

## Digest of the Analyses of Railway Accidents

### For the prevention of derailment accident "Points of management of the track maintenance"

1. Preface .....	1
2. Status of occurrence of the accident .....	2
3. Sample of the accident investigation, five cases .....	4
4. Summary of the Opinion expressed from the JTSTB to the Minister of the MLIT .....	9
5. Sample of the measures for the prevention of the accidents .....	11
6. Summary .....	16

#### 1. Preface

The railway accidents, hereinafter including the tramway accidents, which became to the subject of the investigation by the JTSTB and the former Aircraft and Railway Accident Investigation Commission, were total 273 accidents in 16 years from 2002 to 2017, among these, the derailment accidents were 190 accidents which was about 70 % of the entire accidents. Refer to Table 1.

When viewed from the number of accidents for each category of the accident, the derailment accidents were the dominant in every year except for 2016, and occupied above half of the accidents occurred in each year in 12 years among the above 16 years.

The derailment accident with fatalities of passenger had not been occurred after 2006, but the prevention of derailment accident was selected as the theme of this digest, based on the situation that the derailment accident which might cause severe damages to persons has still been happened continuously.

Particularly, this digest introduces the trends of the occurrence of the accident, examples of the accidents to be referred, examples of the actions to prevent the accident, etc., in order to be referred widely particularly in the railway operators.

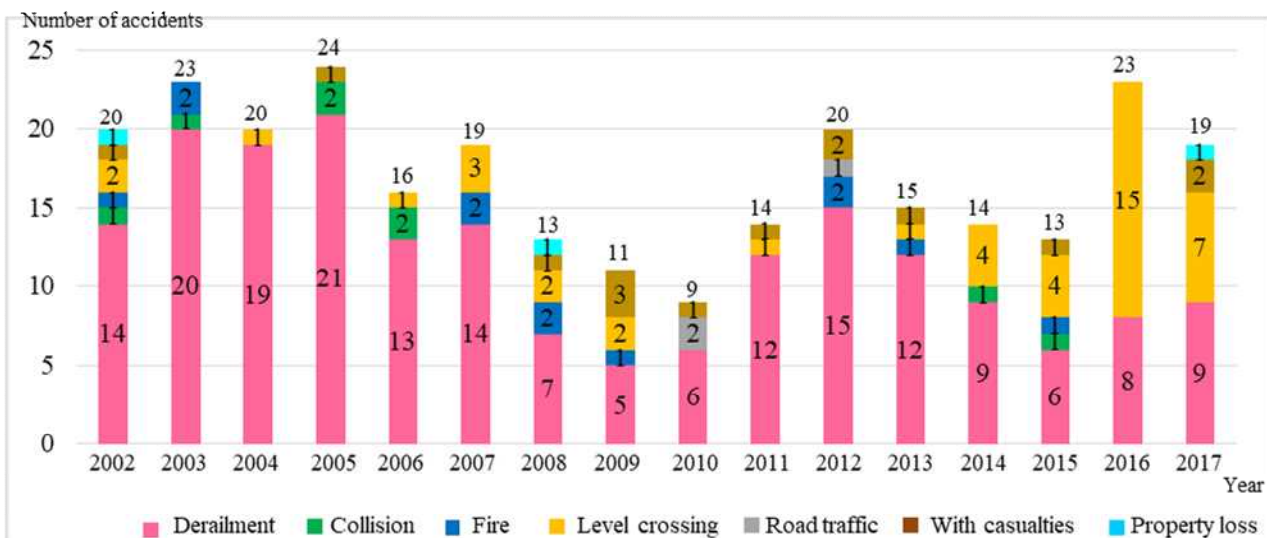


Figure 1. Number of the occurred railway accidents in each category

\* Accidents occurred from January 2002 to December 2017 and became the subject to be investigated by the board were counted. The Aircraft and Railway Accidents Investigation Commission had established in October 2001.

\* The derailment accident of the snowplow vehicle in the snow removing work was extracted from the subject to be investigated, and the accident with fatalities in the Class three and Class four level crossings, where the crossing gate was not equipped, were added to the subject of the investigation, after April 2014.

## 2. Occurred status of the accidents

### Occurred status of the accidents

Two third of the derailment accidents were caused by the level crossing or the natural disaster, etc. However, among the other accidents caused by the maintenance and the handling by the railway operators, ratio of the accidents caused by the maintained status of the ground facilities such as the tracks, was large, in addition, the ratio of the local railway operator\* was high.

\* Local railway operator is the medium and small-scale private railway company, and the third sector operator who succeeded the designated local railways of the former Japan National Railway, and the conventional lines parallel to the projected Shinkansen lines.

The probable causes of the 190 derailment accidents, occurred in the past 16 years, were classified based on the accident investigation reports.

The "level crossing accident" such as the collision with automobile which had entered the level crossing, and the "natural disaster" such as the vehicle ran over the earth and sand flown from the collapsed slope in the track side, were 125 accidents, 66 %, *i.e.*, the two thirds.

In addition, 65 derailment accidents, 34 %, were caused by "maintained status of the ground facilities such as the track" and "handling operation" of the railway operators.

These 65 derailment accidents caused by railway operator were classified as follows.

- Track : 33 accidents, 51 %, related to maintained status of ground facilities such as track.
- Works in the track : Three accidents, 5 %, related to the construction works in the track.
- Vehicles : Seven accidents, 11 %, related to the maintained status of vehicles.
- Operation : 14 accidents, 22 %, related to the handling operation.
- Loading/unloading works : Two accidents, 3 %, related to the handling of loading and unloading works.
- Conflicting : Six accidents, 9 %, were caused by conflicting plural factors in worse direction.

It was cleared that 33 accidents, 51 %, caused by the track were the dominant. Refer to Table 2.

From the view point of railway operators, 68 accidents, 36 %, occurred in the local railway operators among total 190 accident subjected to the investigation. In contrast, 27 accidents, 82 %, in the 33 derailment accidents caused by the track, occurred in the local railway operators. Refer to Table 2.

Table 1. Occurred status of derailment accident, changes per year

	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	Total
Total railway accident to be investigated	20	23	20	24	16	19	13	11	9	14	20	15	14	13	23	19	273
Derailment accident	14	20	19	21	13	14	7	5	6	12	15	12	9	6	8	9	190
Ditto, caused by track	2	2	2	1	2	3	4	1	0	1	3	3	1	2	3	3	33
Ditto, in local railway operator	2	2	2	0	2	3	2	1	0	0	2	2	1	2	3	3	27

Table 2. Occurred status of derailment accident, classified by the category

	Caused by maintenance and handling of railway operators							The other causes					Gross	
	Track	Works in track	Vehicle	Operation	Load/unload works	Conflicting	Total	Level crossing	Against road traffic	Traffic accident	Natural disaster	Total		
Derailment accident	33	3	7	14	2	6	65	48	5	4	68	125	190	<= Ratio in gross <= Ratio in category
	51%	5%	11%	22%	3%	9%	-	38%	4%	3%	54%	-		
Derailment accident in local railway operator	27	0	1	8	1	0	37	16	5	0	10	31	68	<= Ratio in gross <= Ratio of local operators
	82%	0%	14%	57%	50%	0%	57%	33%	100%	0%	15%	25%	36%	

\* "Accident against road traffic" is the accident that the tramway collides with the automobiles, etc., on the road except for level crossing.

