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Mr. Keiichi Ishii,
Minister of Land, Infrastructure, Transport and Tourism

Kazuhiro Nakahashi, Chairman,
Japan Transport Safety Board

On the opinion concerned with the prevention of the train derailment accident caused by the gauge widening

The following four train derailment accidents caused by the gauge widening had been occurred in the period between October 2016 and May 2017, among the railway accidents investigated by the Japan Transport Safety Board.

Ichihashi Line, Seino Railway Co., Ltd., occurred on October 6, 2016,
Railway Accident Investigation Report RA2017-9-2, published on December 21, 2017.
Kishu Tetsudo Line, Kishu Railway Co., Ltd., occurred on January 22, 2017,
Railway Accident Investigation Report RA2018-1-2, published on January 25, 2018.
Fujisaki Line, Kumamoto Electric Railway Co., Ltd., occurred on February 22, 2017,
Railway Accident Investigation Report RA2018-1-6, published on January 25, 2018.
Watarase Keikoku Line, Watarase Keikoku Railway Company, occurred on May 22, 2017,
Railway Accident Investigation Report RA2018-4-1, published on June 28, 2018.

It is probable that these accidents occurred by the dynamic gauge widening due to the rail tilting, etc., because the continuous poorness of the wooden sleepers and the rail fastening devices had been existed.

In many cases, the widening gauge is caused by the factors which are common to the local railways, etc., although different factors are found for individual accidents. Therefore, based on the knowledges obtained from the investigation of these accidents, the matters to be paid attention from the point of view of aiming the prevention of the similar accident in the local railways, etc., are arranged as the attached material "on the prevention of the train derailment accident by the widening gauge".

Consequently, the Japan Transport Safety Board expresses 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.

Furthermore, when some measures were taken responding to this opinion, please let us known on their contents.

Notes

1. To let the railway operators known well on the contents of the railway accident investigation reports of the above four railway derailment accidents and the "On the prevention of the train derailment accident by the widening gauge" attached to this opinion.

2. In view of the actual status, that the derailment accidents due to the poor wooden sleepers and the rail fastening devices had occurred, in order to promote the measures to prevent widening gauge such as the systematic replacement to the PC sleepers considering the priority for the places based on the status of the poorness and the track shape, make an effort to conduct the required instructions including the effective use of the existing public subsidy program and the technical support programs.

Attached material

On the prevention of the train derailment accident by the widening gauge

Summary

The following four train derailment accident caused by the gauge widening had been occurred in the period between October 2016 and May 2017, among the railway accidents investigated by the Japan Transport Safety Board. It is probable that these accidents had occurred by the dynamic gauge widening due to the rail tilting, etc., because the continuous poorness of the wooden sleepers and the rail fastening devices had been existed.

In many cases, the widening gauge is caused by the factors which are common to the local railways, etc., although different factors are found for individual accidents. Therefore, based on the knowledges obtained from the investigation of these accidents, the matters to be paid attention from the point of view of aiming the prevention of the similar accident in the local railways, etc., are arranged as follows.

1 On the method of the maintenance management of the track

It is necessary to manage properly such as the sleepers, the rail fastening devices and the rail flawsby the periodic inspection of the track and the track patrol, also it is necessary to implement the measures to prevent the widening gauge such as to exchange or re-drive spikes, exchange sleepers, install the gauge ties, which are the metals to keep the gauge, depending on the status. It is necessary for the implementation of these measures to pay attention to the continuity of the poorness of the sleepers and the rail fastening devices, and give the priority to the steep curve with large slack, and pay attention not only outer rail side but also inner rail side.

As for the measurement of the track irregularities, the measurement of the track irregularities under loaded condition using the track inspection car is effective. When implement the management of the track irregularities only by the measurement of the track irregularities under unloaded condition, it is necessary to implement management of sleepers and rail fastening devices sufficiently as paying attention on the danger to cause the dynamic widening gauge by the tilting of rail, etc.

2. On the standards of the maintenance management of the railway track

It is necessary to implement the track maintenance properly depending on the status of the track irregularities in order to prevent the derailment accident due to the widening gauge. For this purpose, it is desirable to decide the standard values considering the safety limits and clarify the term for maintenance, on the maintenance standards of the track irregularities. Furthermore, it is desirable to determine the handling of the operation control and the track maintenance, etc., when the remarkable track irregularity was detected, depending on the necessity, in addition to determine the standard values for track maintenance for the existing track maintenance.

As for the slack in the curved track, it is desirable to confirm as being set in the proper value responding to the running vehicles, and to improve the slack in the site in the timing of the track repairing works, etc., when reviewed the present value.

