Earthquake Detection System" had functioned successfully.
・Immediately after the emergency brakes worked, Shinkansen trains that were running with passengers on board slowed down and stopped.
→No derailment



<The condition of Shinkansen moving around Sendai>



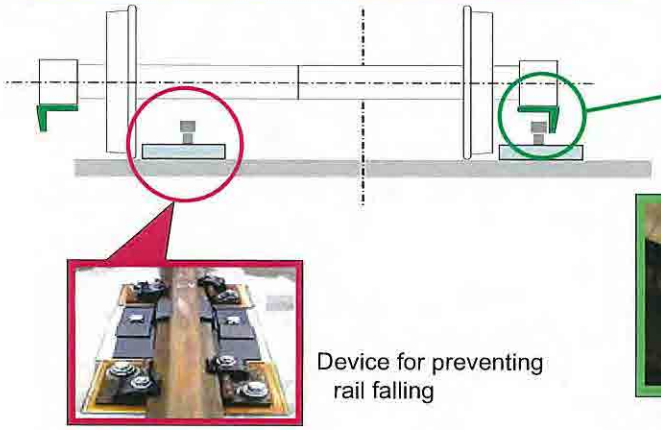
3. The earthquake-proof Shinkansen

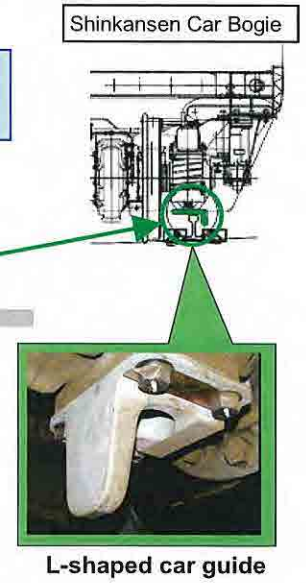
Ministry of Land, Infrastructure, Transport and Tourism

○Deviation/Derailment Preventive Measures

L-shaped car guide

Measures for preventing a derailed train from widely running off the tracks, using a L-shaped car guide installed with the bogie, which gets stuck onto the rail.






Thank you!

Technical Standards System of JAPAN

Railway Bureau
Ministry of Land, Infrastructure, Transport and Tourism

Status of Railway Transportation (Japan-EU-U.S.A)

		Japan	EU	U.S.A
Operating Distance (km)		27, 000	231, 000	226, 000
		(only JR) 20, 000		
Traffic Volume	Freight ×Hundred million (t・km)	230	18, 200	20, 000
	Passenger ×Hundred million (passenger・km)	4, 000	3, 900	500
		(only JR) 2, 500		

※All figures are shown in approximate number.
※ EU (27 countries) are quoted from the website of ERA.

Number of Accidents (Japan-EU-U.S.A)

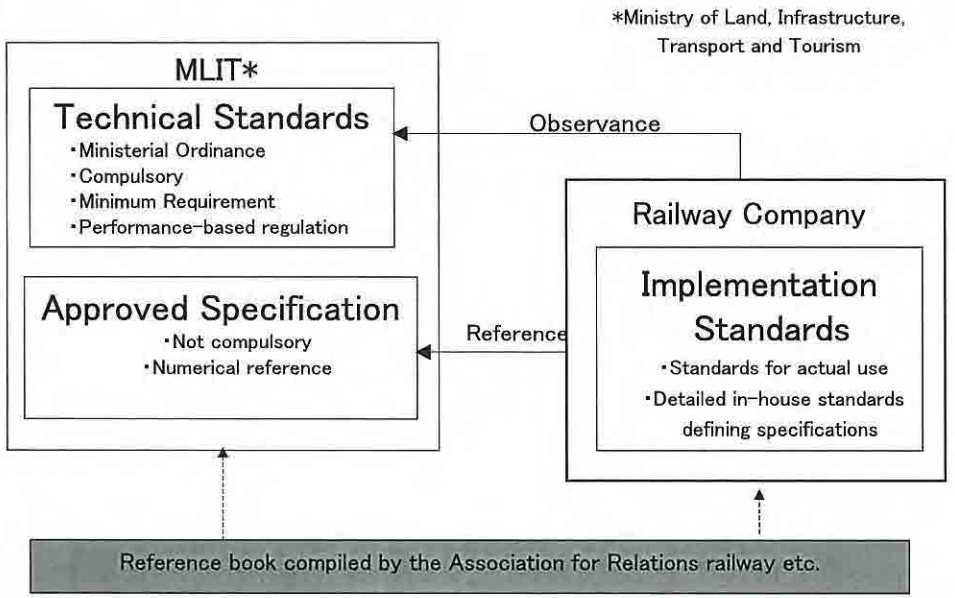
	Japan				EU				U.S.A			
	C	D	F	L	C	D	F	L	C	D	F	L
2006	1	13	0	362	673	499	257	1,355	201	2,194	21	2,941
2007	0	12	2	367	249	346	107	1,196	210	1,934	14	2,776
2008	0	7	2	333	269	319	88	1,034	191	1,778	10	2,430
2009	0	5	1	327	142	177	66	833	133	1,360	20	1,926

Type of Accident
C:Collision
D:Derailment
F:Fire
L:Level crossing

※ EU (27 countries) are quoted from the website of ERA.
※U.S.A. quoted from the homepage of the FRA.
※Selected range of railway in each country do not match.

Preventing collision, derailment, and fire

The Japanese railway system has various measures aiming to prevent railway accidents of collision, derailment and fire from happening to secure safety and stable transportation



- General Rule
- Staff
  - ①Safety Assurance of Train Operation
  - ②Education and Training of Staff
  - ③Duties of Crew to Operate a Motive Power Unit
- Facilities & Rolling Stocks
  - ①Guide way, ②Station, ③Intersection with road
  - ④Electric line facilities, ⑤Operation safety facilities
  - ⑥Rolling stocks
- Maintenance
  - Public Notice Concerning the Regular Inspection of Facilities and Rolling Stocks
- Train Operation
  - ①Loading limitation, ②Train operation, ③Signals

1. In order to prevent derailment, railway operators should install apparatus to prevent speed exceeding at curves .

2. Depending on structure and usage, railway operators appropriately maintain cars, signals, tracks, etc.

3. Railway operators should provide adequate education and training to their staff and crew, in order to be well versed in necessary knowledge and skills.

(Apparatus to Automatically Decelerate or Stop Trains)

Article 57.
In the case when trains are operated by the block system, apparatus to automatically decelerate or stop trains depending upon signal aspects and guide way conditions shall be installed.

In the cases listed below, automatic train stop devices to be located in accordance with the provisions shall be a type that can automatically slow down trains to a safe speed or stop them before the near side of a speed restriction point, a stop limit point, etc., when the train runs at a speed exceeding a certain level at a predetermined position.

There is a risk of overturn to the outside of curves when a train intending to enter a curve comes into the section at a speed enabling operation (i.e., the maximum speed between stations. However, in cases where there is a device to restrict speed in front, or where a train starts from a place where trains necessarily stop, such as at a terminal station, this shall be a speed that can be reached by normal operation under these conditions. The same shall apply hereafter in these items.).

1. In order to prevent derailment, railway operators should install apparatus to prevent speed exceeding at curves .

2. Depending on structure and usage, railway operators appropriately maintain cars, signals, tracks, etc.

3. Railway operators should provide adequate education and training to their staff and crew, in order to be well versed in necessary knowledge and skills.

■ Maintenance of Facilities and Rolling Stocks

●Technical Standards (Ministerial Ordinance Chapter 10)

(87) Maintenance of Facilities and Rolling Stock
(88) Inspection and Field Test of Newly Installed Facilities and Newly Manufactured Rolling Stock
(89) Inspection tour and Monitoring of Main Track and Overhead Electric Line over the Main Track and Inspection of Train
(90) Regular Inspection of Facilities and Rolling Stocks

Public Notice
1) Purpose
2) Periodic Track Inspection
3) Periodic Inspection for Electric Facilities
4) Periodic Inspection for operational safety devices
5) Periodic Inspection of Rolling Stock
6) Special Cases of Inspection

(91) Record

◎ Public Notice Concerning the Regular Inspection of Track and Electric Facilities (Article 2 & 3)

Type of Facilities		Period	
		Shinkansen	Conventional line
Track	Track (Irregularity)	2months	1year
	Track (Others)	1year	
	Structures (Bridge, Tunnel, etc)	2years	2years
Electric Facilities	Circuit Breaker (Feeder side)	3months	1year
	Contact Line	6months	
	Other Electric Facilities	1year	2years

1. In order to prevent derailment, railway operators should install apparatus to prevent speed exceeding at curves .

2. Depending on structure and usage, railway operators appropriately maintain cars, signals, tracks, etc.

3. Railway operators should provide adequate education and training to their staff and crew, in order to be well versed in necessary knowledge and skills.

(Education and Training of Staff)

Article 10.
A railway operator shall provide adequate education and training to those who are directly engaged in train/car operation and do maintenance relevant works for rail facilities and rolling stock, in order for them to be well versed in necessary knowledge and skills.

▪
▪

◆Guide way Alignment

◎ Ministerial Ordinance (Article 13)
Radius of curve and gradient of the main track shall be able to ensure the high-speed and large capacity performance of the rail transport, taking the maximum design speed and tractive effort into consideration.

◆Radius of curvature

◎ Ministerial Ordinance (Article 14)
Radius of curvature shall be set in order not to impair safe car operations, taking the performance capability of negotiating a curve, the operation speed, and other relevant factors into consideration.

○ Approved Specification
- Curve radius of a main track shall be 400 meters or more.

□ Implementation Standard
- Curve radius of a main track shall be 4,000 meters or more.

◆ Track Alignments (Gradient)

◎ Ministerial Ordinance (Article 18. Excerption)
Gradient shall be set in the manner that a train can be started, operated continuously at a designated speed and brought to a stop within a designated braking distance, taking performance of tractive efforts of motive device, capability of braking device and train speed into consideration.
Gradient of the area where a train comes to a stop shall be set not to interfere with train departure and arrival, taking the braking performance of a train into consideration.

◎ Approved Specification (Excerption)
1) The maximum gradient of Shinkansen on the traveling area :
(A) 25/1000
(B) 35/1000 : where the above standard cannot be applied due to topographic or other reasons, considering the performance of the prime mover, power transmission equipment, running gear and brake equipment.
2) The maximum gradient in the stopping areas: 3/1000.

Examples of gradients

Steepest gradients of Shinkansen

Steepest gradients of Shinkansen network

	Tokaido	Sanyo	Tohoku	Joetsu	Hokuriku	Kyushu
steepest gradient (‰)	20	15	20	20	30	35

Approved Specification

◆Construction Gauge

○ Approved Specification

A railway company shall specify a construction gauge and make sure not to set up buildings or other structures within it. Standard drawings of construction gauge for straight tracks are shown in following Figs.

(1) Minimum clearance between construction gauge and basic rolling stock gauge for straight tracks shall be as follows.

–Sideward direction of windows of the rolling stock : 500mm

–Upward and sideward direction of platforms : 50mm

(2) Even within the basic construction gauge, certain constructions can be set up if they are necessary for the traveling of rolling stock or the maintenance of railway facilities and if there is no possibility to impair safe traveling of the rolling stock. In such a case, that shall be stipulated in the construction gauge provisions.

Ministerial Ordinance

◆Construction Gauge

◎ Ministerial Ordinance (Article 20)

Construction gauge at a tangent line shall be set to provide an adequate distance from the car clearance not to impair train operations and the safety of passengers and crew, taking the vibration caused be car operation in consideration.

2. Construction gauge at a tangent line where electric locomotive hauled or electric multiple units are operated, shall be determined in such a way as to provide a sufficient distance from the car clearance to prevent electric shock or fire.

3. Construction gauge at a curve shall be larger than those specified in the preceding two paragraphs depending upon the deviation of rolling stock, and shall be slanted according to the amount of the cant.