\* "Traffic accident" is the accident caused by that the train collided with automobile or the freight of automobile fallen in the railway track, by the effects of the accident of automobiles, etc., except for the level crossing accident and the accident against road traffic.

The 27 derailment accidents caused by the railway track, occurred in local railway operators, were classified in detail as follows. Refer to Table 3.

- 10 accidents were caused by the gauge widening.
- One accident was caused by the rail broken.
- 12 accidents were caused by the track irregularities and the incomplete switching of turnout.
- Four accidents were caused by the track irregularities, etc., except for that described in the above.

Particularly, four accidents among 10 accidents, caused by the gauge widening, occurred in the period from October 2016 to May 2017. Refer to Figure 2.

Table 3. Precise classification of the derailment accident caused by the railway track

Classification of causes of the track	Gauge widening	Rail broken	Turnout	Others	Total
Accidents caused by railway track	11	1	14	7	33
Among the above, occurred in local railway operator	10	1	12	4	27
	91 %	100 %	86 %	57 %	82 %

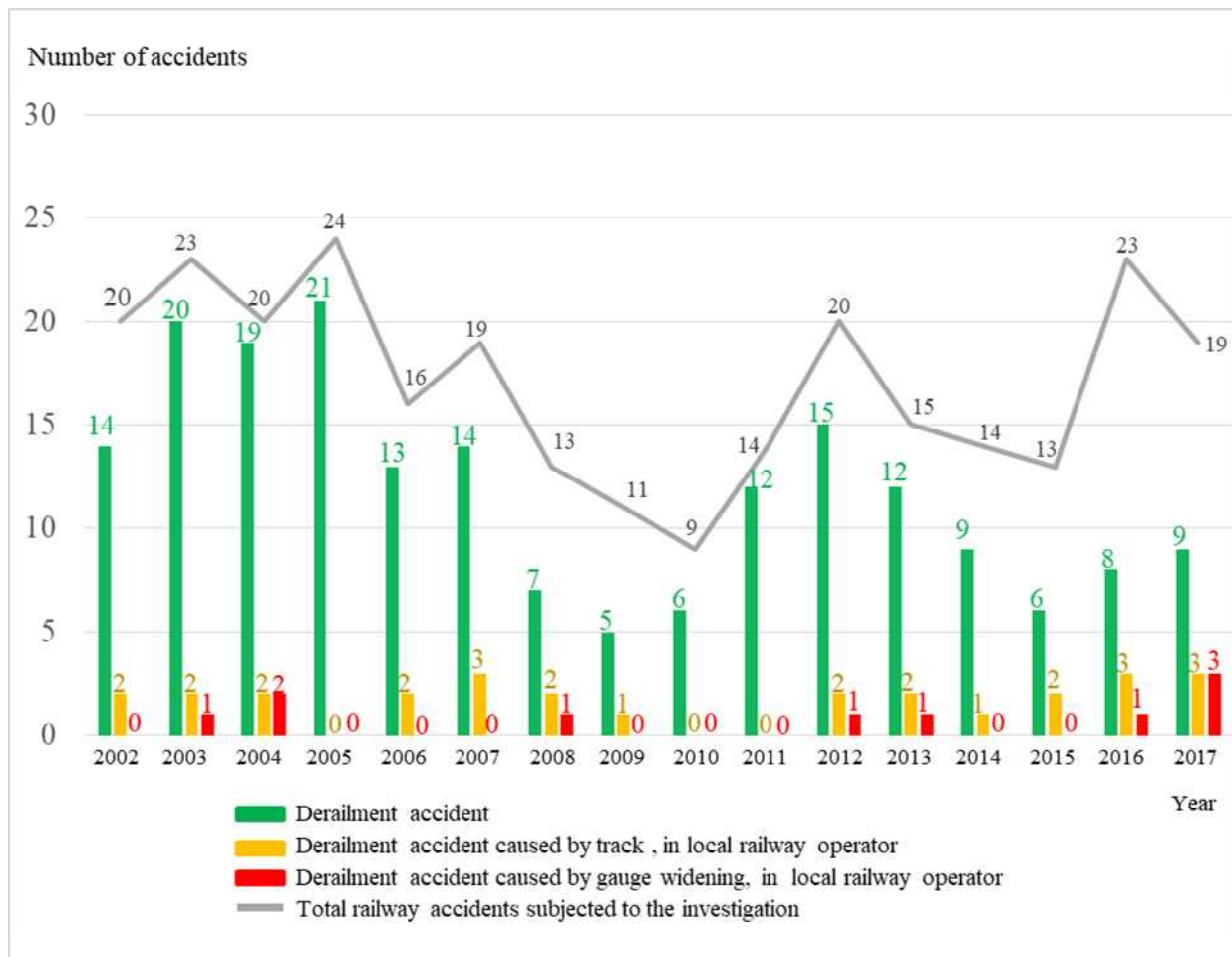


Figure 2. Changes of number of the derailment accidents.

Status of local railway operators in entire derailment accidents caused by the railway track.

### 3. Examples of the accident investigation

Case 1, Gauge widening

Occurred at about 21:26, Wednesday, February 22, 2017

Train derailed by the rail tilting, etc., due to the continuous defects of the rail fastening devices

**Summary :** At about 21:26, the driver of the outbound train composed of two vehicles, just after departed from A station, and operating in around B level crossing at the velocity of about 20 km/h, felt a shock, and applied the emergency brake to stop the train.

All axles in the front bogie of the first vehicle derailed to right when the train stopped. It was cleared that all axles in the rear bogie of the first vehicle once derailed to right and restored to the track, by the investigation after the accident occurred.

There were about 50 passengers and the driver were boarded on the train, but no one was injured.

#### Process to the occurrence of the accident

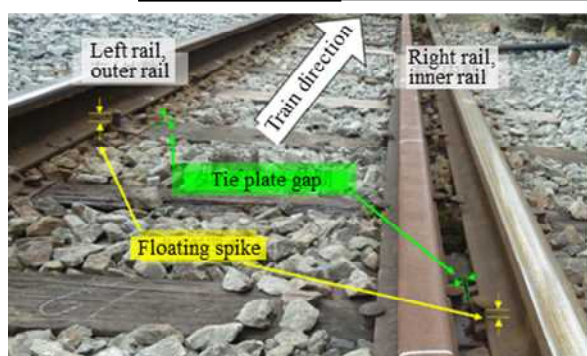
Insufficient comprehension on the danger of dynamic gauge widening by the continuous defects of rail fastening devices.

Slack in relatively large curve.

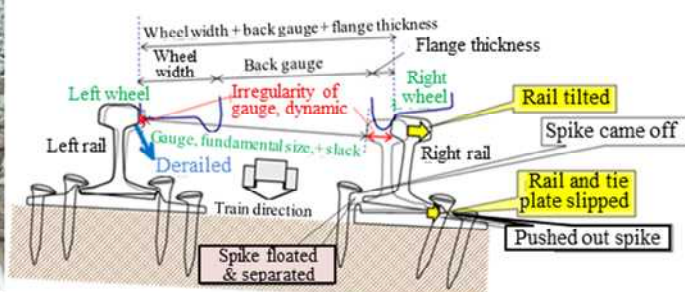
Dynamic gauge widened large due to rail tilting, etc., by the lateral force while train was running.

Decreased margin against derailment to inside gauge.

At about 21:26 Outer rail side wheel fell to inside gauge and the train derailed.