3. On the track structures

It is desirable that the replacement, which including the partial exchanges that replace sleepers in the ratio of one sleeper in several sleepers, conducted systematically with the sleepers such as the PC sleepers which are superior in the durability and easy maintenance compared with the wooden sleepers, considering the prior places based on the status of the existence of poor wooden sleepers and the track shape, etc.

Furthermore, it is desirable that the guard angle or the guard rail are installed as possible in the place with no effects by the falling stones and the snow fall, when installed the guard rails, etc., in the curved track, from the point of view of preventing the derailment accident. In addition, it is necessary to pay attention to the method of installation such as the number of the fasteners to the sleeper, the height difference between rail and the guard rail when installed the guard rail, etc.

Preface

The following four train derailment accident caused by the gauge widening had been occurred in the period between October 2016 and May 2017, among the railway accidents investigated by the Japan Transport Safety Board.

Ichihashi Line, Seino Railway Co., Ltd., occurred on October 6, 2016,
Railway Accident Investigation Report RA2017-9-2, published on December 21, 2017.
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Watarase Keikoku Line, Watarase Keikoku Railway Company, occurred on May 22, 2017,
Railway Accident Investigation Report RA2018-4-1, published on June 28, 2018.

It is probable that these accidents occurred by the dynamic widening gauge[*1] due to the rail tilting[*2], etc., as the continuous poorness of the wooden sleepers and the rail fastening devices had been existed.

As the widening gauge is mainly caused by the factors which are common in the local railways, etc., although different factors are found for individual accidents. Therefore, based on the knowledges obtained from the investigation of these accidents, the matters to be paid attention from the view point to aim the prevention of the similar accident in the local railways, etc., are arranged.

Furthermore, it is important for the local railways, etc., to comprehend properly the status of the track and to conduct the improvement of the facilities and the replacement to the PC sleepers from the prior places systematically, considering the urgency responded to the status of the existence of the poor places, in the maintenance management of the railway track. For this purpose, it is considered as effective to make efficient use of the existing public subsidy program and the technical support programs.

*1 *"Widening gauge" is the status that the gauge was widened due to the damages of the rail fastening device by the lateral force, which is the force that the wheel pushes the rail in lateral direction, or the increase of the wear of rail. When the gauge widened in a certain level, one of left and right wheel became to the status as could not be suspended by the rail top, to cause the derailment. Here, in this context, the widening gauge due to the lateral force accompanied with train running is called as the "dynamic widening gauge".*

*2 *"Rail tilting" is the phenomena that the rail tilted by the load affected by the wheel to the rail.*

1. On the method of maintenance management of railway track

(1) Management of sleepers and rail fastening device

It is important to suppress the dynamic widening gauge by the tilting of rail, etc., by managed the sleepers and the rail fastening devices properly, in order to prevent the

accident that the vehicle derailed to inside gauge due to the widening gauge. [Refer to Figure 1]

For the proper management of the dynamic widening gauge, it is necessary to conduct the periodic inspection and record the inspected results on the status of materials and maintenance for the sleepers and the rail fastening devices, and conduct the measures to prevent the widening gauge such as to exchange or re-drive spikes, exchange sleepers, install the gauge ties, which are the metals to keep the gauge, depending on the status.

Furthermore, the confirmation of the status of the sleepers and the rail fastening devices is also implemented in the track patrol. The track patrol is implemented by boarding on the train, by on foot or by the track cycle, etc., however, it is desired to implement the track patrol basically by on foot, which is easier to comprehend the status, in the track section, etc., where there was a fear in the status of wooden sleepers.

In addition, it is necessary to pay attention on the number of the spikes and the driving method, etc., when the tie plates which affect the tilting of rail, etc., are used. The sample of the standard to drive the spikes for the tie plate[*3] was shown in Figure 2, as the reference.

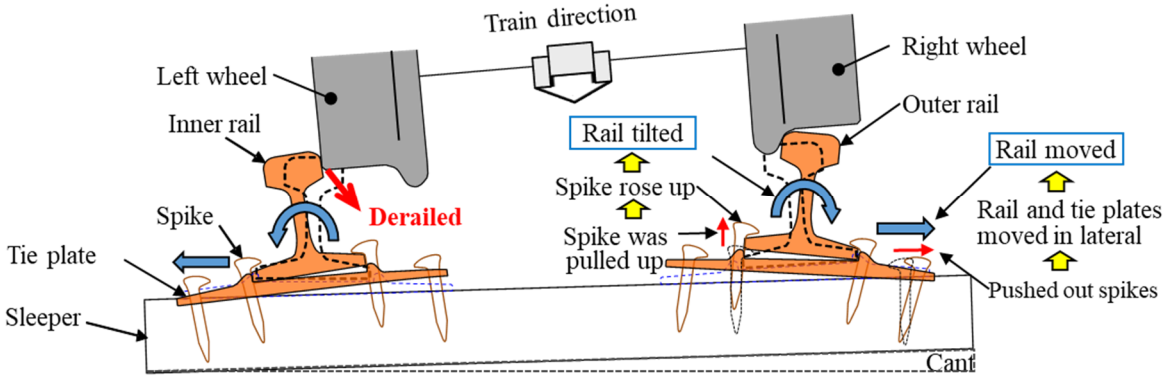
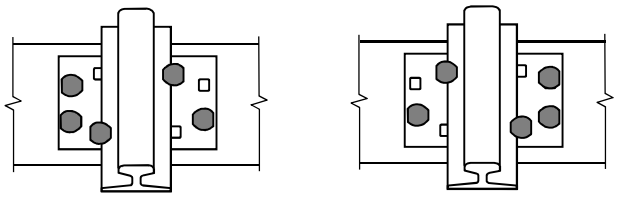