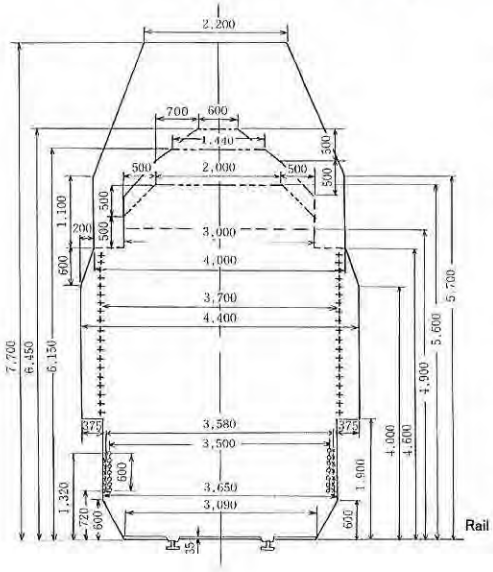
4. No building or structure shall be built within the construction gage.

5. Any object other than a train/car shall not be placed within the construction gage. This rule does not apply, however, to inevitable cases like carrying out necessary construction work, as long as appropriate precautions like speed restriction, for example, are taken to secure safety.

6. Nothing shall be placed even outside of the construction gauge that could fall into the construction gauge.

Examples of construction gauge

Standard drawings of construction gauge



Basic construction gauge

Gauge for tunnels, bridges, overbridges and platform sheds

Gauge for overbridges when the center of slack of messenger wire is used

Gauge for tunnels, bridges, overbridges and platform sheds when overhead contact lines are specially structured in line sections where trains travel at 120km/h or below

Gauge when no overhead contact lines are installed

Gauge for platforms (only if no passing trains), crewmen steps and rolling stock cleaning stations

Gauge for platforms (only if there are passing trains)

Gauge for facilities for rolling stock maintenance, inspection and repair and indicators inside depots

◆Distance between Track Centers

◎ Ministerial Ordinance (Article 22)

The distance between track centers at a tangent track shall be set to maintain the safe car operation by eliminating the possibility of pitching cars touching each other or hurting a passenger leaning out of a train window.
2. Distance between track centers at a curve shall be larger than the one described in the previous provision, according to the deviation of rolling stock.

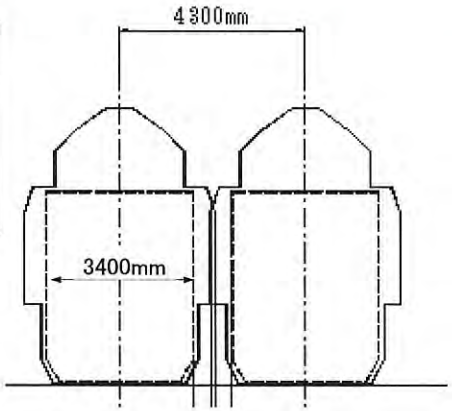
○ Approved Specification (Excerption)

Track-center distance shall be such that there is no possibility of detrimental effect on the safe traveling of the rolling stock and the safety of passengers and crewmen and shall conform to the following standards.
(1) The track-centre distance of a Shinkansen shall be as follows.
-The track-centre distance on the main track in straight-line sections shall be equal to or greater than the maximum value of the basic rolling stock gauge plus 800mm.
-The value shall be increased where necessary for work or the like.

☐ Implementation Standard

- Track-centre distance in a straight line section outside a station shall be 4300 mm or more.
- Track-centre distance in a station shall be 4600 mm or more.

Drawing of reference



The basic rolling stock gauge	:	3400mm
Plus	:	800mm
Increased where necessary for work	:	100mm
		4300mm

A3-41

◆ Structures

◎ Ministerial Ordinance (Article 24)

Structures such as earthwork, bridge, and tunnel shall be able to withstand the anticipated loads. They shall also be free from any impediment for the safe train operation like the deviation of structures caused by the load and impact of the train.

○ Approved Specification (Excerption)

The design of earth structures, bridges, tunnels and other structures shall conform to the notifications in the following "Design Standards for Railway Structures and Commentary."
・earthquake-resistant design, Earth Structures, Concrete Structures, Steel Composite Structures, Foundations and Retaining Structures, Shield Tunnels, Steel and Concrete Composite Structures, Earth Structures for Low Maintenance Tracks, Open Cut Tunnels, Mountain Tunneling Method for Urban Areas, Displacement Constraints

◆Contact Lines and Other Facilities

◎ Ministerial Ordinance (Article 41)

Catenary line , feeder line and their accessories including apparatus, wire and protection equipment shall be installed not to cause electric shock and fire, according to the location, installation method and standard.
2. Overhead contact line and feeder line shall be installed at an appropriate height depending upon the location, installation method and standard voltage to make them free from of the risk of electric shock or other impediment to train traffic,
3. Contact line shall be able to withstand the predictable maximum wind pressure load, tension of electric wire, etc. and also shall be installed appropriately to collect electricity without any impediment according to the train speed and feeder system.
4. Contact line and feeder line shall be installed in such a manner as to prevent failures caused by an inadvertent contact or confusion with other contact line or feeder line that differs in standard voltage, frequency and so on.
5. The voltage of contact line shall be maintained at a sufficient level to guarantee adequate train operations.

◆Contact Lines and Other Facilities

○ Approved Specification (Excerption)

-The overhead single-line system shall be used to install overhead contact lines.
-The height of overhead contact lines shall be 5 meters from the rail surface as standard, ranging between 4.8 and 5.3 meters.
-Contact wires for a main track shall be grooved hard drawn copper wires, grooved cooper alloy wires or grooved copper-covered steel wires with nominal cross-sectional area of 110 mm2 or more and conform to the Japanese Industrial Standards of "grooved hard drawn copper contact wires".
-Overhead contact lines shall be suspended by the catenary suspension system and installed in accordance with an automatic tensioner.
-The distance between supports shall be 60 meters when overhead contact lines are suspended by the simple catenary system.
-The standard voltage of overhead contact lines shall be 25,000 VAC, single-phase.

◆Proximity or Crossing of Overhead Electric Lines

◎ Ministerial Ordinance (Article 42)

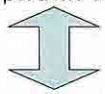
In case the voltage applied part of the overhead contact line, or feeder line is in proximity of or crossing other contact lines, manmade works, or vegetation, it shall be installed with caution to be free from chance of damaging any of the above and causing electric mixture, shock or fire.

○ Approved Specification

The distance of separation of the power-applied portions of overhead electric lines or overhead feeders from other electric lines, structures, etc. shall be of the value specified in the table below, or larger.

(for example)

Power-applied portions of overhead (25,000VAC)



3m or more

Structures (Buildings : When located above or to the side.)

Catenary suspension system,
110 mm² or more and conform to the Japanese Industrial Standards of "grooved hard drawn copper contact wires"

Thank you for your kind attention

※ Download data of Technical Standard for Japanese Railway

http://www.mlit.go.jp/english/2006/h_railway_bureau/Laws_concerning/14.pdf

6th December 2011

East Japan Railway Company (JR East)

- Outline of Shinkansen
- The Fare Charging System
- Life-Style Business

Outline of Shinkansen (High-Speed Rail)

East Japan Railway Company

Outline of JR East

JR EAST, a passenger railroad company, is the largest railroad company in JAPAN

Network: 7,512 km

No. of Passengers: 17 million /day (the largest in the world)

No. of Trains: 13,000 /day

Operating Revenue: $31 billion

Net Income: $0.9 billion

No. of Employees: 70,000

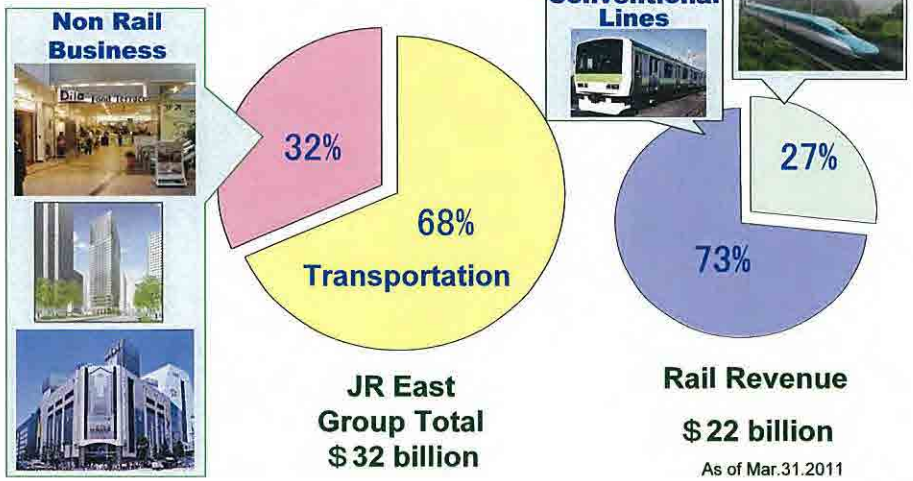
Total Stock Market Value: $22 billion

- No subsidies from the government

*Numbers are as of FY ended March 31 , 2011

Outline of JR East

Revenues from Railroad and Non Rail Businesses



Overview of JR East Shinkansen High-Speed Rail (HSR)

Shinkansen Network (5 direction lines)

1964: Shinkansen began operation

0 fatality for nearly a half century

East Japan Railway

Shinkansen Network: 1,412 km

- On alignment built for Shinkansen:1,135 km
- Improved from existing conventional lines: 277 km

No. of Passengers: 241,000 /day

No. of Trains: 310 to 415 /day

Overview of JR East Shinkansen High-Speed Rail (HSR)

Various Elements to maximize the value of HSR

- **Safety**
- **Punctuality**
- **High speed**
- **High frequency**
- **Large capacity**
- **Through service**
  (Coupling and Uncoupling technology)
- **Environmental friendliness**
- **Disaster countermeasures**
  (earthquake, snow)
- **Shorten total trip time**
  (Urban transit system, such as conventional lines and subways)
- **Comfort**
- **Maintenance**
- **Suica (Smart IC Card)**
- **Commercial development of stations**
- **Cost efficiency**



Overview of JR East Shinkansen High-Speed Rail (HSR)

Three types of Shinkansen

★ With coupling/uncoupling functions

Overview of JR East Shinkansen High-Speed Rail (HSR)


High Speed

- Maximum commercial speed of Series E5 is planned to be 320km/h by 2013.

Through Service

- Maximum commercial speed of Series E6 is planned to be 320km/h by 2014.
- Series E6 will run through onto improved conventional lines at 130km/h in 2013.
- Series E5 & E6 can be coupled and uncoupled automatically.