#### Supposed running status when derailed in this accident



**Probable causes :** It is probable that the train, while passing through the 200 m radius right curve, left wheels on the front and the rear bogies fell to inside gauge due to largely widened gauge, the front bogie derailed to right although the rear bogie restored by the guard rail, in the first vehicle.

As for that the gauge had widened largely, it is likely that the gauge had widened dynamically due to the rail tilting, etc., caused by the lateral force when train was running, because the defects of rail fastening devices had been continued in the curved track, and related by that the margin against derailment to inside gauge had been decreased due to relatively large slack in the curved track.

#### For the prevention of recurrence

##### Required Safety Action

(1) Certain implementation of the track maintenance

- Check the corrosion of sleepers and the loosened spikes, etc.
- Implement re-hammering or additional hammering of spikes, replacement of sleepers or the installation of the gauge tie, *i.e.*, metal to hold the gauge, etc.
- Establish the system that can implement the above two items certainly.
- Maintain in high priority when defects of sleepers, etc., continued or existed in steep curve with large slack.
- Pay attention to the inner rail side same as for the outer rail side in the management of sleepers and rail fastening devices in the curved section.

(2) Change of material of sleepers

- Replace to the concrete sleepers, etc., which is superior in the durability and easiness of maintenance compared to the wooden sleepers.

(3) Study to shorten slack

- In order to increase margin against derailment to inside gauge, study in line with the improvement of the track, and shorten in the possible range.

##### Measures taken by the operator after the accident

(1) Change of material of sleepers in around the accident site, etc.

- Changed to the concrete sleepers and replaced the ballast as the measure to improve the drainage.

(2) Additional hammering of spikes

- The number of spikes fastening the outer rail was increased from one to two, in the place of wooden sleepers in the curves of the radius less than 250 m.

(3) Thoroughgoing of the inspection of sleepers

- Educated the staffs to pay thoroughly attention to the status of drainage in the inspection of sleepers, etc.

The investigation report of this case is published in the home page of the JTSB, published on January 25, 2018,

<http://www.mlit.go.jp/jtsb/railway/rep-acc/RA2018-1-6.pdf>



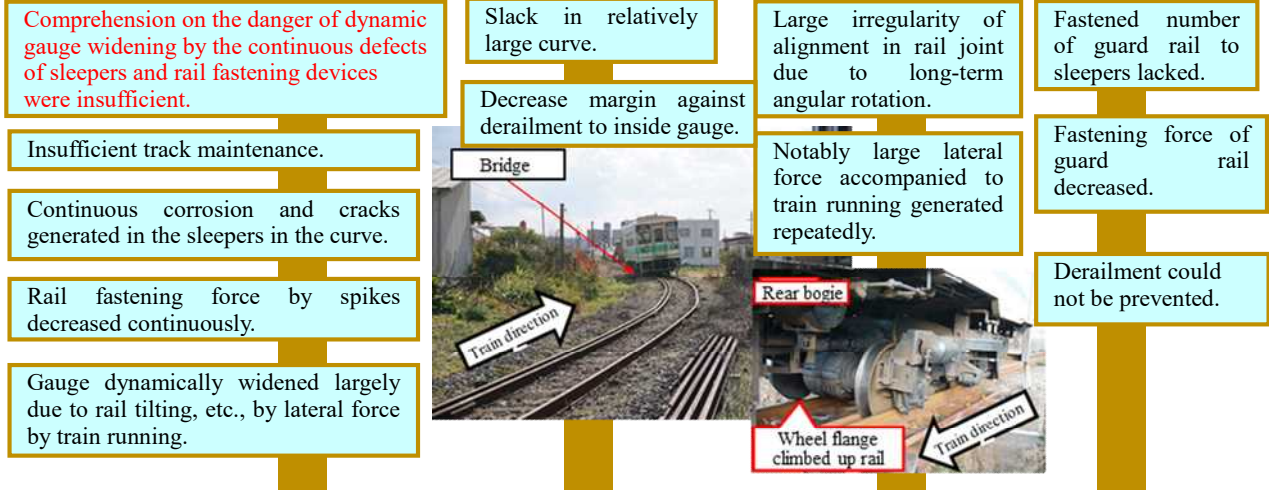
## Train derailed by the rail tilting, etc., due to the continuous defects of the sleepers, etc.

**Summary :** The outbound train composed of one vehicle departed from A station at about 10:58.

The driver of the train noticed abnormal sounds from under floor several times when proceeded about 500 m from A station, therefore, applied the emergency brake to stop the train. The driver detained and checked the situation and found that all axles in the rear bogie of the train had been derailed to right.

There were five passengers and the driver were boarded on the train but no one was injured.

## Process to the occurrence of the accident



At about 11:00 Inner rail side wheel fell to inside gauge and the train derailed

**Probable causes :** It is probable that left wheels in the first and the second axles in the rear bogie derailed to inside gauge, right side of the left rail, *i.e.*, inner rail, because the gauge had widened largely while the train was passing the 160 m radius left curve, in this accident.

There was the possibility that the gauge widened dynamically by the rail tilting, etc., due to lateral force accompanied to the train running, because the rail fastening force by the spikes had been decreased by the effects of the continuous collision and cracks generated in the sleepers in the curve.

It is likely that the rail fastening force had decreased by corrosions and cracks generated in the sleepers continuously, related by that the company had not been comprehended the danger to cause derailment accident by the dynamically widened gauge due to the continuous defects of sleepers and rail fastening devices, in the inspection for track materials, etc., and the track maintenance responded these situations had not been implemented promptly.

## For the prevention of recurrence

**Required Safety Action :** The following measures were added to the measures described in Case 1.

- (1) Review the maintenance standard values
  - Establish the handling when exceeded the maintenance standard value, and to take measures certainly according to it.
  - The maintenance standard value of the gauge shall be increased or decreased corresponding to the slack.
- (2) Proper installation of guard rail, etc.
  - The guard angle shall be installed properly by using tie plate for the section where installed the guard rail, etc.
  - Or study the replacement to the guard angle considering the easiness of the maintenance.
- (3) Inspection of guard rail, etc., and measures when noticed the traces
  - Add the existence of contacted trace with wheel in guard rail, etc., as requiring care item in the periodic inspection, etc.
  - When the trace was found, confirm the existence of abnormality and take measures if there is abnormality.

**Measures taken by the operator after the accident**

- (1) Replacement of sleepers and realignment of track
  - Replaced 100 wooden sleepers and spikes to new ones in the section included the accident site, enforced track by supplied ballasts and tamping, realignment of track.
- (2) Review of the slack
  - Changed the slack in the accident curve from 25 to 20 mm, and managed the irregularities based on the new slack.
- (3) Enforced the management system of the track
  - Hired the retired staffs from the major railway company experienced in the track maintenance, and implemented education from these company staffs to the other company staffs, on the track maintenance.
- (4) Replacement to the guard angle
  - Replaced the guard rail already installed in the accident curve to the guard angle.
- (5) Used the concrete sleepers
  - Replaced to concrete sleeper every one of two wooden sleepers, in the curves scheduled to be maintained next to the accident curve.