Figure 1. Sample of the derailment to inside gauge due to the widening gauge



B type and E type tie plates, the case for curved track of the radius less than 500 m

Figure 2. Sample of the standard driving spikes for the tie plate

The sleepers and the rail fastening devices are the track materials composed of the parallel system(rail and turnout are the series system), and designed as to allow the deteriorations of the individual materials in a certain range[*4]. Therefore, it is necessary to manage on the poorness of the sleepers and the rail fastening devices as paying particular attention on the continuous existence.

Although the standard of the number of the continuous poorness could not be said unconditionally, as it depends on the velocity of the train and the track shape, however, generally, continuous two sleepers is allowable as the maximum[*5].

Note that for these matters it is necessary to pay attention as to implement the maintenance of the steep curve with large slack, where the dangerousness against the derailment to inside gauge increases particularly, in high priority. In addition, the management of the sleepers and the rail fastening devices in the curved track section are more focused to the outer rail side, where large lateral force is easy to be generated generally. However, it is necessary to manage the inner rail side as paying attention, same as in the outer rail side, because the lateral force in the direction to widen the rail toward outside by the circular curve turning lateral force[*6], etc., is generated.

*3 *"Manual for management of track maintenance", Japan Railway Civil Engineering Association, Incorporated Association, March, 2014, p.115.*

*4 *"Manual of management standard to maintain railway structures, etc.", Railway Technology Research Institute, March 2007, p.154.*

*5 *H. Takai, "Common sense and lack of common sense on track maintenance", October 2009, p.39.*

*6 *"Circular curve turning lateral force" is the lateral force caused as the inner rail side wheel resists by the friction force against the outer side wheel in the front axle in the bogie pushed toward inner rail side, in the bogie running in the curved track.*

(2) Rail flaws[*7]

When the rail flaw generated in the rail corner side, the metal surface layer of the rail top deforms and becomes to the status as being pushed out toward inside gauge. On the other hand, the gauge is defined as "the shortest distance between the rail heads at the height within 14 mm, or 16 mm, from top surface", and measured based on this definition. Therefore, when the rail flaw was existed, the gauge is measured from the tip of the rail flaw, then the measured gauge becomes smaller than the actual gauge by the size of the rail flaw, refer to Figure 3. This is the evaluation in the dangerous side against the gauge, and there is the case to cause the derailment to inside gauge, as the rail flaw had folded and damaged. Refer to Figure 4.

Therefore, it is desirable to implement the proper management such as to remove the rail flaw depending on the necessity, when the occurrence of the rail flaw was confirmed in the periodic inspection of rail or the track patrol, etc.

*7 *"Rail flaw" is the part projected to the side surface of the head of rail or the edge surface caused by the plastic flow of the metal of the rail surface as the large contacting pressure was acted by the repeated passing of the wheels on the top surface of rail.*

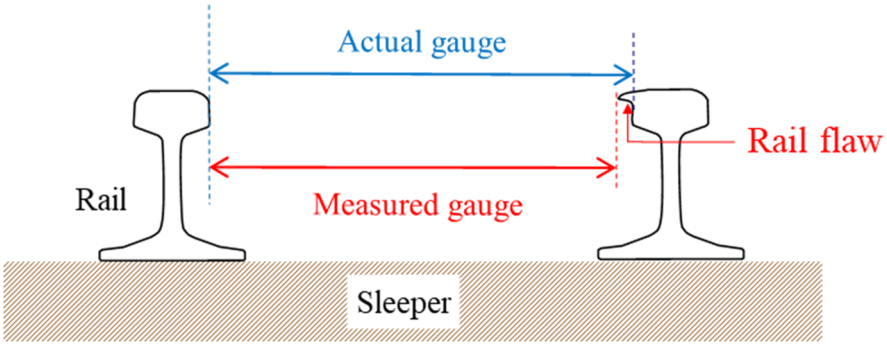


Figure 3. Measurement of the gauge when the rail flaw was existed.

