ANNUAL REPORT 2016-2017

For the year ended March 31, 2017

Railway Technical Research Institute

Foreword

Norimichi KUMAGAI
President of the Railway Technical Research Institute

RTRI celebrated its 30th anniversary on December 10, 2016. Since its inauguration, we have been seeking “safety first”, “head-start research”, “close ties with JR companies”, and having been creating quality research outcomes and working to establish credibility with the support by the government and railway companies.

In 2015, RTRI announced a new vision “RISING – We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society.” It describes RTRI’s basic policy and future direction so that RTRI will be able to meet the expectations from the railway world and Japanese society. This vision also states RTRI’s three missions, “Intensified research and development activities responding to customers’ needs and social change,” “Impartial research activities using the best science available in an ethical way,” “Research activities pioneering cutting-edge technologies,” and the business and management strategies to accomplish the missions. Furthermore, as a mid-term plan to state concrete strategies to implement the vision, we publicized a five-year master plan starting in 2015, “ RESEARCH 2020 - Aiming at Creation of Innovative Technologies -“

In fiscal 2016, the second year of the master plan, we focused on the research and development to enhance railways safety. We implemented projects to make railways more resilient in case of serious natural disasters such as major earthquakes and heavy rainfalls and projects to prevent derailment and tunnel fire. In addition, we have promoted following research and development by introducing information and communications technologies: enhancement of convenience of train travels; reduction of maintenance cost; energy saving of railway systems; development of basic technologies to protect trackside environment and to improve advanced simulation techniques for further increase in Shinkansen’s speeds.

At the same time, we have completed major renovation of the large-scale low-noise wind tunnel in Maibara, and keep improving our test facilities as follows: review of specifications of high-speed pantograph test equipment; review of specifications of high-speed axle test equipment; detailed design of low-noise train model test equipment; basic design of a new building for tests and experiments. We are going to further enhance basic testing equipment and facilities for the research activities in the next 30 years.

We will intensify research and development for the next 30 years in order to build safe and attractive railway systems that more and more people will hope to use. As we believe that railways connect people’s heart and mind as well as connecting them in a material meaning and contribute to the creation of a happier society, we will always keep high motivation to continue the research and development efforts. We hope to be an institute that keeps providing quality research outcomes to the global world as well as to Japanese society and to continue to be relied upon by railway operators and customers. Last but not least, we do hope to ask for continued support and advice from all the rail-related people.

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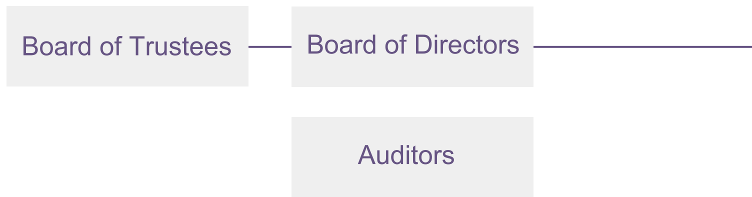
Overview

Organization



- Chairman
  - President
    - Executive Vice Presidents
    - Executive Directors
    - Planning Division
    - Compliance Division
    - Administration Division
      - Miyazaki Test Center
    - Accounting Division
    - Information Management Division
      - Health Insurance Systems Center
    - International Division
    - Research & Development Promotion Division
      - Wind Tunnel Technical Center
    - Marketing & Business Development Division
    - Railway Technology Promotion Center
    - Railway International Standards Center
    - Vehicle Structure Technology Division
    - Vehicle Control Technology Division
    - Structures Technology Division
    - Power Supply Technology Division
    - Track Technology Division
    - Disaster Prevention Technology Division
    - Signalling & Transport Information Technology Division
    - Materials Technology Division
    - Railway Dynamics Division
    - Environmental Engineering Division
    - Human Science Division
    - Maglev Systems Technology Division
      - Yamanashi Maglev Test Center
    - Center for Railway Earthquake Engineering Research

(As of July 1, 2016)

Major Results of Research and Development

IMPROVEMENT OF SAFETY

1. Effectiveness of embankment slope work against cloudbursts

- Insight was gained into the embankment failure mechanisms particularly associated with short, heavy downpours.
- Embankment slope work increased resistance to precipitation by a factor of 1.3.
- These findings can be applied to embankment slopes as a countermeasure to cloudbursts.