Gran Class

Introduction of “first class” car with excellent service

GranClass

on the Series E5

Large Capacity

Series E4 (Double-decker)

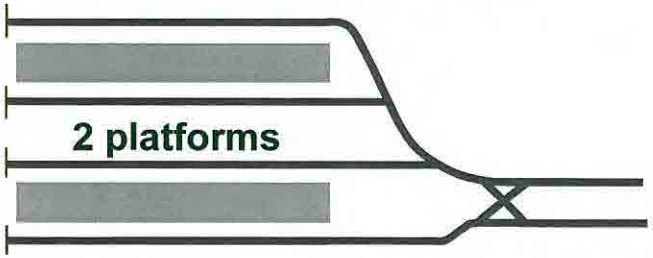
The World's Largest

No. of seats : 1,634
(the world's largest high-speed train)

No. of Shinkansen commuter pass holders

High Frequency

Tokyo Station Shinkansen platforms



4 min. ***Minimum train interval***
400 ***Trains per day***

High Frequency

5 ***Destinations from Tokyo station***
4 min. ***Minimum train interval***

High Frequency

12 min. Turn back

① Train arrives

② Passengers get off

③ Clean up

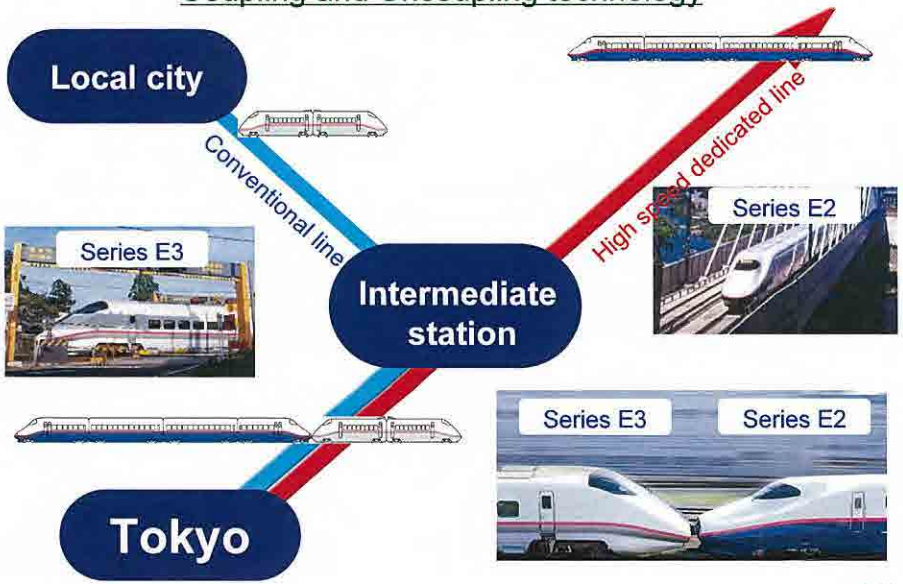
④ Finished

⑤ Passengers get on

⑥ Train departs

Through Service

Coupling and Uncoupling technology



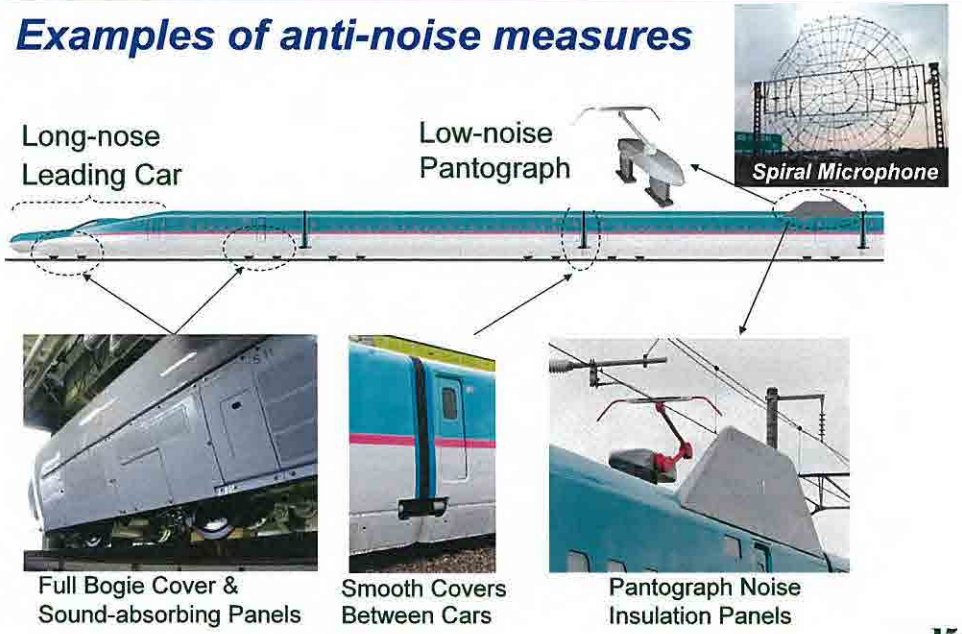
Anti-noise measures & aseismic system

Shinkansen noise level

- Below Japanese environmental standard of 75 dB
- No damage to agriculture or livestock

Anti-noise measures & aseismic system

Examples of anti-noise measures

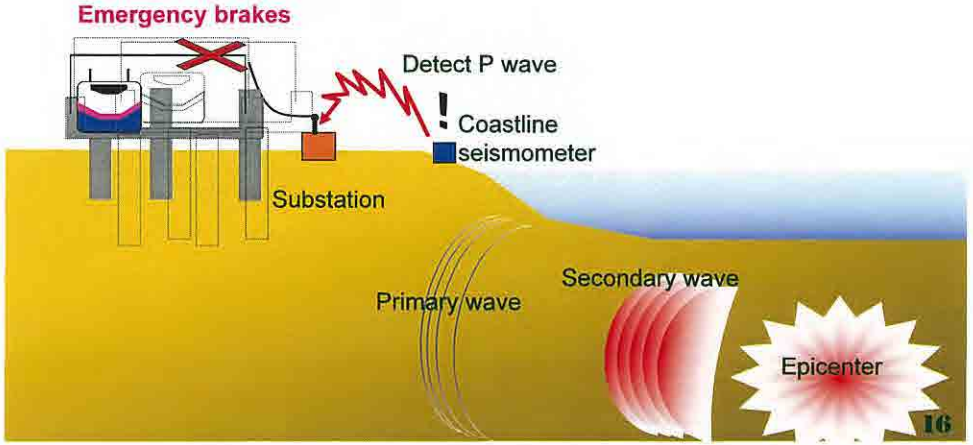


Anti-noise measures & aseismic system

Early Earthquake Alert System

Whenever coastline seismometer detects Primary wave.

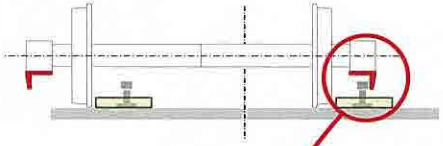
Power shutdown



Anti-noise measures & aseismic system

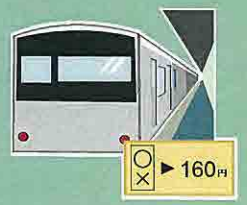
Reinforced Pillars

L-Shaped Car Guides



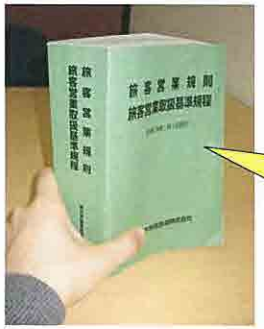
17

The Fare Charging System



East Japan Railway Company

The concept of the fare charging system is wholly prescribed as a "rule."



Rules of Passenger Transport Business

Standards on the Procedures for Passenger Transport Business

1,200 pages

Example: Travel from Tokyo to Sendai

Travel by **conventional line**

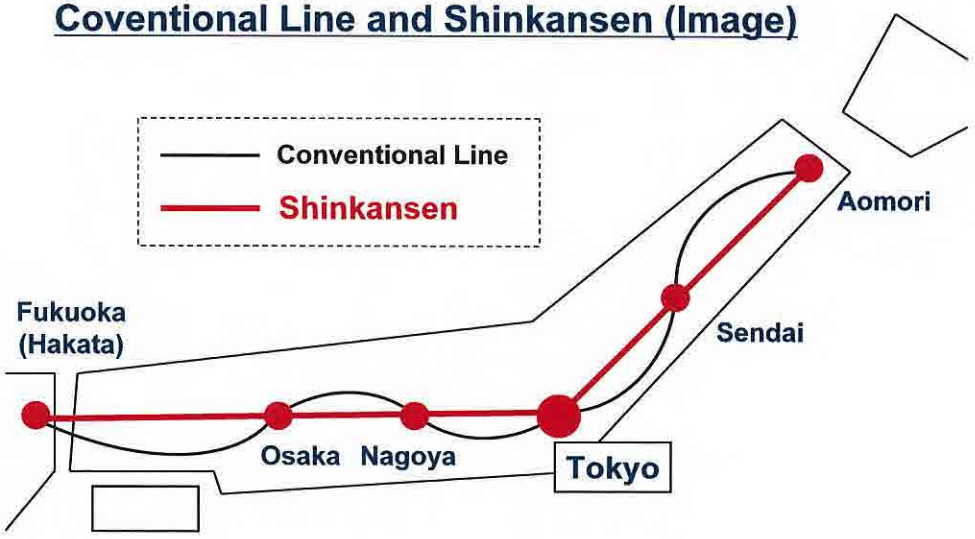
Fares

The amount charged for the travel is called "a fare."

Tokyo → Sendai

Fares = Amounts charged for transport services

Coventional Line and Shinkansen (Image)



Example: Travel from Tokyo to Sendai

Travel by Shinkansen trains

Charges (charges for limited express trains)

Fares

The charge for a limited express train, a charge for speed, is surcharged.

Tokyo ⟶ Sendai

Charges = Surcharges for additional services

Example: Travel from Toyko to Sendai

Travel by a special car (green car) of Shinkansen trains

Charges (green car charges)

Charges (charges for limited express trains)

Fares

A green car charge is surcharged for high-grade accommodations in addition to the limited express train charge

Tokyo ⟶ Sendai

Categories of charges

Charges= Surcharges for additional services

- **Charges for limited express trains**
  Surcharges for **high speed** services
- Green car charges
  Surcharges for high-grade accommodation services
- **Sleeping car charges**
  Surcharges for sleeping car services

7

Fares and Charges

Travel from Tokyo to Sendai, by a Shinkansen train up to Shin-Shirakawa and by conventional line local train thereafter

Charges (charges for limited express trains)

Fares

Toyko — Shin-Shirakawa — Sendai

Tokyo to Sendai **Fares** + Tokyo to Shin-Shirakawa **Charges (charges for limited express trains)**

8

Fares and Charges

Fares → Charges for transport services
Charged for the travel from the boarding to the alighting stations.

Charges → Charges for additional services
Charges for the section where passengers are provided with the services

Categories of Fares

Fares → Fare Tickets

Types of fare tickets
- One-way ticket
- Round-trip ticket
- Commuter Pass

Categories of Charges

Charges
- Charges for limited express trains → Express train tickets
- Green car charges → Green car tickets
- Sleeping car charges → Sleeping car tickets

Categories of surcharge tickets
- Shinkansen limited express train tickets
- limited express train (conventional line) tickets
  (Non-reservation seats, reservation seats, green car seats)

Combination of Fares and Charges

Travel from Tokyo to Shin-Aomori in *GranClass* Car

Charges (charges for limited express trains + *GranClass* charges)

Fare

Tokyo — **Total amount 26,360 yen** — Shin-Aomori

Tokyo to Shin-Aomori **Fare tickets**	+	Tokyo to Shin-Aomori **Express train tickets + Green car tickets (*GranClass*)**
9,870 yen		(6,490 yen + 10,000 yen)

Fares and charges of Tohoku Shinkansen

from Tokyo to	Construction Kilometers (km)	Operating Kilometers (km)	Total amount of Fares and Charges (Hayate, Yamabiko, Max Yamabiko, Nasuno, Max Nasuno)				Total amount of Fares and Charges (Hayabusa)					
			Economy Class		Business Class		Economy Class		Business Class		First Class	
			(Yen)	(Yen /km※)	(Yen)	(Yen /km※)	(Yen)	(Yen /km※)	(Yen)	(Yen /km※)	(Yen)	(Yen /km※)
Utsunomiya	109.0	109.5	4,800	44	6,290	57	—	—	—	—	—	—
Fukushima	255.1	272.8	8,700	32	11,190	41	—	—	—	—	—	—
Sendai	325.4	351.8	10,590	30	14,080	40	10,890	31	14,380	41	19,380	55
Morikoka	496.5	535.3	13,840	26	17,330	32	14,340	27	17,830	33	22,830	43
Hachinohe	593.1	631.9	15,350	24	18,840	30	15,850	25	19,340	31	24,340	39
Shin-Aomori	674.9	713.7	16,370	23	20,860	29	16,870	24	21,360	30	26,360	37

※ Operating kilometers

Overview of JR East's Life-Style Business
— Present Situation and Future Prospects —

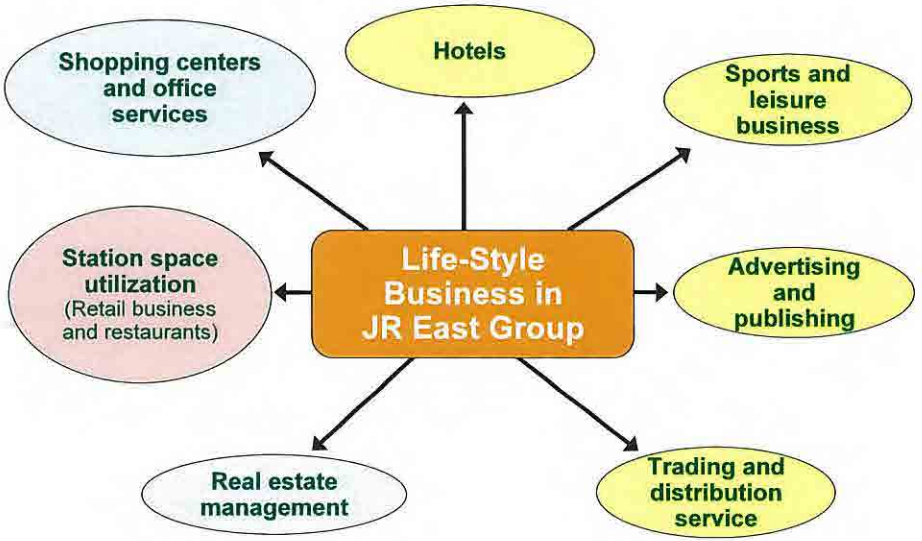
December 6, 2011

International Department

East Japan Railway Company

Future Prospects of JR East's Life-Style Business

Life-Style Business Diversification



Promotion System of Life-Style Business

JR East Group
(Life-Style Business)

Life-Style Business Development Headquarters
- Large-scale Development Div.
- Development Strategy Div.
- Regional revitalization Div.
- Shopping Centers and Office Services Promotion Div.
- Station Space Utilization Promotion and Property Management Div.
- Hotel and Media Business Promotion Div.
- Business Strategy Div.