The investigation report of this case is published in the home page of the JTSB, published on January 25, 2018, <http://www.mlit.go.jp/jtsb/railway/rep-acc/RA2018-1-2.pdf>

## Train derailed by the folded and damaged rail

**Summary :** The inbound train composed of one vehicle departed from A station on schedule at 19:23.

After that, the driver of the train, while operating in the coasting operation between A station and B station at the velocity of about 50 km/h, noticed abnormal sounds and severe vibration in the tunnel, therefore, immediately applied the emergency brake to stop the train. After the train had stopped, the driver derailed and checked the surroundings of the train and found that all two axles in the rear bogie had been derailed to left. There were two passengers and the driver were boarded on the train, the driver was injured in this accident.

## Process to the occurrence of the accident

The status that cross-section of rail had been decreased remarkably by corrosion could not noticed.

Missed to find crack in the rail.

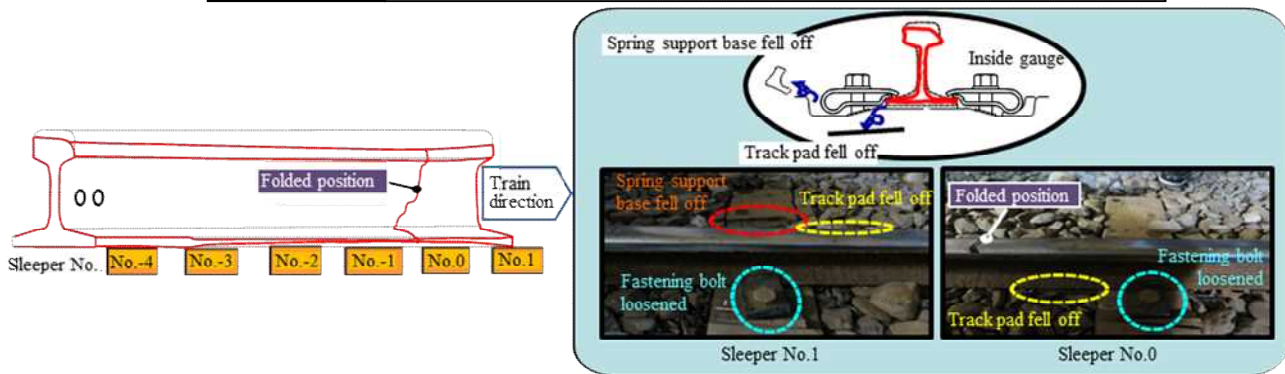
Missed to find continuous looseness of rail fastening bolt and removed track pads, in the track where relatively large irregularity of cross level had been existed.

Lateral force in outer rail generated in the curve increased by the existence of relatively large irregularity of alignment.

Rail, outer rail, was folded and damaged.

Derailment coefficient increased due to decrease of outer rail side wheel load and increase of lateral force.

At about 19:25 Outer rail side wheel ran over the rail and the train derailed.



**Probable causes :** It is likely that left wheel in the third axle in the rear bogie of the train ran over the rail and derailed, because the wheel load decreased significantly and the derailment coefficient had increased while the train was running in the circular curved section in the tunnel, based on the followings.

- (1) The outer rail side lateral force which is generated steadily in the curved track, increased further due to the existence of relatively large irregularity of alignment.
- (2) The loosed fastening bolts of the rail fastening devices and the falling off track pads had been existed continuously, in the track where relatively large irregularity of cross level to promote to decrease wheel load had been existed.
- (3) The left rail, the outer rail, had been folded and damaged when the rear bogie of the train passed.

## For the prevention of recurrence

**Required Safety Action :**

- (1) On the measures for the folded and damaged rail
  - On the places of leaking water from tunnel, manage properly as to concentrate to confirm the corroded status of rail, including the replacement of rails according to the necessity. It is effective to suppress leak of water from tunnel, and to introduce rust proof treatment which apply antiseptic to rails.
  - Conduct systematic replacement of rails when the corrosion of rails had been deteriorated.
  - Replace rail as soon as possible when deterioration of corrosion of rail was in danger. When replacement was difficult, watch carefully the change of the rail by on-foot patrol and reinforce the rail according to the necessity.
- (2) Implementation of the careful track inspection.
  - Implement careful inspection so as not to overlook continuous looseness of the rail fastening devices and the falling off track pads.

**Measures taken by the operator after the accident**

- (1) Replacement of the decrepit rails in the tunnel section.
  - Total 25 rails in five tunnels were judged to be replaced in the status inspection including the rail bottom, and completed to replace all designated rails.
- (2) Certain implementation of track inspection in the tunnel section.
  - Adopted bolt cap with white one line and paint of fitting mark with a marker, in order to find looseness of bolts visually and easily.
- (3) Measures against folded and damaged rails in the tunnel sections.
  - Newly installed the point to measure the corroded status of rails in the place of water leakage in tunnel section, and implemented the status check of rails by the on-foot patrol, etc.
- (4) Measures against the folded and damaged rails in the open section.
  - Reinforced the rails which the flaw was found on the rail head, according to the necessity.
- (5) Implemented education and training.
  - Planned the standardization of inspection method and improvement of the inspection accuracy, by increased chances of practical education and training, referring the cases of the past accidents and the measures taken in the other companies, etc.

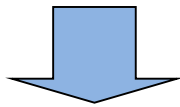
The investigation report of this case is published in the home page of the JTSB, published on February 23, 2017, <http://www.mlit.go.jp/jtsb/railway/rep-acci/RA2017-1-1.pdf>

## Train running in the turnout entered the route different to the designated direction and derailed

**Summary :** The outbound train composed of two vehicles departed from A station on schedule at 17:29. The driver of the train confirmed the speed restriction signal of the outbound home signal of B station, while the train was running at around No.11 turnout in the premises of B station at the velocity of about 20 km/h, and felt abnormal sound and applied the brake. But the driver further felt large sound and vibration, and the train had stopped. The driver confirmed the situation after the train had stopped, and found that all axles in the front bogie of the first vehicle had been derailed to right, and all two axles in the rear bogie of the first vehicle and all axles of the second vehicle had been entered the up main line in the branch line side different from the designated direction of travel, i.e., the down main line.

There were 11 passengers, the driver and the conductor were boarded on the train, but no one was injured.

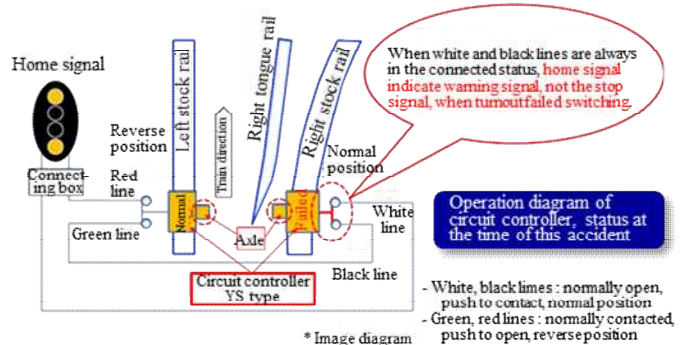
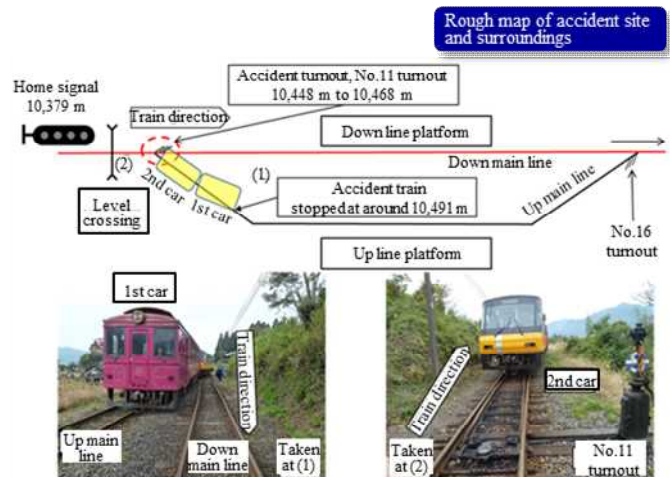
It is likely that the turnout had been in the status of defect of switching, furthermore, it is highly probable that the outbound home signal of B station had not indicated the stop signal, but had been indicated the speed restriction signal, when the train entered the down main line of B station. Therefore, the factors to cause these situations were analyzed.