Some embankments, which under normal rainy conditions present no weaknesses have been found to collapse when subjected to sudden short bursts of torrential rain. Consequently, precipitation tests were conducted on a full-scale model to clarify the mechanisms behind embankment failures caused by cloudbursts and to investigate the effectiveness of measures applied to embankment slopes.

Test results revealed that during short downpours the cause was not so much related to water infiltration into the heart of the embankment, but rather due to the high volume of precipitation that collects in the bottom of the track bed. This water then flows over onto the shoulder of the embankment causing erosion. The remaining water that does not overflow seeps down into the base of the embankment which also causes erosion and eventually leads to collapse over time.

In the next step of the study, the model embankment featured in Figs. 1 and 2 was employed to test the effectiveness of pre-cast concrete frames as a countermeasure to cloudbursts. Trials demonstrated that the remedial work reduced the volume of water found inside the embankment, and slowed the erosion process down (Fig.3). In addition, it was found that the original embankment failed up to the shoulder when a cumulative precipitation of 480 mm was reached, whereas the reinforced embankment resisted, with only localised areas failing, with 1.3 times as much cumulative precipitation. This demonstrated the ability of the reinforcement measure to restrict failure to localised areas, thereby preventing collapse of the whole embankment.

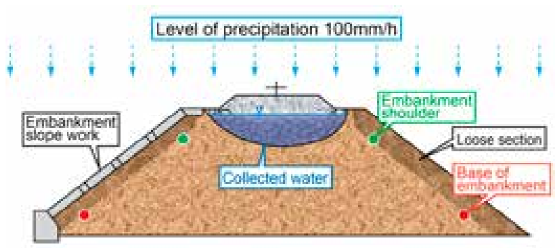


Fig. 1 Picture of model embankment

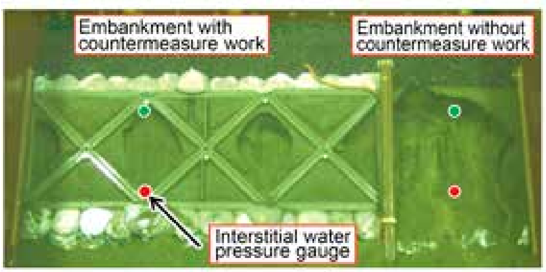


Fig. 2 Picture of test conditions (showing collapse of original embankment without countermeasure work)

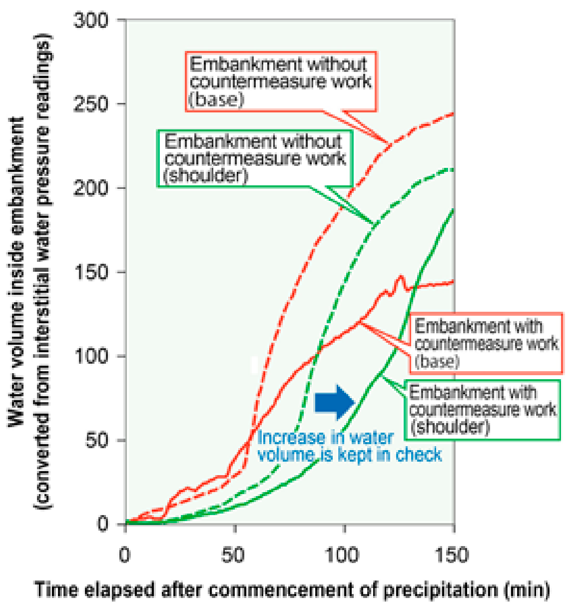


Fig. 3 Water level progression over time inside the embankment

2. Development of seismic reinforcement methods for bridge abutment and proposal for new design method

- A new seismic reinforcement method for bridge abutments was developed which does not encumber the space in front of abutments.
- A seismic design method adapted to level 2 earthquake motion was proposed.
- It was confirmed that the new method more than doubles resistance to earthquake motion compared to bridge abutments without reinforcement.