Business departments in local administrative offices

12 Branch offices
3 Construction offices

Group companies

42
(As of July 1, 2011)

Life-Style Business – 42 Group Companies

As of July 1 , 2011

●16 Station building and SCs
Tetsudo Kaikan Co., Ltd.
atre Co.,Ltd.
Lumine Co., Ltd.
Tsurumi Station Building Co., Ltd.
Yokohama Station Building Co., Ltd.
Shonan Station Building Co., Ltd.
JR East Department Store Co., Ltd.
JR Tokyo West Development Co., Ltd.
Utsunomiya Station Development Co., Ltd.
Takasaki Terminal Building Co., Ltd.
Mito Station Development Co., Ltd.
Kinshicho Station Building Co., Ltd.
Chiba Station Building Co., Ltd.
JR East Aomori Commercial Development Co., Ltd.
Station Building MIDORI Co., Ltd.
JR Chuo Line Mall Co., Ltd.

●1 Office service
JR East Building Service Co., Ltd.

●5 Hotels
Nippon Hotel Co., Ltd.
SendaiTerminal Building Co., Ltd.
Morioka Terminal Building Co., Ltd.
Akita Station Building Co., Ltd.
Hotel Metropolitan Nagano Co., Ltd.

●7 Retail business and restaurants
JR East Retail Net Co., Ltd.
Nippon Restaurant Enterprise Co., Ltd.
JR East Food Business Co., Ltd.
JR East Station Retailing Co., Ltd.
Delicious Link Co., Ltd.
JR East Water Business Co., Ltd.
Kinokuniya Co., Ltd.

●2 Trading and distribution services
East Japan Railway Trading Co., Ltd.
JR East Logistics Co., Ltd.

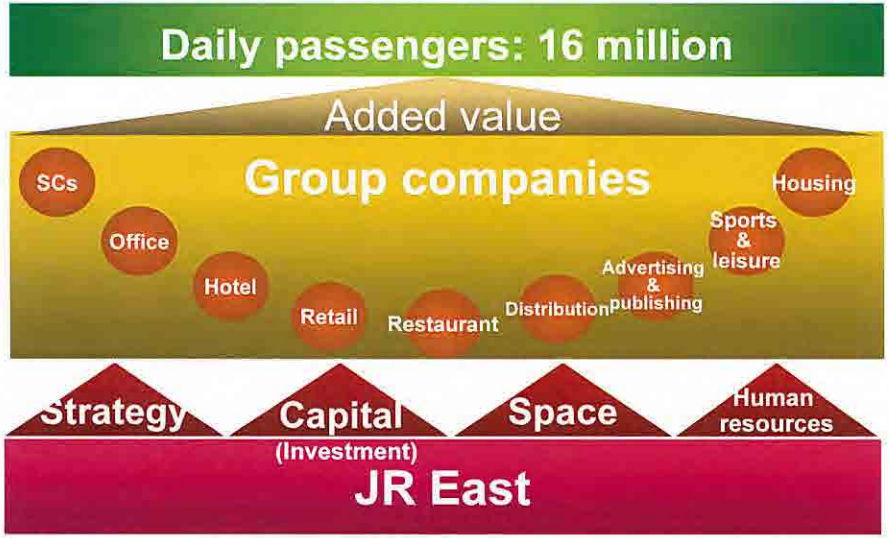
●2 Sports and leisure business
JR East Sports Co., Ltd.
Gaia Yuzawa Co., Ltd.

●1 Real estate management
JR East Urban Development Corporation

●3 Advertising and publicity
East Japan Marketing & Communications, Inc.
Tokyo Media Services Co., Ltd.
The Orange Page, Inc.

●5 group companies by branch offices
Tohoku Sogo Service Co., Ltd.
Juster Co., Ltd.
JR Atlis Co., Ltd.
Tokky Co., Ltd.
Shinano Enterprise Co., Ltd.

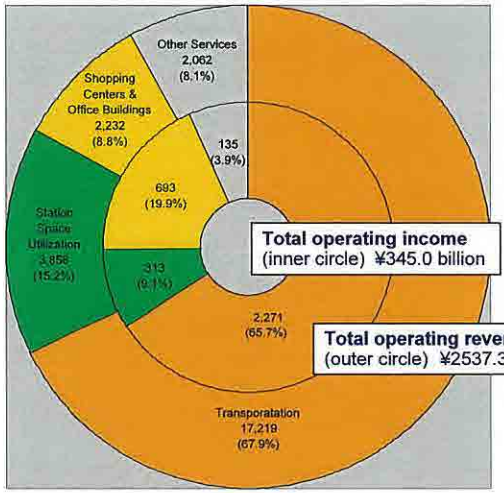
Group Companies Play Major Roles in Life-Style Services Business



JR East Group Consolidated Settlement of Accounts

■FY2010 JR East Group Consolidated Settlement of Accounts

(75 consolidated subsidiaries)



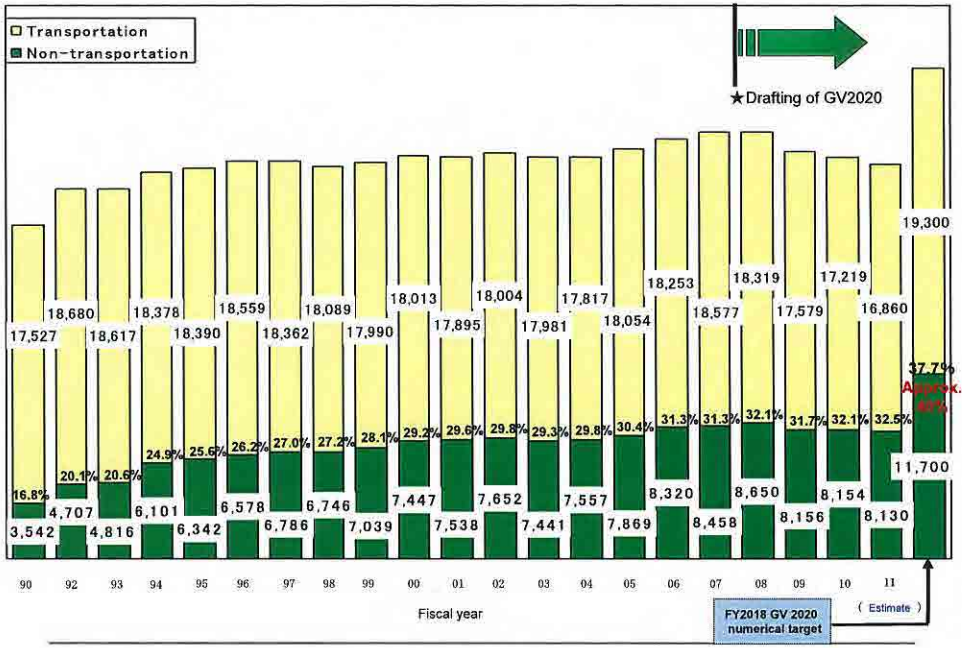
Operating revenues
¥2537.3 billion

Operating income
¥345.0 billion

- **Transportation (railways, buses)** Approx. 67.9%
- **Non-transportation (mainly life-style businesses)** Approx. 32.1%

Changes in Non-transportation Business Sales Revenue

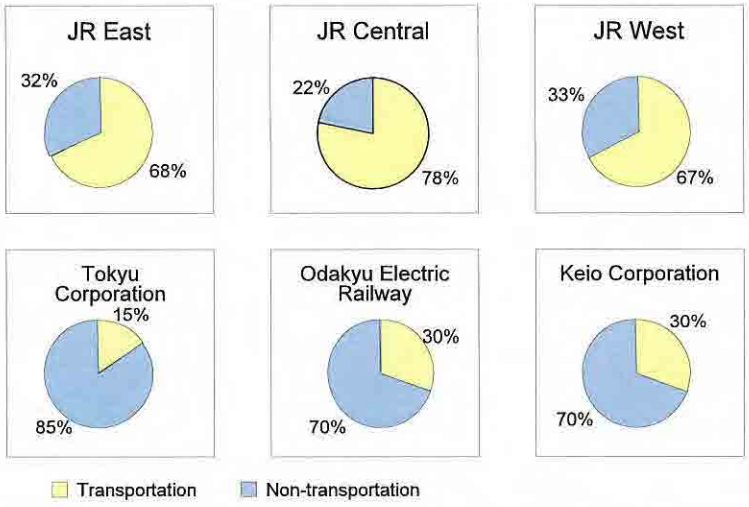
【Unit: ¥100 million】



A3-54

Non-transportation Businesses Sales Revenue

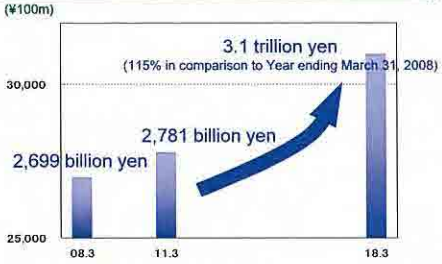
■ **Comparison with other JR companies and other railway operators**



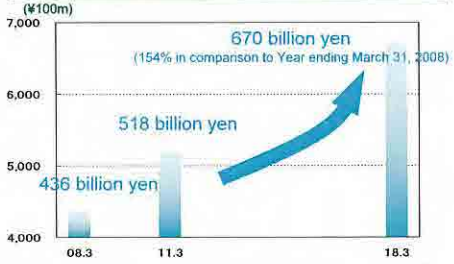
Achievement of Goals in FY2017

(Year ending March 31, 2018)

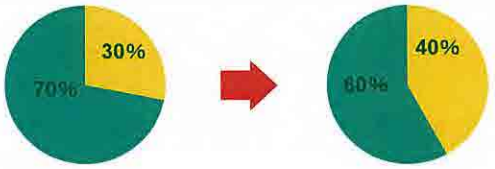
Consolidated operating revenues 3.1 trillion yen



Consolidated operation income 670 billion yen



Ratio of non-transportation operating revenues Approx. 40%



Ekinaka (in-station) Business – Retail businesses and restaurants –

■ **Retail businesses (approx. 1,830 shops)**

* Number of shops as of April 1st, 2011

Convenience store NEWDAYS (432 shops)

KIOSK (515 shops)

Plame Collome (10 shops)

Ekiben-ya Umaimon (5 shops)

■ **Restaurants (approx. 640 shops)**

Beck's Coffee Shop (77 shops)

Ajisai-Chaya, Gotouchi soba shops (203 shops)

P.style (3 shops)

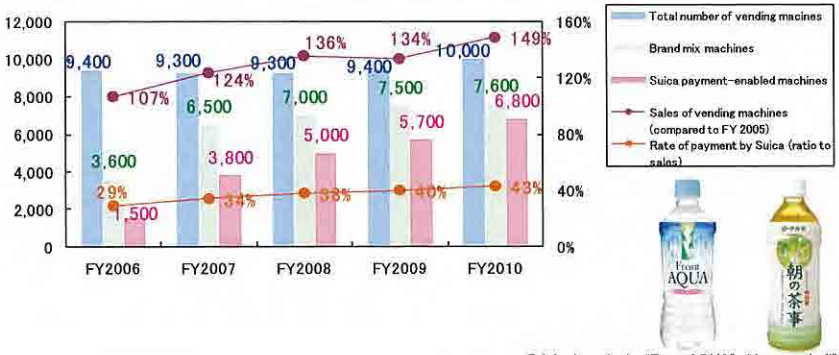
- **Making shops' renewal to match the market needs**
- **Enhancing organization to increase competitiveness**

Ekinaka (in-station) Business – Beverage Business –

■ **Vending machine innovation**

JR East water business is promoting vending machine reforms

- Over the past five years sales increased by 149% through brand mixing and Suica payment.
- Developing the new "Next generation vending machine" by applying digital signage.