**(1) Defect of switching of the turnout**

It is likely that the switching load exceeded the switching force of the spring switch, due to the increase of the coefficient of friction between the tongue rail and the floor board, caused by **the lack of lubrication to the floor board in the point part of the turnout.**

**(2) Signal indication of the home signal**

It is highly probable that the home signal did not indicate the stop signal but indicated the speed restriction signal even though the turnout had been in the status of the defect of switching, because **the insufficient contact of the tongue rail could not be detected caused by that the contact point of the micro switch in the circuit control device to detect the defect of switching of the turnout did not switched and in the status as being conducted.**



**Probable causes :** It is probable that right wheel flange of the first axle of the front bogie of the first vehicle went into the space between right stock rail and right tongue rail, and derailed to right, and the rear bogie of the first vehicle and all bogies of the second vehicle had entered to the up main line side different from the designated direction of travel, because right tongue rail of the turnout did not contact to the normal position side and in the status of the defect of switching, when the train entered the straight line side of the turnout obeying to the indication of the speed restriction signal of the home signal, in this accident.

## For the prevention of recurrence

**Required Safety Action :** To comprehend the status that the home signal did not indicate the stop signal but indicated the speed restriction signal even though the circuit control device was in the status as could not detect the defect of contact in the home position side, was the dangerous status with the possibility of derailment, and implement the followings.

- (1) Implement the maintenance and the management of changes by years of the circuit control device, certainly.
- (2) Make reliability higher as not to spoil safety even in case of troubles.

Furthermore, it is desirable to implement lubrication to the floor board in the point part of the turnout, considering the status of rains, etc., in high frequency.

**Measures taken by the operator after the accident**

- (1) Replaced the spring switch of the accident turnout by the new product.
- (2) Decided the limited speed when passed the accident turnout and No.16 turnout in the premises of B station as 15 km/h or slower, and let the train crews known well, and newly installed the speed limit sign.
- (3) Improved the security level of the circuit control device by making dual system in the home position side of the accident turnout and the No.16 turnout, because the exact signal control could not be implemented. Furthermore, replaced the circuit control device by new one.
- (4) Implemented the switching test of the accident turnout once a month, in order to reinforce the confirmation of safety.
- (5) Increased the number of the lubrication for the floor board in the point part of the accident turnout, certainly in the inspection described in the above (4) and when the effects by rainfalls are considered.

The investigation report of this case is published in the home page of the JTSB, published on September 29, 2016, <http://www.mlit.go.jp/jtsb/railway/rep-acci/RA2016-7-1.pdf>



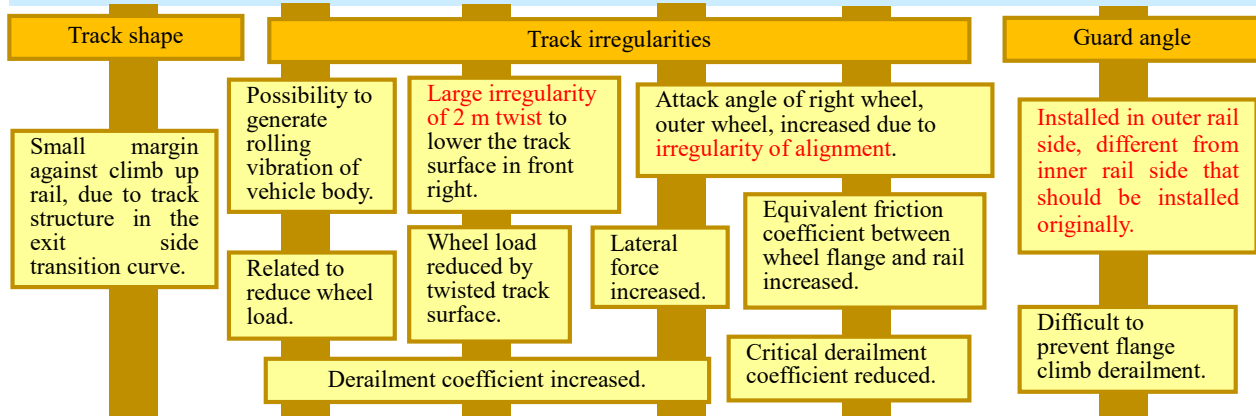
## Train ran over the rail and derailed by the track irregularities in exit side transition curve

**Summary :** The outbound train composed of two vehicles departed from A station on schedule at 11:57, by the one-man operation. The driver of the train, while operating in the powering operation in the 200 m radius left curve at the velocity of about 55 km/h, felt abnormal sounds and vibration in the vehicle, therefore applied the emergency brake to stop the train.

All two axles in the front bogie of the front vehicle had been derailed to right.

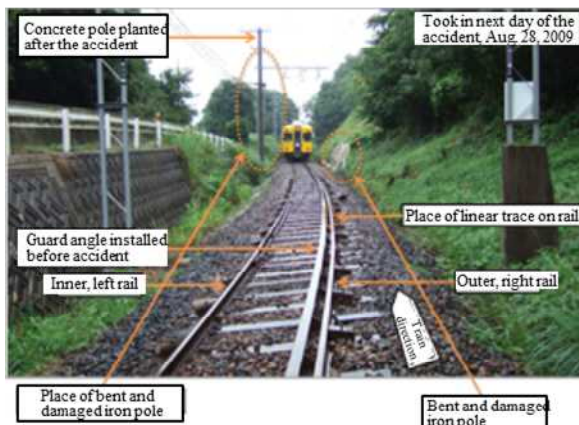
There were 18 passengers and the driver were boarded on the train, among them, three passengers were injured.

## Process to the occurrence of the accident



At about 11:58

**Outer rail side wheel climbed up rail and the train derailed in exit side transition curve**



**Probable causes :** It is probable that right wheel in the first axle in the front bogie of the front vehicle climbed up right rail, outer rail, and derailed to right, because the lateral force had increased and the wheel load had decreased for the right wheel, outer rail side wheel, due to the existence of the irregularity of alignment in the direction to shorten radius of curvature and the irregularity of 2 m twist in the direction to lower front right of the track surface, in the exit side transition curve connected to the 200 m radius curve. In addition, it is highly probable that the derailment could not be prevented because the guard angles had been installed in outer rail side, different from the inner rail side where it should originally be installed.

## For the prevention of recurrence

**Required Safety Action :**

- (1) Guard angle in this accident site
  - It is highly probable that this derailment accident could not be prevented because the guard angles had been installed in the place different from the place where it shall be installed originally.
  - It is necessary to implement the safety measures of the company by using sufficiently the railway accident investigation reports and the security information, etc., and comprehending the purpose of the measures to prevent the recurrence which should be taken after the accident from the examples of the other accidents.
- (2) Method of track management
  - Comprehend the track irregularities from the results of the track inspection, review to enable the proper management of the track irregularities, and should maintain the track in good condition.