Abutments are structures standing between bridge or viaduct sections and embankments. Past earthquake damage includes inclination of abutments and disrupted train operations due to backfill settlement. Seismic reinforcement methods for abutments proposed previously require construction space in front of the abutments; therefore, it was difficult to execute especially on the abutments of railway bridges crossing over roads in urban areas, because of limited space availability and restricted working conditions.

Based on this background, a new seismic reinforcement method for abutment using large diameter soil nailing was developed (Fig.1). This method allows work to be carried out from the side of a backfill, thereby avoiding any hindrance in front of the abutment. Model tests and numerical analyses were conducted on this reinforcement method and another method using column soil improvement into the backfill from the track side (Fig. 2), in order to clarify the reinforcement mechanisms and effectiveness of the methods (Fig. 3). Using the insight gained from the tests, new seismic design methods were proposed.

Design calculations for actual abutments were conducted on the basis of this method, which confirmed not only that this seismic reinforcement more than doubled resistance compared to abutments without reinforcement, but also that it significantly reduced deformation of the abutment itself and settlement of the backfill.

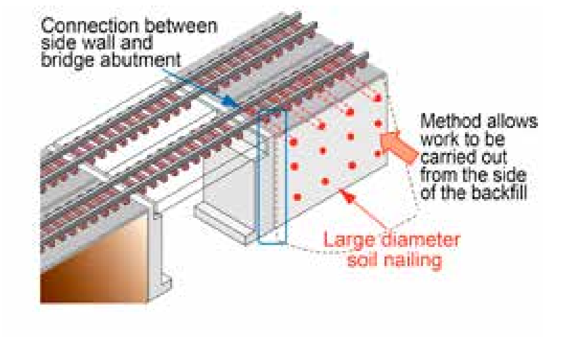


Fig. 1 Seismic reinforcement method using large diameter soil nailing

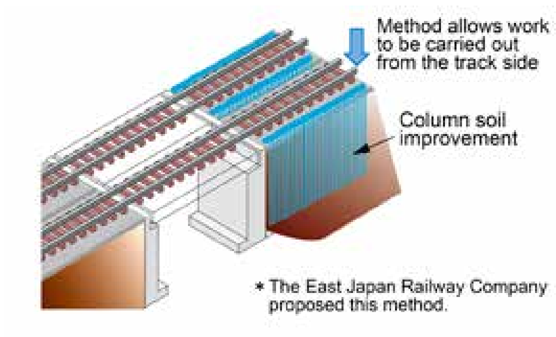
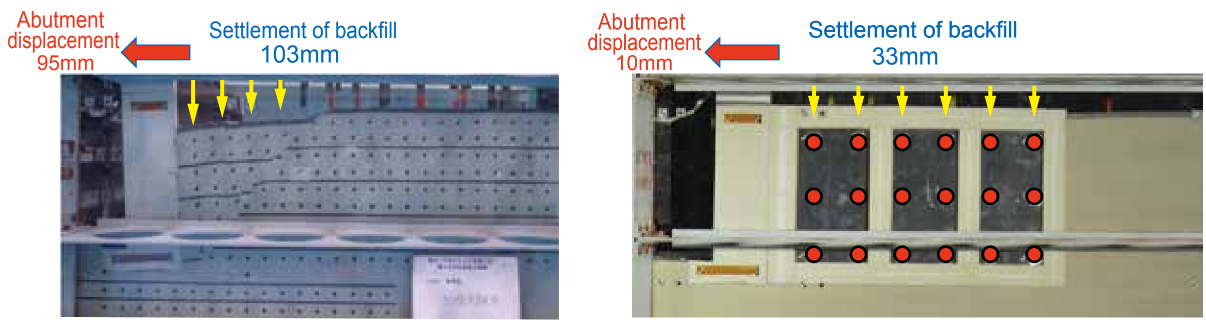