Original products: "From AQUA" "Asa no chaji"

Development of next-generation drink vending machines

- From August 10th, 2010
- Installed 50 machines (as of August 2011)
- To install 500 machines

■Features of next-generation vending machine

(1) Large-screen touch panel display
(2) Intelligent Marketing Solutions
① Sensors equipped in the machine recognize age and sex of the customer and display recommendations on the screen based on the data.
② The machine creates unique targeted imagery based on factors such as season, time of day, and temperature advertisement on a large-screen display.
③ The sold out items will not appear and stocked items appear on the display (Red lamps showing "sold-out" items will not be displayed).
④ POS information will be linked to customers' profiles recognized to be used for future marketing.
(3) Digital Signage Network
① Delivering updated content via WiMAX network
② Offering free service of beverages in times of disaster with the aid of remote-controlled operation

■Switching imagery on the display

"When people are not in its near vicinity"

"When a customer nears the machine"

"When the customer purchases the product"

■Sales

- Earns twice as much as those of conventional vending machines installed on the same location.
- Conventional VMs sell most in the morning. Next-generation VMs sell same level as the conventional ones and more in the afternoon and the evening.
- Awarded Digital Signage Award 2011

Shopping Center Business: Transition in No. of Operating Companies

Integration and Restructuring of Station Building Operation Companies

Y/M/D	Merger	New company	No. of companies
2002 7 1	Chiba Station Building Co., Ltd. + Sobu Station Development Co., Ltd.	→ Chiba Station Building Co., Ltd.	55
2003 4 1	LUMINE Co., Ltd. + LUMINE Ogikubo Co., Ltd.	→ LUMINE Co., Ltd.	51
	Sendai Terminal Building Co., Ltd. + Fukushima Station Development Co., Ltd.	→ Sendai Terminal Building Co., Ltd.	
	Mito Station Development Co., Ltd. + Tsuchiura Station Development Co., Ltd.	→ Mito Station Development Co., Ltd.	
	Nagano Station Building Co., Ltd. + Matsumoto Station Building Co., Ltd.	→ Station Building Midori Co., Ltd.	
2004 4 1	The EKIBIRU Development Co.Tokyo (*2) + Kameido Station Building Co., Ltd. + Meguro Station Building Co., Ltd.	→ The EKIBIRU Development Co.Tokyo (*2)	46
	Sendai Terminal Building Co., Ltd. + Koriyama Station Co., Ltd.	→ Sendai Terminal Building Co., Ltd.	
	Utsunomiya Station Development Co., Ltd. + Oyama Station Development Co., Ltd.	→ Utsunomiya Station Development Co., Ltd.	
	Akita Station Department Store Co., Ltd. + Akita Terminal Building Co., Ltd.	→ Akita Station Building Co., Ltd.	
2004 10 1	Sendai Terminal Building Co., Ltd. + Yamagata Terminal Building Co., Ltd.	→ Sendai Terminal Building Co., Ltd.	44
	Tokky Co., Ltd. + Echigo Station Development Co., Ltd.	→ Tokky Co., Ltd.	
2005 4 1	The EKIBIRU Development Co.Tokyo (*2) + Omori Primo Co., Ltd. + Akihabara	→ The EKIBIRU Development Co.Tokyo (*2)	38
	Hiratsuka Station Building Co., Ltd. + Lumine Chigasaki Co., Ltd. + Abonde Co., Ltd.	→ Shonan Station Building Co., Ltd.	
	Morioka Terminal Building Co., Ltd. + Aomori Station Development Co., Ltd.	→ Morioka Terminal Building Co., Ltd.	
	Takasaki Terminal Building Co., Ltd. + Kumagaya Station Development Co., Ltd.	→ Takasaki Terminal Building Co., Ltd.	
2006 4 1	LUMINE Co., Ltd. + Shinjuku Station Building Co., Ltd.	→ LUMINE Co., Ltd.	35
	Hachioji Terminal Building Co., Ltd. + Kokubunji Terminal Building Co., Ltd. + Kofu Station Building Co., Ltd.	→ Hachioji Terminal Building Co., Ltd. (*1)	
2007 4 1	JR East Department Store Co., Ltd. + Kamata Station Building Co., Ltd.	→ JR East Department Store Co., Ltd.	33
	The EKIBIRU Development Co.Tokyo (*2) + Kichijoji Lonlon Co., Ltd.	→ The EKIBIRU Development Co.Tokyo (*2)	
2008 10 31	Dissolution of Iwaki Chuo Station Building Co., Ltd.		32
2009 4 1	Reorganization of group companies by branch office		27
2009 7 1	JR East Urban Development Corporation + JR East Housing Development & Realty Co., Ltd.	→ JR East Urban Development Corporation	26
2009 7 24	Opening of "Perch Tsuchiura" (JR East)		27
2009 10 1	atre Co., Ltd. + Kawasaki Station Building Co., Ltd. + Boxhill Co., Ltd.	→ atre Co., Ltd.	25
2010 4 1	LUMINE Co., Ltd. + Ikebukuro Terminal Building Co., Ltd.	→ LUMINE Co., Ltd.	25
	Ikebukuro Terminal Building Co., Ltd. (Tobu Department Store section)	→ JR East Building Co., Ltd.	

*1: Renamed JR Tokyo-West EKIBIRU Development Co., Ltd.; *2: Renamed atre Co., Ltd.

A3-56

Shopping Centers – Outline –

* As of April 1, 2011

■Total number of operating companies : 25 Total number of buildings : 139

Lumine Shinjuku
(Lumine Co., Ltd.)

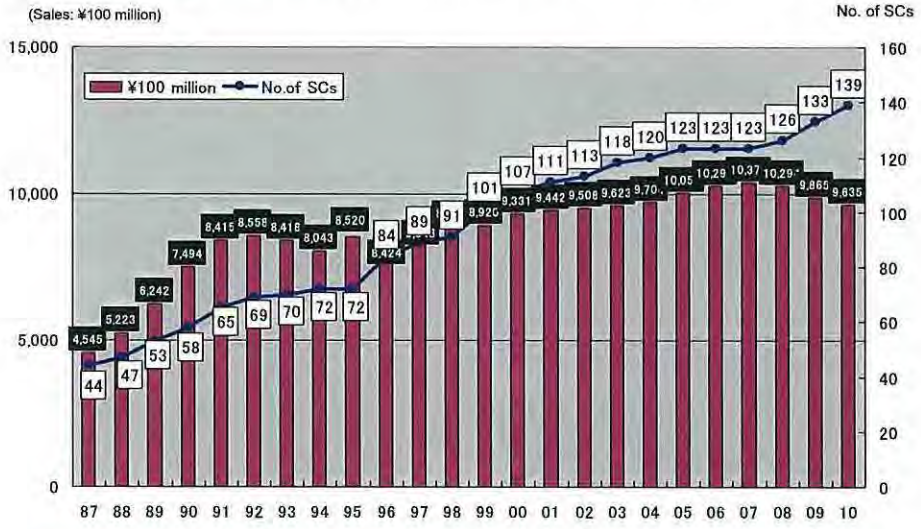
atré Ebisu
(atre Co., Ltd)

S-Pal Sendai
(Sendai Terminal Building Co., Ltd.)

GRANDUO Tachikawa
(JR East Department Store Co., Ltd.)

14

Shopping Centers (Time-series sales and no. of outlets)



Since the formation of the company, the number of shopping centers and the amount of sales have expanded by approximately 2.8. and 2.3 times respectively

16

Out line of Office Services

JR East Shinagawa East Building

■ **Vision: Terminal Station Specialized Developer**

We will establish the position of Terminal Station Specialized Developer to further promote large-scale developments at Tokyo, Shinjuku, Shinagawa and other terminal stations and strengthen our presence in designated areas.

■ **Current**

(1) No. of office buildings: 20

(2) Total floor space for lease: Approx. 220,000 ㎡ (as of March 2011)

(3) Major office buildings

Building name	Nearest Station	Opening date	Area for lease	Operating company
GranTokyo South Tower	Tokyo	Oct.2007	49,418㎡	JR East Building Co.,Ltd
GranTokyo North Tower		Oct.2007	15,314㎡	
Sapia Tower		Mar.2007	31,689㎡	
Tokyo Building		Oct.2005	13,182㎡	
JR East Shinagawa East Building	Shinagawa	Mar.2004	27,996㎡	
JR Tokyu Meguro Building	Meguro	Apr.2002	10,404㎡	
JR Ebisu Building	Ebisu	Oct.1997	16,333㎡	
Metropolitan Plaza	Ikebukuro	Jun.1992	20,408㎡	
Head Office	Shinjuku	Sept.1997	11,953㎡	JRE Tokyo Branch Office

Tokyo building

■ **Business operation system**

2005.7 JR East Building Co.,Ltd established

2005.11 Most Group office businesses split and absorbed into the JR East Building Co.,Ltd

2007.3 Sapia Tower Opened.

2007.10 GranTokyo South and North Tower completed

2010.4 Shopping Center operating business is transferred from Ikebukuro Terminal Building Co., Ltd. to JR East Building Co.,Ltd

GranTokyo North Tower/South Tower

		GranTokyo South Tower	GranRoof	GranTokyo North Tower	
				2nd phase	1st phase
Main use		Offices, retail outlets, etc.	Railway marketing facilities, retail outlets, pedestrian deck, etc.	Department store, etc.	Offices and department store, etc.
Floors		42 floors above ground	4 floors above ground	13 floors above ground	43 floors above ground
		4 floors below ground	3 floors below ground	3 floors below ground	4 floors below ground
Total floor area		Approx. 140,000㎡	Approx. 212,000㎡		
Area for lease	Offices	Approx. 79,700㎡	–	-	Approx. 65,500㎡
	Retail Outlets	Approx. 800㎡	Approx. 1,700㎡	Approx.13,700㎡	Approx. 50,900㎡

A3-57

Office Buildings Business – Opening Schedule –

●JR South Shinjuku Bldg. (provisional name)

To open: Summer 2012

Yoyogi 2-chome, Shibuya-ku (JR Tokyo General Hospital site)

Floor space: Approx. 36,000m² (Offices)

●JP Tower (provisional name)

To open: Spring 2012

Marunouchi 2-chome,Chiyoda-ku (Tokyo Central Post Office site)

Floor space: Approx. 131,600 m² (Offices)

● Kanda Manseibashi Bldg.(provisional name)

To open: Dec. 2012

Kanda Sudacho 1-chome, Chiyoda-ku (Transportation Museum site)

Floor space: Approx. 23,000m² (Offices)

● JR Otsuka Station South Exit Bldg. (provisional name)

To open: Autumn 2013

Minami Otsuka 3-chome, Toshima-ku

Floor space: Approx. 7,400 m² (Offices)

Hotels — Outline —

■ **Total number of rooms in JR East hotel group**

Name of the hotel chain	No. of hotels	No. of rooms
Metropolitan Chain	10	3,036
Hotel Mets Chain	21	2,325
Familio & Folkloro	9	272
Seaside Hotel Shiba Yayoi	1	155
Hotel Dream Gate Maihama	1	80
Hotel New Grand	1	251
Total	43	6,119

* Number of hotels and rooms as of April 2011 (including Mets Tabata)
* Not including the number of rooms of partner facilities
  Partner facilities: Liza Woody Lodge, Schönes-Heim Kaneyama, Crawford Inn Onuma, Hachimantai Resort Hotel

Metropolitan Hotels

HOTEL METS

ファミリーオ

フォルクローロ

HOTEL DREAM GATE

シーサイドホテル 芝弥生

HOTEL NEW GRAND

Hotels — Main business formats —

■ Hotel Metropolitan Chain (10 hotels, 3,036 rooms)

Metropolitan Hotels

- Large-scale city hotels in the Tokyo Metropolitan area and at Shinkansen stops
- Near from the stations
- Easy access to business or sightseeing trip

Hotel Metropolitan Sendai

Hotel Metropolitan (Ikebukuro)

Hotel Metropolitan Marunouchi (in Sapia Tower)

Hotels — Main business formats —

ファミリーオ Familio　フォルクローロ Folklore

■ Familio & Folklore (9 hotels, 272 rooms)

Directly operated by JR East with the aim of achieving local community revitalization through the synergy of railway networks and life-style services business.