**Measures taken by the operator after the accident**

- (1) Installed the guard rail in inner rail side of the accident curve, in addition, installed the guard angles in inner rail side of the curve in eight curved section, with the radius of 200 m or shorter, where the guard angles or the guard rails had been installed only in the outer rail side.
- (2) The company reviewed the track management so as to estimate the track irregularities based on the measured values of the track measurement in the periodic inspection and manage the track irregularities based on the maintenance standard values.

The investigation report of this case is published in the home page of the JTSB, published on August 27, 2010,  
<http://www.mlit.go.jp/jtsb/railway/rep-acci/RA2010-4-1.pdf>



#### 4. Summary of the "Opinion" that the JTSB expressed to the Minister of the MLIT

The Japan Transport Safety Board, the JTSB, can express its opinions to the Minister of Land, Infrastructure, Transport and Tourism, the MLIT, or to the director of the related administrative organization on the measures that should be taken in order to prevent accident, etc., and to reduce damages, pursuant to Article 26 of the Act for Establishment of the Japan Transport Safety Board.

On June 28, 2018, the JTSB stated its opinion to the Minister of the MLIT, on the four train derailment accidents due to the gauge widening occurred in the period from October 2016 to May 2017.

##### **On the opinion to prevent the train derailment accident caused by the gauge widening**

Opinion stated on June 28, 2018

Among the railway accident that the JTSB implemented the investigation, the four train derailment accidents due to gauge widening occurred in the period from October 2016 to May 2017, as follows :

Accident in Ichihashi Line, Seino Railway Co., Ltd., occurred on October 6, 2016

Report RA2017-9-2 was published on December 21, 2017.

Accident in Kishu Railway Line, Kishu Railway Company, occurred on January 22, 2017

Report RA2018-1-2 was published on January 25, 2018.

Accident in Fujisaki Line, Kumamoto Electric Railway Company, occurred on February 22, 2017

Report RA2018-1-6, was published on January 25, 2018.

Accident in Watarase Keikoku Line, Watarase Keikoku Railway Company, occurred on May 22, 2017

Report RA2018-4-1 was published on June 28, 2018.

It is probable that these accidents were caused by the the generation of dynamic gauge widening due to the rail tilting, etc., in the status that the defects of wooden sleepers and rail fastening devices had been existed continuously.

Many factors to cause the gauge widening are commonly existed in the local railway companies, etc., even though there were the factors differed for each accident, therefore, based on the knowledges obtained from the investigation of these accidents, the JTSB summarized the points to be paid attention, from the view point to prevent the similar accidents in the local railway companies as the attached material "On the prevention of train derailment accident due to gauge widening".

Hence, the JTSB expressed its opinions as follows to the Minister of Land, Infrastructure, Transport and Tourism, pursuant to Article 28 of the Act for Establishment of the Japan Transport Safety Board.

When some measures were taken responded to this opinion, the JTSB will appreciate to manage to let us known on these contents.

##### Notes

1. Let well known the railway operators on the contents of the railway accident reports of four train derailment accidents and the "On the prevention of train derailment accident due to gauge widening" attached in this opinion.
2. Considering the actual circumstances that the derailment accidents caused by the defects of sleepers and rail fastening devices occurred in the local railway operators, etc., have to provide the required guidance including the effective use of the existing public subsidy system and the technical support system, etc., in order to promote the measures to prevent gauge widening such as the systematic replacement to the concrete sleepers considering the places in high priority based on the occurred status of the defects or the track shape, etc.

[Attached material]

## On the prevention of train derailment accident due to gauge widening, extract

### Summary

Among the railway accident investigated by the JTSB, four train derailment accident caused by the gauge widening had occurred in the period from October 2016 to May 2017. It is probable that the occurrence of these accidents caused by the generation of dynamic gauge widening by the rail tilting, etc., due to the existence of continuous defects in wooden sleepers and rail fastening devices.

Many factors to cause the gauge widening are commonly existed in the local railway companies, etc., even though there were the factors differed for each accident, therefore, based on the knowledges obtained from the investigation of these accidents, the JTSB summarized the points to be paid attention, from the view point to prevent the similar accidents in the local railway companies, in order to assist to improve safety still more in the future, as follows.

#### 1. On the managing method of the track maintenance

It is necessary to manage sleepers, rail fastening devices and rail flaws, etc., properly by the periodic inspections of tracks and the track patrols, and also it is necessary to implement measures to prevent gauge windings such as the exchange of spikes or the additional hammering of spikes, replacement of sleepers, installation of the gauge ties, *i.e.*, the metal to hold the gauge, etc. It is necessary to pay attention to the continuity of looseness of sleepers and rail fastening devices, and to give priority to steep curve with large slack, and to pay attention for not only for the outer rail side but also for the inner rail side.

The measurement of dynamic track irregularities using the track inspection car is the effective method on the measurement of track irregularities. It is necessary to pay attention for the danger to generate dynamic gauge widening due to tilting of rail, etc., and manage sleepers and rail fastening devices adequately, when implement the management of track irregularities based on the measurement of static track irregularities only.

#### 2. On the managing standard of track maintenance

It is necessary to implement the track maintenance properly according to the status of track irregularities in order to prevent the derailment accident due to gauge widening. Therefore, it is desirable to decide the standard values considering the limit of safety, and to make clear the period of maintenance. Furthermore, it is desirable to decide the handling of the operation control and the track maintenance, etc., when the remarkable track irregularity was detected according to the necessity, in addition to the standard values for track maintenance for the conventional track maintenance, etc.

As for the slack in the curved track, it is desirable to confirm that it is arranged to the proper value corresponded to the running vehicles, and to improve the slack at site together with the track repairing works, etc., when review the present values.

#### 3. On the track structure

It is desirable to implement systematically the replacement to the concrete sleepers, etc., which have superior in durability and easy maintainability compared with wooden sleepers, including the partial replacement to replace in the ratio of one sleeper in several sleepers, considering the places in high priority based on the generated status of defects of sleepers and the track shape, etc.

It is desirable to install the guard angles or the guard rails as possible for the places without effects by the falling stones and the snowfalls, when installed the guard rail, etc., in the curved section, from the point of view preventing the derailment accident. Furthermore, it is necessary to pay attention to the installation method such as the number of fastenings to sleeper, the height difference between rail and guard rail, in the installation of the guard rails and similar facilities.

\* The opinions, full text, is published in the home page of the JTSB,  
[http://www.mlit.go.jp/jtsb/railway/kankokuiken\\_rail.html](http://www.mlit.go.jp/jtsb/railway/kankokuiken_rail.html)

## 5. Examples of measures for the prevention of accident

In order to contribute the prevention of accidents and to improve safety of transportation, the examples of measures such as the technical supports or the technical developments conducted by each corporation and the national support system are introduced in the followings.

### (1) Examples of the technical supports

#### (i) Railway Technical Research Institute, public foundation, RTRI

Railway Technology Promotion Center, RTRI, implemented "Site investigation", "Visiting advice by the rail advisor", "Presentation of literatures and opinion of the laboratory, etc." responding to the technical consultation from the members of railway operators.



Status of "site investigation"

[Summary]

##### - "Site investigation"

The researchers of the RTRI implement the technical diagnosis and advice directly at site for about half day in free of charge.