Figure 4. Sample of the derailment to inside gauge as the rail flaw was folded and damaged.

(3) Method to measure the track irregularities

Many derailments to inside gauge due to the widening gauge were caused by the dynamically widened gauge by the rail tilting, etc., due to the lateral force by the running train. It is probable that there is the possibility to prevent the accident from happening, by finding the abnormality in advance by the measurement of the dynamic track irregularity[*8], particularly the measurement of the dynamic values of the irregularity of gauge, among them.

Therefore, it is desirable to implement the measurement of the dynamic irregularity of gauge by the track inspection car, etc., when the dynamic widening of gauge is concerned depending on the maintained status of the sleepers and the rail fastening devices.

As a side note, the development of the simple device to measure the dynamic track irregularity[*9], *i.e.*, irregularity of gauge and the irregularity of twist, was implemented targeted at the local railway at present. It is probable that this will become to the effective management tool when it is put into practical use.

When it is difficult to measure the dynamic track irregularities and the track irregularities is managed only by the measurement of the static track irregularities, it is necessary to manage the sleepers and the rail fastening devices sufficiently, based on the above (1), as paying attention to the danger to cause the dynamic widening gauge due to the rail tilting, etc.

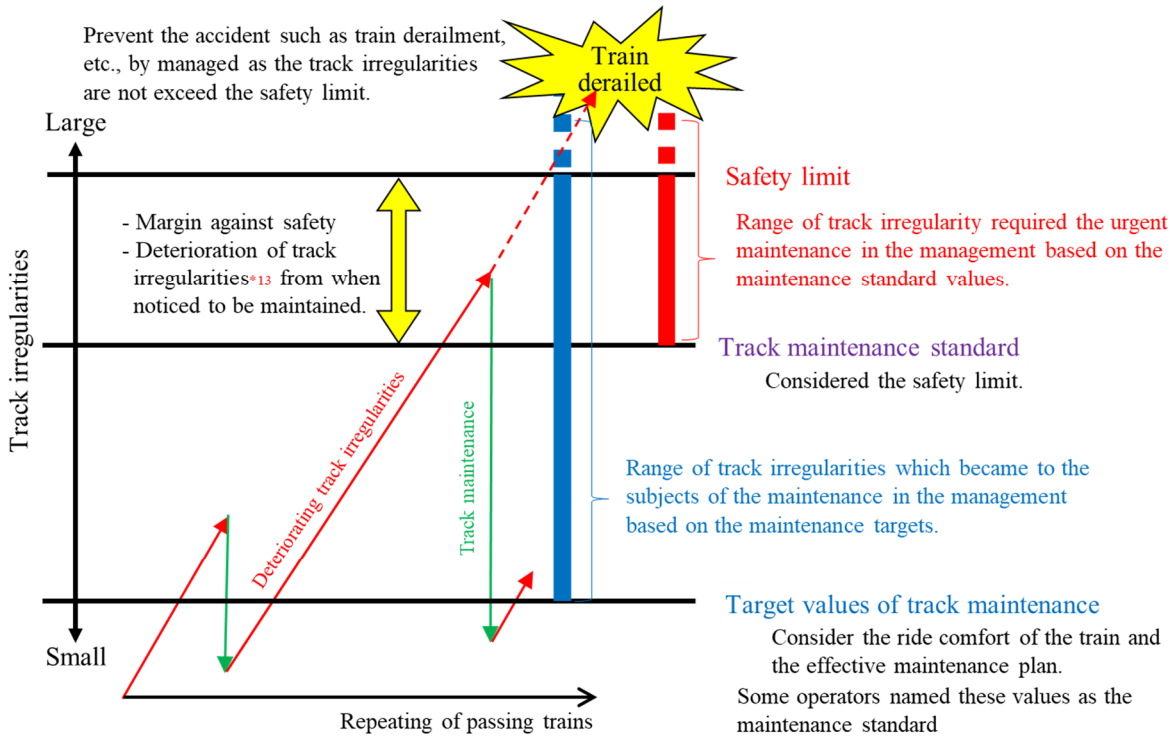
*8 *"Dynamic track irregularity" is the track irregularity in the status that the load weight of the train, etc., is loaded by the track inspection car, etc. On the other hand, the track irregularities, measured by the chord-to rail measurement or the track irregularity measuring device by the staffs, in the status that the load weight of the train, or the similar load weight, is not applied is called as the static track irregularities. Furthermore, the measured values of the dynamic track irregularity are called as the dynamic value, and the measured value of the static track irregularity are called as the static value.*

*9 *"Report of the study meeting on the ideal local railways", Ministry of Land, Infrastructure, Transport and Tourism, March 2015, p.26.*

2. On the standards of the management of the track maintenance

(1) Standards of the maintenance of the track irregularities[*10]

The standards of the maintenance of the track irregularities is categorized as to decide in order to secure the safe operation of the trains and to decide in order to maintain effectively as being preserved the good ride comfort of the train. The former is called as the standard values for track maintenance[*11], and the latter is called as the target values for track maintenance[*12], generally.