Familio Tateyama

"Familio":
Hotels enveloped in the great nature to provide travelers with relaxation and comfort

Familio Niiharu
Familio Tateyama
Familio Sado-Aikawa
Familio Tsugaike

"Folklore":
Hotels located near regional railway stations or the area surrounding stations for active travelers

Folklore Tono
Folklore Kakunodate
Folklore Takahata
Folklore Iwate Towa
Folklore Ominato

Folklore Iwate Towa

Familio Sado-Aikawa

Hotels — Main Business Formats

HOTEL METS

■Hotel Mets Chain (21 hotels, 2,325 rooms)

Attained high quality interiors at reasonable prices by controlling development costs and providing ample accommodation functions

Hotel Mets Shibuya

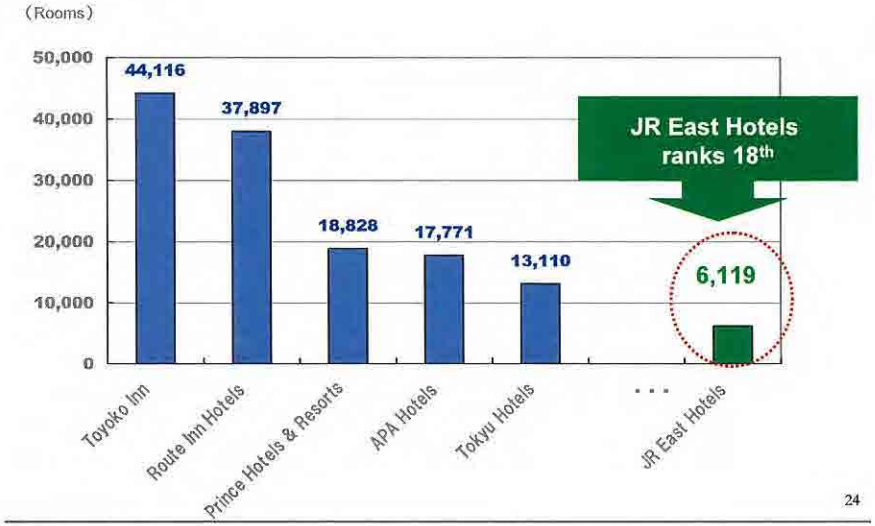
Hotel Mets Mizonokuchi
Hotel Mets Kamakaura-Ofuna
Hotel Mets Tsudanuma
Hotel Mets Mito
Hotel Mets Tachikawa
Hotel Mets Komagome
Hotel Mets Yokohama-Tsurumi
Hotel Mets Tabata (under FC contract with JRF Hotel)

Hotel Mets Hachinohe

Hotels — Outline —

■ Number of Hotel Rooms Ranking

Number of Hotel Rooms Ranking



Advertising and Publishing

■Management of present methods of advertising

Posters in stations and railcars, ,signboards, railcar body advertisements, Train Channel (video advertising inside trains), etc.

■Development of new methods utilizing advanced technologies

J. AD Vision, Station Channel (video advertising in station yards

■ Advertising business

Publication business includes consumer information magazine *Orange Page* (twice monthly)

J. AD Vision (Shinagawa Station)

Train Channel

(Yamanote line, Chuo line, Keihin-Tohoku line)

Orange Page

Digital Signage

- **Digital signage is strengthening as a new advertising media and is expected to double its market by 2015.**
- **JR East offers J. AD Vision, Train Channel, and Station Channel advertising opportunities and is working on the expansion of installment sites and improved content.**

~Digital signage market scale~

- **The overall digital signage market was valued at ¥55.7 billion in 2009. Of this, advertisements and related content accounted for approximately ¥10 billion.**
- **The overall market value is estimated to rise to ¥95 billion by 2013, of which advertisements will account for approximately ¥22 billion.**
- **By 2015, the latest estimates show an overall value of ¥128 billion, of which advertisements will account for ¥40 billion.**

Sports and leisure business

Operation of 12 "Jexer" fitness clubs by taking maximum advantage of superior locations adjacent to railway stations to further improve service programs.

Operation of 15 "RelaXe" relaxation spots within Group SCs, and health support businesses

Jexer Musashikoganei (Musashi-Koganei Station Build.)

Jexer Ikebukuro (Hotel Metropolitan)

Jexer Toda-Koen

Jexer Kamata (GRANDUO Kamata)

Jexer Higashi-Kanagawa (CIAL PLAT)

Jexer Yotsuya

Jexer Oimachi (atré Oimachi)

Jexer Omiya

Jexer Kawaguchi

Jexer Akabane

Jexer Ueno

Winter resort business (Ski)

GALA YUZAWA winter resort is directly connected with Shinkansen station and provides a new concept of making a day trip for skiing from the Tokyo metropolitan area.
With its popular snowboard park and adjacent SPA "Gala no yu" (baths), the resort attracts many people up to early spring.

GALA YUZAWA winter resort
Open: December 1990 Surface area: 292 ha (Skiing ground: 54 ha)
16 skiing course 11 lifts Annual number of visitors: 193,000 (FY2008 results)

CHEERS Restaurant

IRORI Lounge

Location Service Business & Property Licensing Business

- **Location service business**
  This business offers stations, trains and other railway assets as locations for movie, TV and advertising filming
- **Property licensing business (including character business)**
  This business collects royalties from third parties (manufacturers, etc.) who commercialize model figures and toys using intellectual properties owned by JR East and make profits

Location service filming scene

Property licensed products

Character business licensed products

Suica Penguin goods store (Tokyo Station Yaesu south exit)

Support for "JEF United Ichihara Chiba"

Operation of Japan-League football club "JEF United Ichihara Chiba", co-supported by Furukawa Electric Co. Ltd., with the aims of contributing to developing sports culture, interchange with local communities through holding matches and schools, and ticket sales at station counters and promotion of usage of railways.

"JEF United Ichihara Chiba"
Name of company: JEF UNITED CORPORATION
Home town: Ichihara and Chiba cities in Chiba Prefecture
Home stadium: Fukuda Denshi Arena (8 min. walk from Soga Station)
Main achievements: Yamazaki Nabisco Cup Champions (2005 and 2006)

Fukuda Denshi Arena

JEF UNITED Park

Decorations at Soga station

Housing development and sales

Operations of housing development and marketing as part of area development along railway lines linked with railway businesses.
Properties in View Forest Kitsuregawa, a housing area with a hot spring, and View Verger Annaka-Haruna, a resort-style residential town located in beautiful nature with good access of about one hour from Tokyo Station by Nagano Shinkansen, are now on sale.

View Verger Annaka-Haruna
(Annaka city, Gunma pref.)

View Forest Kitsuregawa
(Sakura city, Tochigi pref.)

15th December 2011

Railway Technical Research Institute (RTRI)

- High Speed Shinkansen- Bolsterless Bogie, Improving Running Performance and Riding Confort
- Noise Problem of High-speed Train in Japan : Development of Noise Reduction Technology
- Recent Technologies of Train Control Systems in Japan
- Track Technology for High Speed Line in Japanese Railways

High Speed Shinkansen

Bolsterless Bogie
Improving Running Performance
and Riding Comfort

Okamoto Isao

Technical Adviser
Railway Technical Research Institute, Japan

History of maximum speed of Shinkansen

(1) Maximum revenue service speed

- 1964～ 210km/h inauguration of Tokaido Shinkansen
  Series 0 "Hikari"
- 1986～ 220km/h Series 0, 100 Tokaido Shinkansen
- 1985～ 240km/h Series 200 Tohoku Shinkansen

(1987 breakup and privatization of Japanese National Railways)

- 1992～ 270km/h Series 300 "Nozomi" Tokaido Shinkansen
- 1997～ 300km/h Series 500 "Nozomi" Sanyo Shinkansen
- 2011～ 300km/h Series E5 "Hayabusa" Tohoku Shinkansen
- (2013～ 320km/h Tohoku Shinkansen)

(2) Maximum test speed

- 1996 443km/h Series 300X Tokaido Shinkansen

Shinkansen Trains

Maximum revenue service speed of Shinkansen

Development of High-Speed Shinkansen Bogies

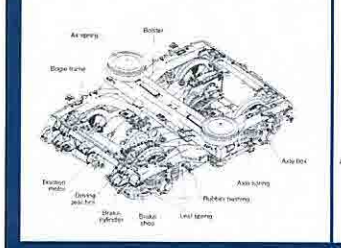
Conventional Shinkansen Bogie
(1964～1992 Series 0, 100, 200)

Bolsterless Shinkansen Bogie
(1992～ Series 300 and later)

	Conventional Shinkansen Bogie for Series 100	Bolsterless Shinkansen Bogie for Series 700
Bogie weight	9,860 kg	6,660 kg
Unsprung mass	4,630 kg	3,420 kg

Comparison Conventional and Bolsterless Bogie

(Conventional Shinkansen Bogie) (Bolsterless Shinkansen Bogie)



Design Concept for Bolsterless Shinkansen Bogie

(1)To attain a good balance between increased high-speed running stability and improved performance in negotiating curves to reduce lateral force,

①Select optimum lateral and longitudinal stiffness of the axle box suspension between wheelset and bogie frame by newly developed analytical method.

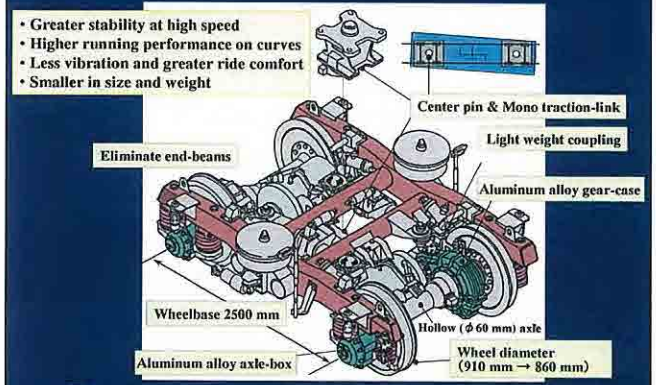
② Lighten a bogie weight, especially unsprung mass by adopting,

- Simplified shape (Bolsterless, End-beamless) bogie frame made of high-strength steel sheet 8 mm thick
- Aluminum alloy gear-case and axle-box
- Hollow axle and 860 mm diameter wheel
- Caliper-type brake gear and monobloc brake disc
- Asynchronous induction motor

(2)To improve riding comfot, adopt newly designed primary and secondary suspension

Bolsterless Shinkansen Bogie

- Greater stability at high speed
- Higher running performance on curves
- Less vibration and greater ride comfort
- Smaller in size and weight



Comparison Concentrated & Distributed traction system

■ Locomotive hauled train (Concentrated traction system)

TGV (France)
ICE (Germany)

- No slip
- Lower axle load
- Lower center of gravity
- Utilization of floor area
- Regenerative brake

Powered Axle
Converter/Inverter
Transformer

■ Electric Multiple-Unit train (Distributed traction system)
(e.g., Series 700)

Shinkansen (Japan)
AGV (France)
ICE3 (Germany)

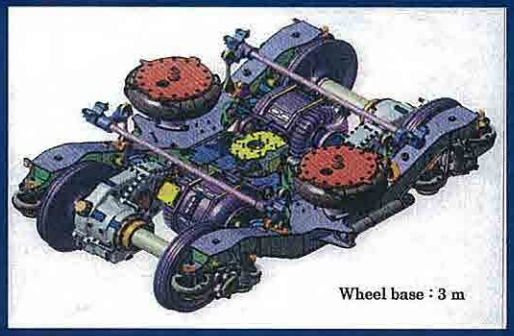
By distributing traction devices, EMU attained high-speed, lightweight, environmental friendliness, etc.