##### - "Visiting advice by the railway advisor"

The RTRI dispatch the rail advisor, *i.e.*, the expert retired from railway operator, having the deep knowledges and plentiful actual experiences to the site, and implemented advises, etc., also free of charge same as "site investigation".

##### - "Presentation of literatures and opinion of the laboratory"

Send the literatures or integrate opinions of researchers in the RTRI into the text and answer by telephone, facsimile, or E-mail.

[Home page of the RTRI] <http://www.rtri.or.jp/tecce/>

[Phone] Railway Technology Promotion Center, RTRI, 042-573-7236

#### (ii) Japan Railway Construction, Transport and Technology Agency, JRJT

The JRJT have been implemented the support "Railway family doctor" by effectively using the experiences and the knowhow cultivated in the duties of the railway construction and the railway support, for the railway operators and local public organizations supporting the local railways.



Concretely, the JRJT implemented the technical advice and the provision of information such as the introduction of the precedents and provision of references, etc., responding to the consultation on the repairing, the maintenance management, the replacement plan, etc., of railway facilities, and introduced proper construction methods responding the situation based on the investigation of the facilities implemented at site according to the necessity, in free of charge.

[Concrete samples]

- Advise on the inspection method of the aged facilities and the points required attention on the maintenance management.

- Introduction of the construction methods and materials for the repair works.

- Advise on the decision of the construction plans, ordering of the construction works, the supervising of the construction works.

- Introduction of the supporting systems.

[Home page of the JRJT] <https://www.jrjt.go.jp/construction/outline/family-doctor.html>

[Phone] Railway General Support Section, International, General Affairs Dept., JRJT, 045-222-9016

(iii) Japan Railway Civil Engineering Association, JRCEA

The JRCEA hold the "Lecture course on the management of track maintenance" in each district transport bureau, in order to promote succession of technical abilities required to proper track maintenance management, targeted the local railway operators, as one of the supports for local railway operators.

[Home page of the JRCEA] <https://www.jrcea.or.jp/>

[Phone] Planning Dept., JRCEA, 03-5846-5300

(iv) Japan Railway Rolling Stock & Machinery Association, RMA

The RMA hold the "Training course for succession of technologies for the vehicle maintenance in the local railways" in each district transport bureau, together with the Ministry of Land, Infrastructure, Transport and Tourism, and the JR, the major railway operators, in order to secure safety and maintain and continue the technical abilities in the local railways.

[Phone] Vehicle Dept., RMA, 03-3593-5611



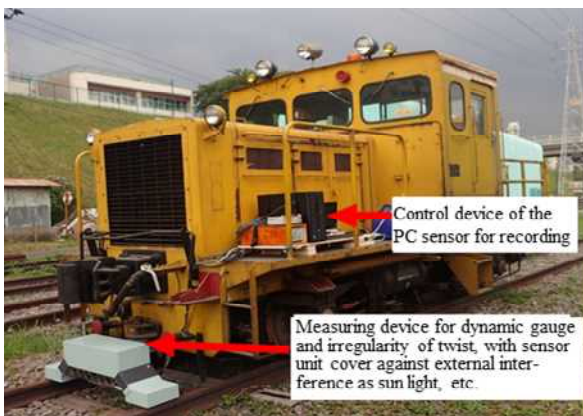
(2) Examples of technology development on the track management

Railway Technical Research Institute, public foundation, RTRI

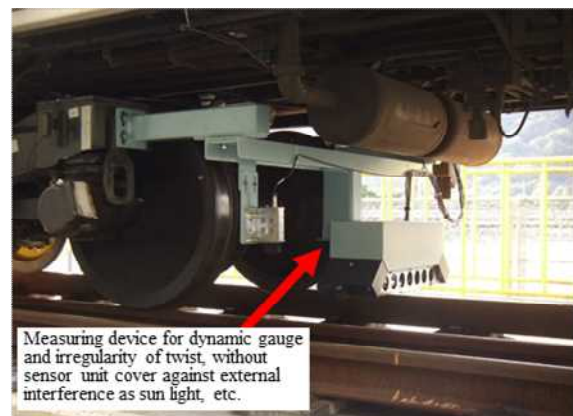
The RTRI is developing measuring devices and software to support as to enable vehicles running in safety on the ballasted track deteriorated by years in the local deserted section, etc.

(i) Measuring device for the dynamic gauge and irregularity of cross level

It is desirable to use the track inspection car for the measurement of the track irregularities, but it is not easy to introduce it due to high cost. Therefore, the RTRI is developing simple measuring device for the gauge and irregularity of cross level, which can be attached to the attachment base of the guard iron of the commercial vehicle or the coupler of the motor car, etc., for the purpose to prevent the derailment to inside gauge and the flange climb derailment.



Mounted to the motor car



Mounted to the commercial vehicle



(ii) The support system to decide the changing plan to PC sleepers

There is the case to replace to the PC sleepers in the curved track section consisted of the wooden sleepers, for the purpose to prevent the derailment to inside gauge. Therefore, the RTRI developed the system to evaluate the priority for individual curve to change to the PC sleepers, and to support decision of the construction plans.

[Phone] Track management Lab., Track Technology Div. RTRI, 042-573-7277



Display indicating the estimated and selected results of the priority and the target curves for the replacement to PC sleepers.



Display indicating the investigated results of the ratio of partially replaced PC sleepers.

Column

Work on the "Project to share technical abilities" of the Tohoku Railway Association

When drawing up this digest, we visited the Tohoku Railway Association who carry out the original works to prevent accident, and interviewed Mr. Misawa, Managing Director, on the outline of the project and the effects of the works.

[Interviewed results to the Tohoku Railway Association]

Total 20 railway operators, i.e., 15 passenger railway operators and five freight railway operators, in six prefectures in Tohoku district and southern Hokkaido, are joining in the Tohoku Railway Association. The environment surrounding the railway business is severe also in Tohoku district, as confronted with various problems such as the reduced railway users due to the reduced track side population and changes to use private cars, and due to the resulting deterioration in management environment, the lacked and aged engineers accompanied to the slim down of employees and reduction of employment, deteriorating facilities and vehicles, etc.



Mr. Misawa, Managing Director, Tohoku Railway Assoc.

Furthermore, two Train collision accidents occurred in short period in a railway operator from 2000 to 2001, responded to this situation, the MLIT asked all railway operators to prepare the "conservation provision plan" and to implement the provision of facilities, etc., based on the "project to review safety urgently" conducted in 2002 to 2003, then as a part of this project, the association held the "training course on conservation provision plan" in 2005, which became to the opportunity to increase the trend to cooperate and solve the common problems in each operators, and started to study on the "project to share technical abilities" which improve the safety by sharing the technical abilities in individual operators commonly.



In-service track maintenance training, Tohoku Railway Assoc.

The project started to hold the joint training and the joint training course, the mutual supply of the grained railway components or the high cost inspecting and measuring devices, trust or entrust of the maintenance such as the wheel turning or the ultrasonic flaw detection of wheel axles, etc., from 2008 FY, and established the "Adviser system on railway technology and safety" which aimed to bring up young engineers and inherit technologies by implemented the guidance and the advice responding to the consultation from each company, by the advisor who was the experienced engineer having high technical abilities, and organized "[1] High level training on railway safety", "[2] Training lessons for new drivers", "[3] In-service track maintenance training", "[4] Seminar to utilize the terrified or startled information" as the yearly project, in 2010 FY. Among these, [2] and [3] are worth to be noticed, because the practical skill training for the purpose to acquire the practical technologies by the guidance of the engineers having the professional skills, was implemented in addition to the lectures, and these joint trainings accompanied with these practical skill training are held continuously in every fiscal years.