Notes : Maintenance standard of track irregularities are decided corresponding to the status of facilities in each track section and the running vehicles by each railway and tramway vehicles.

Figure 5. Image of the maintenance standard of the track irregularities

The maintenance standards of the track irregularity are decided by the individual railway and tramway operators corresponding to the status of the facilities in each track section and the operating trains. However, there is the case to set only the values close to the target values for track maintenance, depending on the operators.

As a side note, there are some operators decided the period till to implement the track maintenance when exceeded standard values of track maintenance was found, *hereinafter referred to as "the maintenance limit"*, but others did not decide the period clearly.

In order to prevent the derailment accident due to the widening gauge, it is important to manage the track irregularities, particularly management of the irregularity of gauge, therefore it is necessary to implement the track maintenance properly responding the status of the track irregularities. For this reason, it is desirable to establish the standard values considering the safety limits and set clearly the maintenance period when exceeded, in the maintenance standards for the track maintenance, toward the more certain management of the rack irregularities. Refer to Table 1 and 2.

Table 1. Standard values for track maintenance, example of the JR conventional lines

Maximum speed / Irregularity	Maintenance standard value				
	Section of 120 km/h and above	Section of above 95 km/h	Section of above 85 km/h	Section of above 45 km/h	Section of 45 km/h and below
Gauge	- Straight track & curved track of the radius above 600 m : 20 [14] mm - Curved track of the radius from 200 m to 600 m : 25 [19] mm - Curved track of the radius less than 200 m : 20 [14] mm				
Cross level	[Maintenance should be implemented based on the twist]				
Longitudinal level	23 [15] mm	25 [17] mm	27 [19] mm	30 [22] mm	32 [24] mm
Alignment	23 [15] mm	25 [17] mm	27 [19] mm	30 [22] mm	32 [24] mm
Twist	23 [18] mm [Including the gradual diminution of the cant]				

Remarks : [1] Numbers indicated the dynamic values measured by the high speed track inspection car. The numbers in the square brackets here indicated the static values.

[2] Twist indicates the changed amount of the cross level for 5 m.

[3] The slack, the cant and the versine, including the vertical curve, are not included in the curved track section.

The standard value for track maintenance considering the safety limits of Japan National Railway, *hereinafter referred to as "the old JNR"*, prescribed to repair the track irregularity exceeded the standard values should be repaired within 15 days, considering the deterioration of the track irregularity[*14].

Note that the standard value for track maintenance of the irregularity of gauge shown in Table 1, was decided as the track irregularity including the slack did not to exceed the limit value of the irregularity of gauge shown in Figure 6. Furthermore, the static values are set as the value corresponded to the upper limit value of the distribution in the relationship of the static irregularity of gauge and the dynamic irregularity of gauge shown in Figure 7, and decided considering as to convert the dynamic irregularity of gauge, against the static irregularity of gauge as the standard value, in the safety side as possible.

*10 *"Comments on technological standards on railways, civil engineering edition, the 3rd edition", Supervised by the Railway Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, December 2014, pp.661-662.*

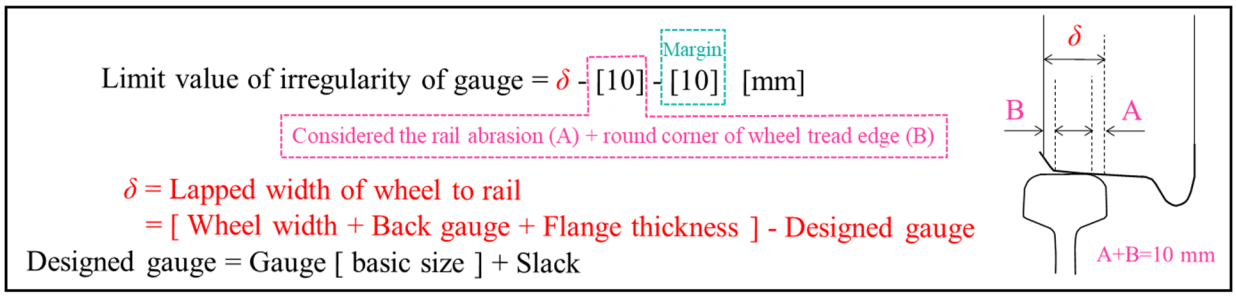
*11 *"Standard values for track maintenance" is the values of the track irregularities set as to take the urgent correcting works in order to secure the running safety of the trains.*