Railway Technical Research Institute

ICE3 Bogie (Siemens Germany)

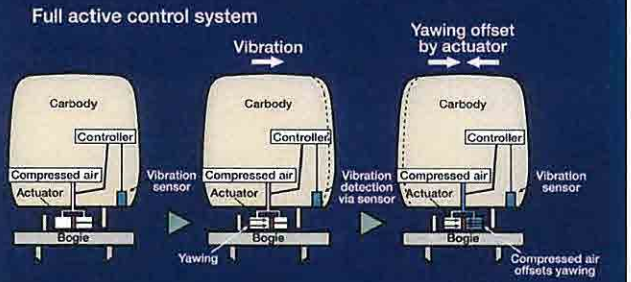
Railway Technical Research Institute

AGV Bogie (Alsthom France)



Railway Technical Research Institute

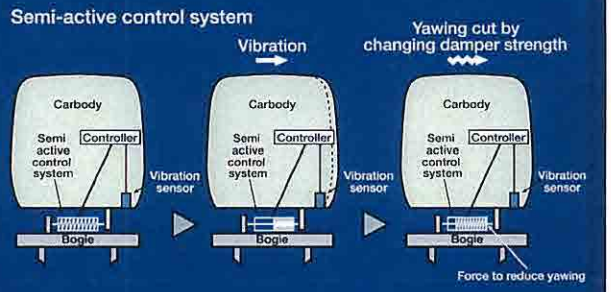
Full active control system improving riding comfort



for Series 500, E2, E3, E5, E6

Railway Technical Research Institute

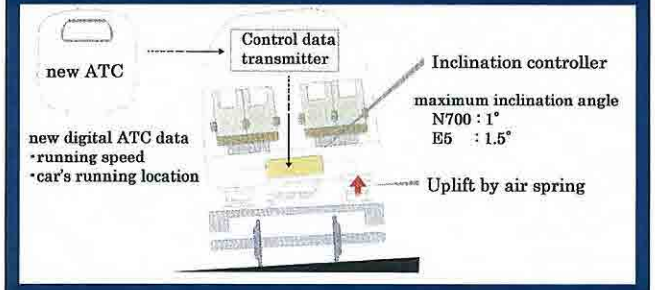
Semi-active control system
improving riding comfort



for Series 500, 700, N700, 800, E2, E3

Railway Technical Research Institute

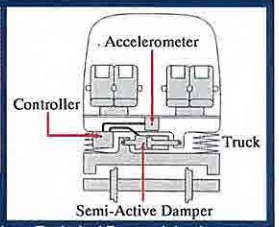
Shinkansen car body inclination control system
improving curving performance & riding comfort



Railway Technical Research Institute

Semi-Active Suspension

- Power sources not required
- Safety against abnormal working
- Simple mechanism
- Lower cost than "active type"
- Practically-used system installed in Shinkansen vehicles



for Series 500, 700, N700, 800, E2, E3

Railway Technical Research Institute

High-Speed Rolling Stock Test Plant

Maximum test speed : 500 km h^{-1}

Railway Technical Research Institute

Brake Testing Machine

Maximum test speed : 500 km h^{-1}

Railway Technical Research Institute

Ride Comfort Simulator

Motion system and simulated passenger cab

Passenger cab (Interior)

Railway Technical Research Institute

Thank You !

Railway Technical Research Institute

Noise Problem of High-speed Train in Japan:
-Development of Noise Reduction Technology-

Kiyoshi NAGAKURA
Railway Technical Research Institute, Japan
Environmental Engineering Division
Noise Analysis Group

Introduction

Network of Shinkansen lines in Japan

Contents

- Introduction
- Environmental quality standards for Shinkansen railway noise
- Survey of Shinkansen railway noise
- Countermeasures against noise sources of Shinkansen train
- Conclusion

Shinkansen Trains (Tokaido and Sanyo)

Shinkansen Trains (Tohoku and Joetsu)


Series 200, 240km/h, 1982


Series E2, 275km/h, 1997


Series E1, 240km/h, 1994


Series E5, 300km/h, 2011


Series E4, 240km/h, 1997

Railway Technical Research Institute

Environmental quality standards for Shinkansen railway noise

(the Environment Agency 1975)

Category of area	Standard value
I	$L_{pA,Smax}$ 70 dB or less
II	$L_{pA,Smax}$ 75 dB or less

Category I : the area for mainly residential use,

Category II : other areas, including commercial and industrial areas, where normal living conditions should be preserved.

Railway Technical Research Institute

A3-68

- **Environmental quality standards for Shinkansen railway noise**

Railway Technical Research Institute

Temporary 75dB countermeasures

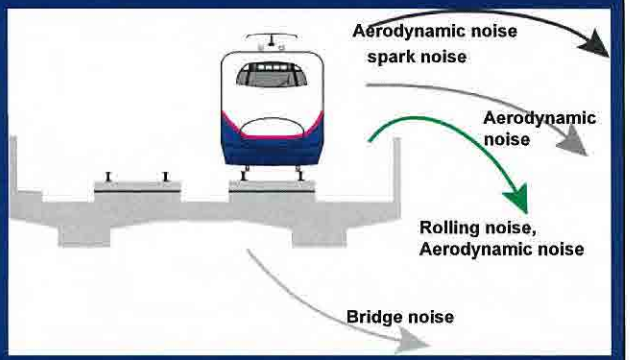
(the Environment Agency, since 1985)

Phase	Period	Target areas for 75 dB countermeasures	
		Tokaido and Sanyo Shinkansen lines	Tohoku and Joetsu Shinkansen lines
1	1985 -1994	Areas with highly dense houses continuously	Areas with highly dense houses, Areas with dense houses
2	1992 -1996	Areas with dense houses	Areas with nearly dense houses
3	1998 -2002	Areas with nearly dense houses	Areas with dense houses except those with sparse houses

Railway Technical Research Institute

Temporary 75dB countermeasures and state of Shinkansen noise

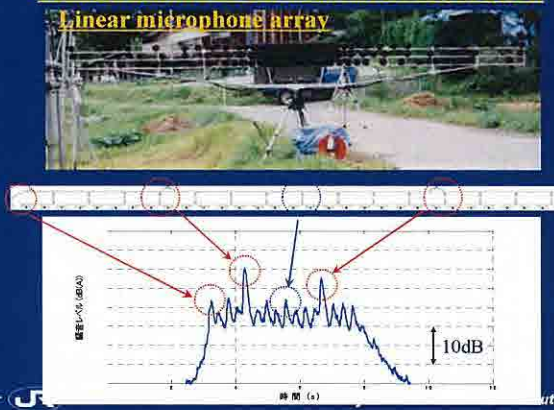
After the third temporary 75dB countermeasures, the peak noise level $L_{pA,Smax}$ is less than 75dB at all measured points in target areas in Tokaido, Sanyo, Tohoku and Joetsu Shinkansen lines.



- Survey of Shinkansen railway noise

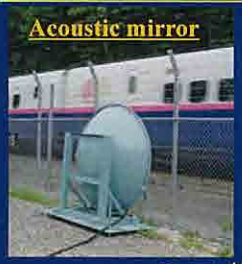
Measurement of noise source distribution

Linear microphone array

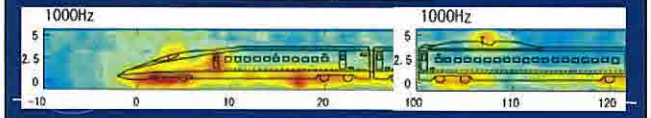


Measurement of noise source distribution

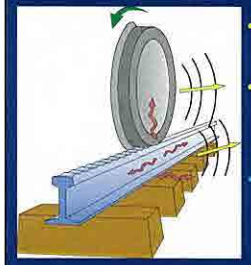
Acoustic mirror



40dB



Rolling Noise from Wheels and Rail



- Smoothing of wheel tread surface
- Smoothing of rail tread surface
  Grinding of rail from 5 to 6dB
- Damped wheels nearly 1dB

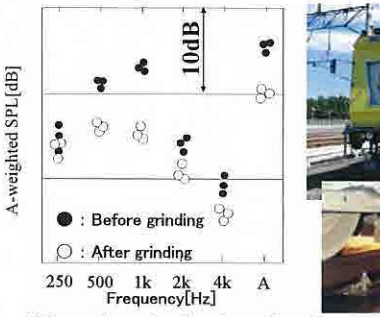
Railway Technical Research Institute

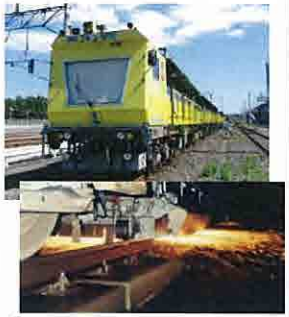
- Countermeasures against noise sources of Shinkansen train

Railway Technical Research Institute

Rolling Noise from Wheels and Rail

Grinding of rail





SPL at the point 2m from the rail

Railway Technical Research Institute

A3-70

Noise from Concrete Bridge Structures

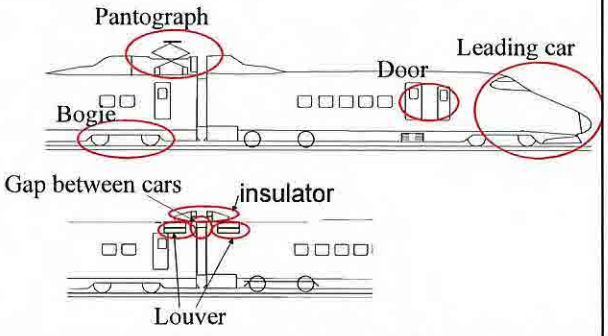
Countermeasures by reduction of external forces

- **Smoothing of wheel tread surface**
- **Smoothing of rail tread surface**
  Grinding of rail **nearly 5dB(A)**
- **Reduction of train weight**