Fig. 2 Seismic reinforcement method using soil nails



(a) without reinforcement

(b) Reinforcement method using large diameter soil nailing

Fig. 3 Resulting effectiveness of proposed reinforcement method (condition after level 2 earthquake)

3. Fracturing grouting as a countermeasure against soil liquefaction

- A method was developed to densify ground against soil liquefaction using grout injection.
- The volume of injected material was cut by 1/3, reducing cost and work time.
- This method was found to be a suitable countermeasure against soil liquefaction directly under existing railway embankments.

A fracturing grouting method was developed to reduce soil liquefaction, requiring a lower volume of injection material (Fig. 1). The hardening time and viscosity of the grout used in this method were adjusted before injection in order to allow the grout to fracture the ground.

The fracturing densifies the surrounding ground increasing resistance to liquefaction. The present method allows the grout to be injected in various directions, making it possible to bring improvement to the area of ground being targeted.

Figure 2 shows the result of a ground survey after applying an injection rate of 10% (1/3 of the existing method). The Nd value indicating hardness, the coefficient of earth pressure at rest and soil density increased after the grouting. These results were used to make estimations of the possibility of soil liquefaction and level of liquefaction damage, which in turn were used to verify the degree of liquefaction influencing a structure that could be ignored and the amount by which liquefaction could be reduced. This demonstrated that ground condition could be improved significantly even using a lower injection rate, which also cut cost and work time compared to present methods. In addition, this procedure can be used in a wide range of conditions, since it can be applied under existing structures because of the small amount of ground upheaval and irregular displacement of the ground surface, and used in confined locations because of the compact size of the grouting machine. The present working method has already been applied along in-service lines directly beneath earth embankments as a countermeasure against soil liquefaction. This experience demonstrated that the method can be applied without any trouble, and does not cause any track deformation.

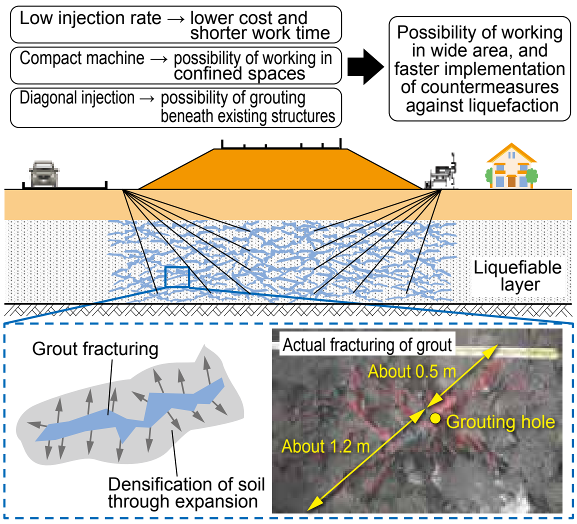


Fig. 1 Fracturing grouting work as countermeasure against soil liquefaction

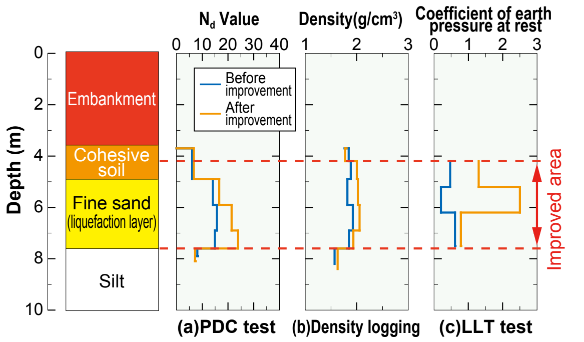


Fig. 2 Example of increased ground constant after grouting

4.Anti-seismic measures using a vibration control damper

- A design method for a vibration control device has been developed for work on difficult structures, such as bridge piers constructed in rivers.
- Using the proposed design drawing, the effectiveness of the vibration control can be estimated to within an error margin of approximately 10% .
- Guidelines including some numerical examples have been proposed to assist application of the vibration control device in design work.