*12 *"Target values for track maintenance" is the values of the track irregularities set as to suppress the amount of the urgent track maintenance works while preserving the ride comfort at a certain level.*

*13 *"Deterioration of track irregularity" is the phenomena that the track irregularities increase gradually according to the repeating passage of the train.*

*14 *"Manual for management of track maintenance", Japan Railway Civil Engineering Association, Incorporated Association, March, 2014, p.10.*

*15 *"Manual of management standard to maintain railway structures, etc., track edition", Railway Technology Research Institute, March 2007, p.31.*



Here, assumed as the minimum size of wheel axle, the gauge, 1,067 mm and slack 0 mm,
Limit value of irregularity of gauge = [Wheel width + Back gauge + Flange thickness] - Designed gauge - 10 -10
= [120 + 988 + 22] - 1,067 -10 -10 = 43 : = 40 [mm]

Refer to "Comments on the technological standard for railways, civil engineering edition, 3rd edition", supervised by the Railway Bureau of the Ministry of Land, Infrastructure, Transport and Tourism.

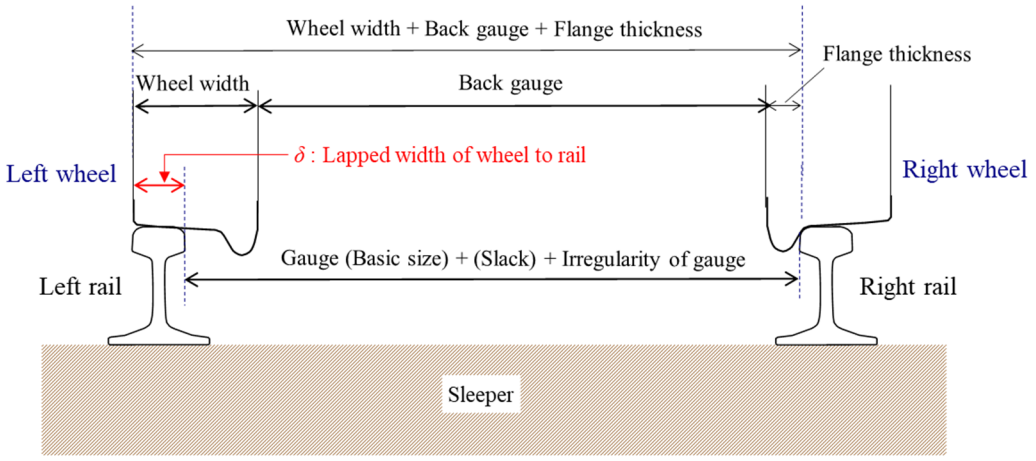


Figure 6. Limit value of the irregularity of gauge

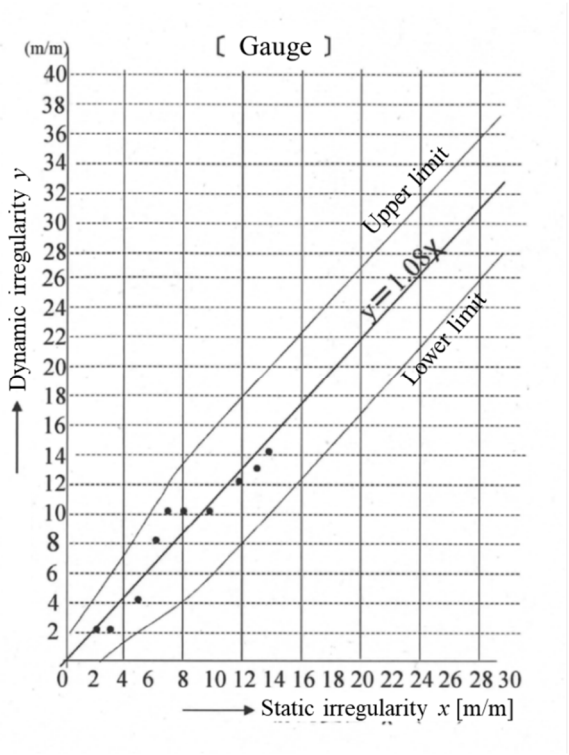


Figure 7. Relations between dynamic irregularity of gauge and static irregularity of gauge

Table 2. Target value for track maintenance, example of JR conventional line

Category of irregularity \ Maximum speed		Maintenance target values			
		120 km/h and above	Above 95 km/h	Above 85 km/h	85 km/h and below
Gauge	Radius 800 m and above	+10 [+6] mm -5 [-4] mm	+10 [+6] mm -5 [-4] mm		
	Radius 200 m and above		+15 [+9] mm -5 [-4] mm		
	Radius of below 200 m		+10 [+6] mm -5 [-4] mm		
Cross level		11 [7] mm	12 [8] mm	13 [9] mm	16 [11] mm
Longitudinal level		13 [7] mm	14 [8] mm	16 [9] mm	19 [11] mm
Alignment		13 [7] mm	14 [8] mm	16 [9] mm	19 [11] mm
Twist		-			

Remarks : [1] Numbers indicated the dynamic values measured by the high speed track inspection car. The numbers in the square brackets here indicated the static values.