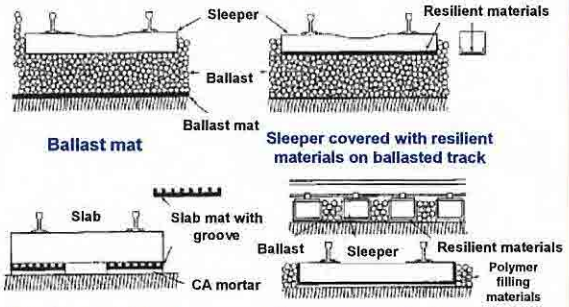
$\triangle L_N = 20\log_{10}(W_1/W_0)$

W_1 : Reduced weight, W_0 : Non-reduced weight

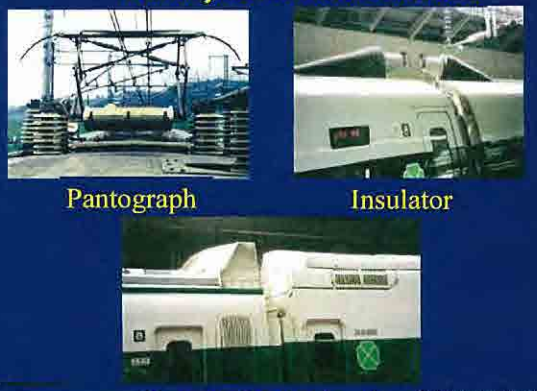
Aerodynamic noise sources

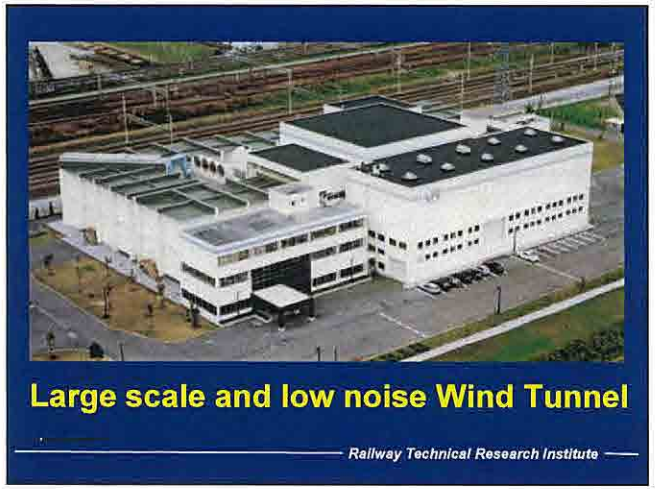


Countermeasures by insulation of vibration

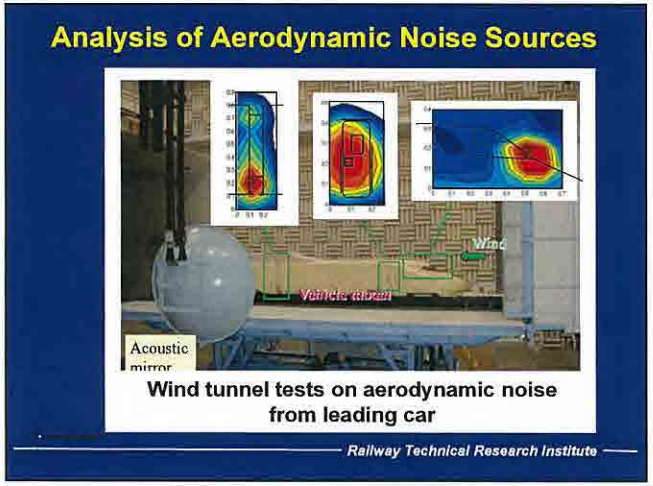


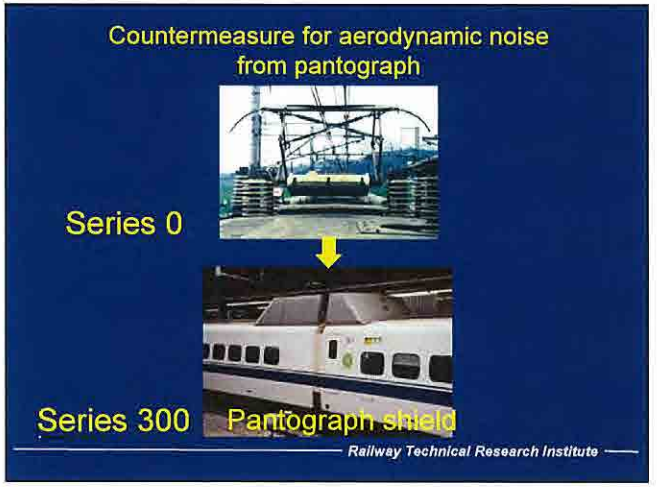
Aerodynamic noise sources




Large scale and low noise Wind Tunnel
Railway Technical Research Institute


Countermeasures for Aerodynamic Noise
Series 100
Smoothing
car surface
Series 700
Series 200
Series N700
Railway Technical Research Institute


Analysis of Aerodynamic Noise Sources
Wind
Vehicle model
Acoustic
Wind tunnel tests on aerodynamic noise
from leading car
Railway Technical Research Institute


Countermeasure for aerodynamic noise
from pantograph
Series 0
Series 300
Pantograph shield
Railway Technical Research Institute

Development of low noise pantograph

Series 500

Series E2

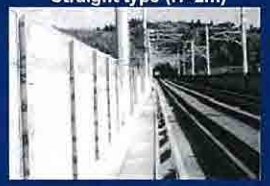
Series 700

Series 0

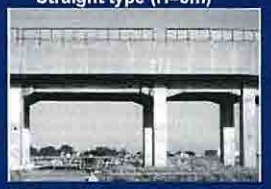
Railway Technical Research Institute

Sound barrier

Straight type (H=2m)



Straight type (H=3m)

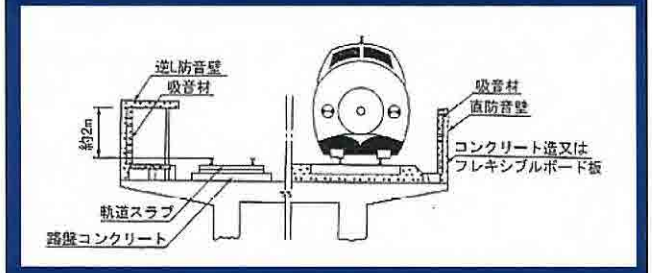


Inversed-L type

Sound absorbing material

Railway Technical Research Institute

Sound Barrier



Railway Technical Research Institute

Utilization of land plan

Presented by Central Japan Railway Company

Transition of land utilization along wayside

- Countermeasures by utilization of land plan are not powerfully promoted.

Railway Technical Research Institute

Conclusion

A number of countermeasures against Shinkansen noise: bridge structure noise, rolling noise, spark noise and aerodynamic noise have been developed since Tokaido Shinkansen line was opened in 1964.

At present, the peak noise level can be kept less than 75dB specified in areas of category II in all Shinkansen lines.

Successive efforts are needed to achieve 70dB specified in areas of category I.

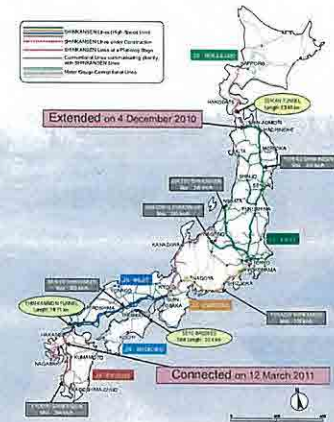
Recent Technologies of Train Control Systems in Japan

Ikuo WATANABE

Director
Research & Developent Promotion Division
Railway Technical Research Institute

Recent technologies of train control systems in Japan

- Safety and Reliability
- System development
  - Traffic control
  - Interlocking
  - Automatic train protection
  - Train detection
  - Train radio



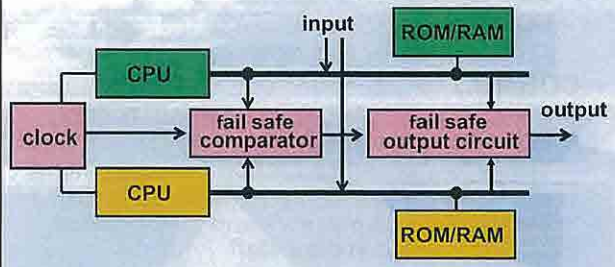
Safety and Reliability

Safety technologies
- Redundancy
  (2 out of 3 CPUs, dual CPUs)
- Error detection
- Safety-fixed output

High reliability technologies
- Redundancy
  (dual CPUs)×2, 2 out of 3(dual CPUs)

Safety technology

- dual computer architecture -



Railway Technical Research Institute

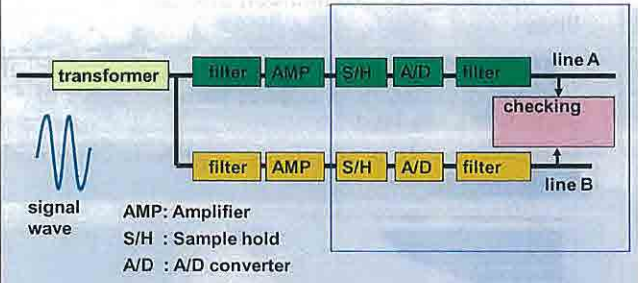
Traffic control systems

- Integrated traffic control systems has been developed
  - COMTRACK
  - COSMOS
- COSMOS
  - transportation plan, traffic control, facility management, rolling stock management
  - Temporary speed restriction from dispatcher
  - Maintenance procedures are directly carried out between dispatchers and maintenance worker without station staff

Railway Technical Research Institute

Safety technology

- analogue input circuit -



Railway Technical Research Institute

Electronic interlocking

- More than 1000 electronic interlocking systems are operating on Shinkansen and convention lines
- Improvement of microcomputer's performance
- Various architectures coping with the scale of station are realized
- Improvement of productivity, maintainability and facile installation.
  - CAD system generating interlocking table

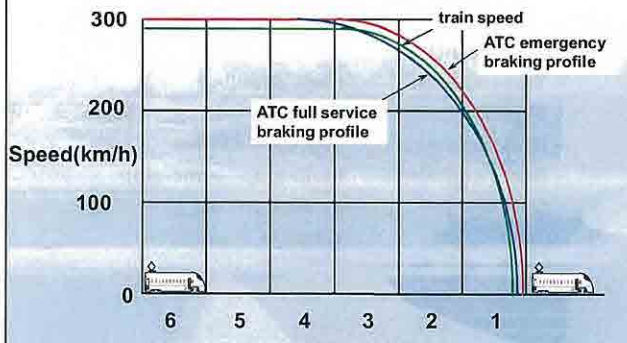
Railway Technical Research Institute

Automatic train protection

- ATC (cab signal, continuous transmission using track circuit)
  - Transmitting: track circuits
  - Signal : speed → distance to go
  - Data transmission: analog → digital
  - Brake control: multi-step → one-step
  - Data and process for train control: wayside → on-board

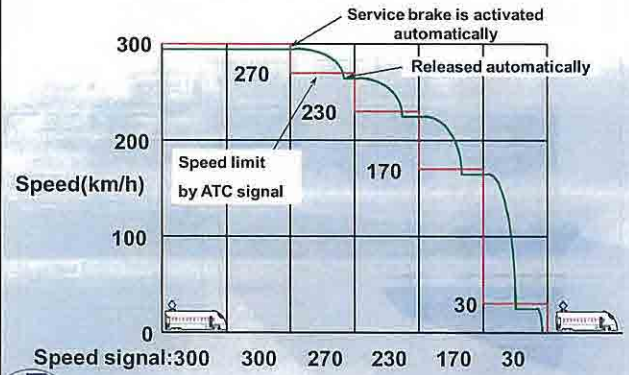
Railway Technical Research Institute

Digital ATC

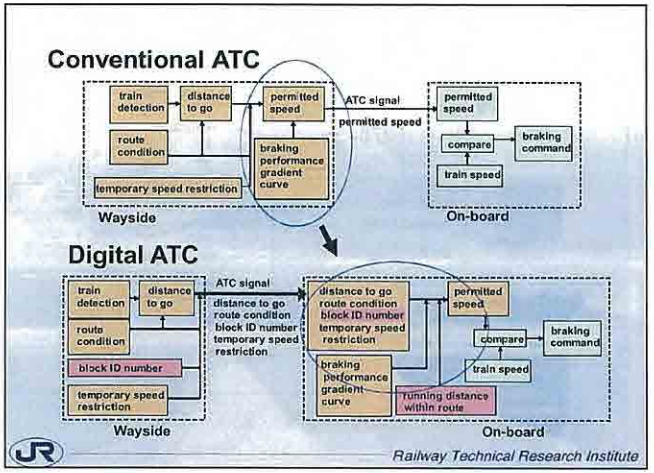


Railway Technical Research Institute

Conventional ATC



Railway Technical Research Institute



Railway Technical Research Institute

Train detection

- Track circuits are widely used
  - prevention of shunting malfunction
  - EMC (electromagnetic compatibility)

Train radio

- LCXs (Leaky Coaxial cables), instead of space-wave radio, are used for stable communication
- Digital transmission systems are introduced
- Specification

frequency:	400MHz band
service area:	more than 99.99%
bit error rate:	less than 10^{-4}

- Information such as emergency information, character news are transmitted to trains

Conclusion

- Various requirements
  - Train headway, Train speed
  - RAMS
  - Cost
  - Convenience
  - Environment-compatibility
- Technical circumstances
  - Power supply frequencies
  - Radio frequency bands

Progressive information technologies and network technologies should be utilized