The training is the precious chance that the technology can be acquired using the forefront facilities owned by the professional companies in addition to the lectures and the practical skill guidance, and the in-service track maintenance training have been held in the training camp type, obtaining the cooperation of Senken Industry Company who construct the facilities such as station, railway track, bridges, mainly targeted the company staffs engaged in the duty of track maintenance with a little experiences. The flat connections over each companies can be established in the camp type training and this connection generated the merits in various cases when duties are implemented in each company after the training camp, and there are many requests to continue this project as the worthwhile project, to the Association.

After interviewed, we were given the chance to take field trip of "the site practiced the in-service track maintenance training", "house to learn in accidents" and "training facility" of Senken Industry Company.



"House to learn in accidents" Senken Industry Co., Ltd.

The "house to learn in accidents" exhibit the panels of the railway serious accidents occurred in various places in the whole country in

the past and the equipment parts at the time of the accidents, and set up for the purpose to resolute not to cause the similar accidents by studying the background of the accidents, and to possess commonly the importance of the consciousness of safety in individual staffs charged in the work.

We felt the enthusiasm on the safety when we saw these forefront facilities actually by our eyes.



Inside of the "House to learn in accidents", Senken Industry Co., Ltd.

Those who attended to this program such as the in-service track maintenance training said that they became conscious to the developing measures to their duties and to endeavor to prevent accidents voluntarily, by having the broad view in addition to acquire the technologies supporting daily duties. Concretely, the railway operators joined to the Tohoku Railway Association continue the status that the railway accident and railway serious incident, except for the accident originated in the level crossing accident and obstruction in level crossing, that are subjected to the target of the investigation by the JTSB, did not occurred, after 2008.

We expect that these projects do not remain only in a region but develop widely in the whole country, and result to reduce accident and improve safety, etc.

### (3) National subsidy system

**Support for project cost for general safety measures for railway facilities, project to improve safe transport facilities of railway and tramway.**

**Subsidy for project cost to improve, maintain, secure the local public traffics, project to improve safe transport facilities of railway and tramway.**

#### [Outlines]

The support to renew facilities, etc., to contribute improvement of safety conducted by the local railway operators to secure safe railway transportation.

(Operators to be supported) Railway and tramway operators

(Ratio of support) One third of the expense subjected to be supported, etc.

(Facilities to be supported) Rails, sleepers, facility to prevent falling stones, ATS, train radio facility, windbreak facilities, bridges, tunnels, vehicles\*, etc.

\* "Vehicle" is the targeted support facility of the subsidy for project cost to improve, maintain, secure the local public traffics, project to improve safe transport facilities of railway facilities.

[Home page of the MLIT] [http://www.mlit.go.jp/tetudo/tetudo\\_tk5\\_000001.html](http://www.mlit.go.jp/tetudo/tetudo_tk5_000001.html)

[Phone] Planning Div., Railway Dept., Hokkaido District Transport Bureau, 011-290-2731  
Planning Div., Railway Dept., Tohoku District Transport Bureau, 022-791-7526  
Planning Div., Railway Dept., Hokuriku-Shin'etsu District Transport Bureau, 025-285-9153  
Planning Div., Railway Dept., Kanto District Transport Bureau, 045-211-7243  
Planning Div., Railway Dept., Chubu District Transport Bureau, 052-952-8033  
Planning Div., Railway Dept., Kinki District Transport Bureau, 06-6949-6422  
Planning Div., Railway Dept., Chugoku District Transport Bureau, 082-228-8797  
Planning Div., Railway Dept., Shikoku District Transport Bureau, 087-802-6755  
Planning Div., Railway Dept., Kyushu District Transport Bureau, 092-472-4051



## 6. Summary

[The railway accidents occurred from 2002 to 2017, and subjected to the investigation]

- Among total 273 accidents subjected to the investigation, category "derailment accident" was the greatest number 190 accidents, *i.e.*, 70 %.
- Among derailment accidents, 34 % were caused by the maintenance or handling of railway operators.
- The most of the derailment accidents caused by maintenance or handling of railway operators were caused by the maintained status of the ground facilities such as the track, etc., 51 %.
- The derailment accidents caused by the maintained status of ground facilities such as the track occurred in local railway operators in high ratio, 82 %.
- Among the derailment accidents occurred in local railway operators, 10 accidents were caused by the gauge widening, among these, four accidents occurred in the period from October 2016 to May 2017.
- On June 28, 2018, the JTSB issued its opinion to the Minister of MLIT, on the prevention of train derailment accidents due to the gauge widening.

Besides, when we interviewed the Tohoku Railway Association to draw this digest, we also heard on the possibility that the proper maintenance management is affected by the following problems, *i.e.*, the local railway operators were in severe circumstances due to the decrease of the track side population and the decrease of the transport passengers accompanied to the change to use private cars, and the facilities were deteriorating because the positive investment in facilities could not be implemented, and the lacked knowledges in the site accompanied to the difficulty of technology succession such as lacked engineers and aging of engineers due to the reduction of personnel and restrained employment.

There is the risk to cause many casualties once the train derailment occurred in the railway transportation. Therefore, **it is necessary for the railway operators to complete their obligation certainly to keep safety transportation and never cause the accident, by implemented the management of the track maintenance, etc., properly.**

As a help to complete their obligation, the technical support and the technology development implemented in each corporation, and the national subsidy system are introduced in this digest. We hope the effective use of these information by each railway operator according to their judgement.

To edit this digest, we obtained the cooperation from Railway Technical Research Institute, Japan Railway Construction, Transport and Technology Agency, Japan Railway Civil Engineering Association, Japan Railway Rolling Stock & Machinery Association, the Tohoku Railway Association, and other many relevant parties, we express many thanks.

---

### **Comment of the Director of the Analysis, Recommendation and Opinion**

Most infrastructures, not limited in railways, are the system that "the completion of construction is not the conclusion", *i.e.*, the deterioration started from the day of completion, although there is difference in the deteriorated levels. Therefore, it is important to secure safety by the proper maintenance management, etc., and take measures to restrain the occurrence of accidents.

The proper maintenance management, etc., of the facilities is needed for long term as far as the business continues, and then the required technical abilities were not allowed to deteriorate by years. For that purpose, it is considered as important to promote, in cooperation with each railway operator and relevant corporation, etc., the "cooperation to bring up talented people" such as the improvement and the succession of technologies, and the "cooperation in the practical duties" such as the commonly possession of technologies and knowhow, as introduced in this digest, on the measures which became difficult to be taken in each operator alone by the change of the surrounding status.

The opinion on the JTSB digest and the order of the visiting lectures are welcome.

Att.

The Accident Prevention Analyst  
Assistant to Director for Management  
Secretariat

JAPAN TRANSPORT SAFETY BOARD

15th Floor, Yotsuya Tower

1-6-1, Yotsuya, Shinjuku-ku, Tokyo

160-0004, Japan

TEL +81-3-5253-8823 (Ext.54236)

FAX +81-3-5253-1680

URL <http://www.mlit.go.jp/jtsb/index.html>

e-mail : [hqt-jtsb\\_bunseki@gxb.mlit.go.jp](mailto:hqt-jtsb_bunseki@gxb.mlit.go.jp)