[2] Twist indicates the changed amount of the cross level for 5 m.

[3] The slack, the cant and the versine, including the vertical curve, are not included in the curved track section.

[4] In the side track, follow the values in the 85 km/h and below.

(2) Handling of the remarkably large value of the track irregularity

The standard values for the track maintenance, which are decided as to secure the safe operation of the trains, is the value considering the margin such as the deterioration of track irregularities in the period from found the value as exceeded the standard value till to

the maintenance, etc. Therefore, when the measured value was confirmed as remarkably exceeded such margins at the time when the track irregularity was found, it is desirable to decide the value of the track irregularity which becomes to the judging standard, *hereinafter referred to as "the remarkably large value"*, and the handling when exceeded the remarkably large value, depending on the necessity, in order to implement the operation control such as the operation suspension, and the track maintenance, etc.

Note that it is important to implement the track maintenance based on the standard value for track maintenance and the target values for track maintenance, even when the remarkable large values and its handlings are stipulated.

Table 3. Track irregularities and handling operation control, example of Watarase Keikoku Railway, established after the train derailment accident occurred on May 22, 2017.

Track irregularities	Dynamic tack irregularity	Static track irregularity	Operation control
Gauge including slack	+42 mm and above & -12 mm and below	+38 mm and above & -12 mm and below	Operation suspension
Twist including gradual diminution of cant	27 mm and above	21 mm and above	
longitudinal level	39 mm and above	34 mm and above	
Alignment	35 mm and above	33 mm and above	
longitudinal level	36 mm and above & less than 39 mm	29 mm and above & less than 34 mm	Slowing down at 25 km/h and slower
Alignment	34 mm and above & less than 35 mm	28 mm and above & less than 33 mm	

* If the track irregularities in above table had found, communicate to the related sections and implement repair works such as track maintenance, promptly. The operation control should be released after confirmed that the track irregularities were within the track maintenance standard values.

(3) Setting the slack[*16]

It is desirable that the slack in the curved track is smaller in the possible range to increase the margin from the view point as not to cause the derailment to inside gauge due to the widening gauge.

The upper limit value and the lower limit value of the slack, in the section other than the section where the two axle vehicles are mainly operated, *i.e.*, the section where the three axle vehicles are operating, are as follows.

$$S_{max} = 1000 \left(9 B^2 / \left(32 R \right) \right) - \eta$$

$$S_{min} = 1000 \left(B^2 / \left(8 R \right) \right) - \eta$$

S_{max} : Upper limit of slack [mm], S_{min} : Lower limit of slack [mm]

B : Maximum wheel base of the vehicle running in the concerned curve [m]

R : Radius of curvature [m], η : Movable margin [mm]

Sample of estimation for the case of 200 m radius curve and three axle vehicle for the case of B = 4.3 m and η = 7 mm, was as follows.

$S_{max} = 1000 (9 * 4.3^2 / (32 * 200)) -7 = 19.0$ mm

$S_{min} = 1000 (4.3^2 / (8 * 200)) - 7 = 4.6$ mm

In addition, the standard values of the slack in the general curves in the old JR, after February 1987, are as shown in Table 4.

Table 4. Amount of the slack

Radius of curve	3 axle vehicle	2 axle vehicle
Less than 200 m	20 mm	5 mm
200 m or above & less than 240 m	15 mm	-
240 m or above & less than 320 m	10 mm	-
320 m or above & less than 440 m	5 mm	-

In order to decide the optimum value in the range of the possible slack, it is required to consider the conditions of the vehicle operating in individual track sections, however the values for the 3 axle vehicle, in the Table 4, are considered as valid on the whole, considering the balance, etc., between the smooth running of the variety of vehicles and the margin against the derailment to inside gauge, in the many track sections.

As a side note, the change of the amount of slack is accompanied with relatively large scale construction work, therefore it is desirable to repair in order by construct together with the improving construction of the subjected curved section, etc.

*16 *"Comments on technological standards on railways, civil engineering edition, the 3rd edition", Supervised by the Railway Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, December 2014, pp.115-121*

3. On the track structures

(1) Change of sleeper material

It is desirable to exchange the sleepers to the sleepers made of concrete, etc., such as the PC sleepers, which is superior to to the wooden sleepers in the durability and the easy maintenance. Note that it is necessary to implement the exchanging works to the sleepers made of concrete, etc., *i.e.*, the PC sleepers, etc., systematically,

Figure 8. Example of partly changed PC sleepers

considering the places in higher priority based on the status of the existence of the poor sleepers and the track shape, etc.

Note that it is effective to replace sleepers partly which exchanges sleepers in the ratio of one in several sleepers when it is difficult to exchange all sleepers from the cost problem, etc. Refer to Figure 8. In this case, it is desirable to determine the ratio of the sleepers made of concrete, etc., for exchange, considering the conditions of the running vehicles and the track shape, etc.

(2) Guard rail and its kind to be installed in the curved track[*17]

(i) Kinds

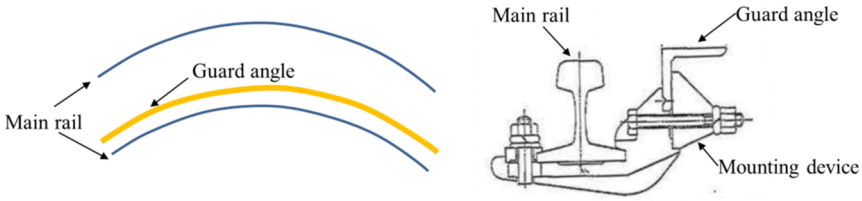
The guard rail and its kind are installed in the places in the "curve where the safety factor of flange climbing is lower than 1.2" which was the measure to prevent the recurrence of the accident in Hibiya Line of Tito Rapid Transit Authority, present Tokyo Metro, occurred on March 8, 2000, the other places where there is the risk of the derailment, and the places where the harms by the derailment is enormous, etc., and there are the guard angle[*18], the guard rail[*19], and check rail[*20] as its kind.

The guard angle and the guard rail are installed for the purpose to prevent the derailment from happening, on the other hand, the check rail is installed for the purpose to prevent the deviation after derailed as far as possible. Therefore, from the view point to prevent the derailment accident, it is desirable to install the guard angle or the guard rail as far as possible.

Generally, the installation of the check rail has been prescribed as "to install check rails where it is required to install the guard angle or the guard rail but inconvenient to attach them", and these inconvenient places are judged considering the maintainability, *i.e.*, economic efficiency, etc., of the track, in addition to the falling stones and the snow falls.

*17 *"Manual of track management shown by photographs", Japan Railway Civil Engineering Association, Incorporated Association, September, 2016, p.232-234.*

*18 *"Guard angle" is the L-shaped steel guard device installed in inside gauge as parallel to the main rail, in order to prevent the serious accident caused by the derailment.*



*19 *"Guard rail" is the rail installed in inside gauge as parallel to the main rail, in order to prevent the serious accident caused by the derailment.*

*20 *"Check rail" is the rail for guidance installed along the main rail in order to prevent serious accident by the turning over or the falling of the vehicle which was derailed and deviated to outside gauge.*

(ii) Installation method

It is necessary to install the guard angle, the guard rail and the check rail properly so as to show their effects.

As for the installed place, install in the inside gauge of the opposite side rail in the place where considered as dangerous, such that the derailment causes the hindrance of the neighboring track, or the damages by the turned over vehicle is supposed as severe, furthermore, install in both side according to the necessity.

In addition, when the guard angle and the guard rail are lower than the main rail, it is considered as possible not to show the function to prevent derailment sufficiently as the wheels becomes easy to run over due to the small lapped width against the back side rim when the back side rim of the wheel had contacted. Therefore, it is desirable that the guard angle and the guard rail are installed in the same height or higher than the main rail. Furthermore, it is desirable to fasten the guard rail to each sleeper by the spikes, etc.

The check rail should be installed in the inside gauge of the rail opposite to more dangerous side, but install in the outside gauge of the rail in the more dangerous side for the places where there are many fallen stones or snow falls. In addition, the fastening of the check rail to the sleepers by the spikes, etc., are allowed to fasten to every two sleepers.

(iii) Management by the periodic inspection and the track patrol

It is necessary to inspect and confirm on the status of the materials and the maintenance by the periodic inspection or the track patrol for the guard rail, etc., and repair depending on the status.

In addition, the guard rail and its kind, especially attention is required to the guard angle and the guard rail, are installed as the side surface of the guide rail and the back side rim of wheels contacted when derailed, etc. Therefore, it is necessary to implement the required inspection and repairing, considering the possibility of the derailment, *i.e.*, derailment to inside gauge or the flange climbing, when there is the scratching traces, etc., in the side surface of the guard rail, thus, there is the possibility to prevent the derailment accident.