Given the environmental constraints on bridge piers in rivers, ordinary reinforcement measures such as concrete jacketing are relatively difficult to apply. By using a vibration control damper however, it is possible to significantly improve the seismic resistance of the bridge pier by reinforcement the upper part of the structure alone.

Given that structural design methods have not been devised to integrate the use of vibration control devices however, incorporating such devices would require numerous complicated dynamic analyses, requiring significant investment of time and labour.

Consequently, a design drawing has been proposed by which structural damage and design loads for the vibration control device can be estimated, avoiding the need for detailed dynamic analyses (Fig. 1). The design drawings can be used to estimate the characteristics of the vibration control device required to contain structural damage to a level that would allow the structure to remain intact, considering the basic design characteristics of the structure, such as natural period, yield seismic intensity, ground conditions and maximum acceleration of seismic motion.

In order to verify the accuracy of this design drawing, the vibration control device was applied to an actual bridge. The vibration control damper loads required to contain damage to the bridge to a level that would allow the structure to remain intact were estimated, and dynamic analyses were conducted. Results showed that the bridge pier response (Fig. 2) was 0.90 times the yielding limit. This demonstrated that the design drawing could be used to design the vibration damper for an actual structure, and that the margin of error in damage prediction was approximately 10%.

Following this, a set of guidelines and examples to help this method were drawn up bringing together the design drawing itself, control methods to verify members and the basic impact of the vibration control reinforcement, and other design related points. Following this, a proposal was made to disseminate the vibration control device as one of the possible anti-seismic measured for bridges and/or viaducts.

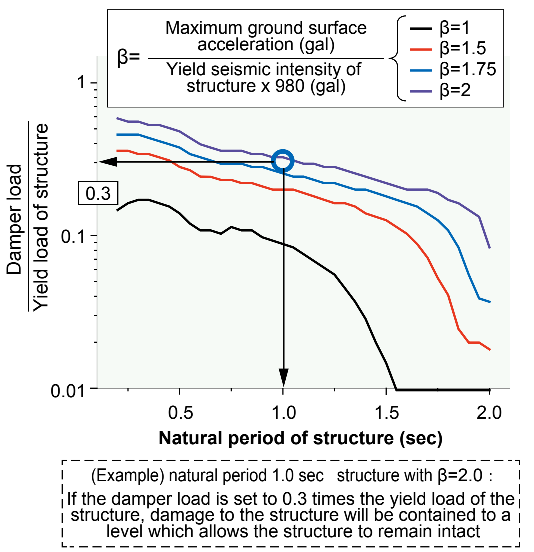


Fig.1 Design drawing for vibration control device (L2 earthquake spectrum II/ G3 ground conditions)

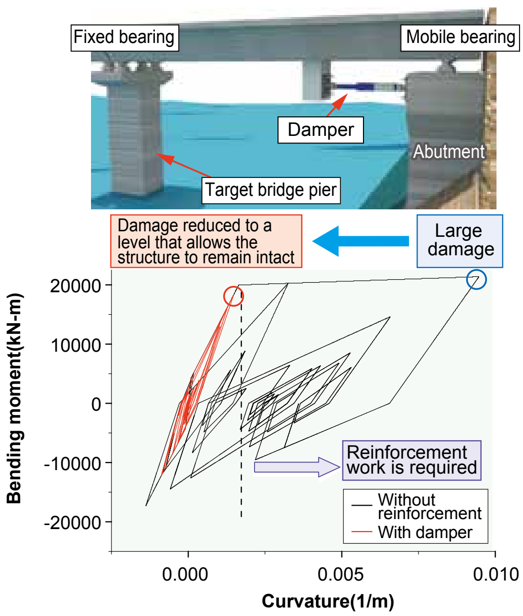


Fig. 2 Verification of the design drawing through dynamic analyses

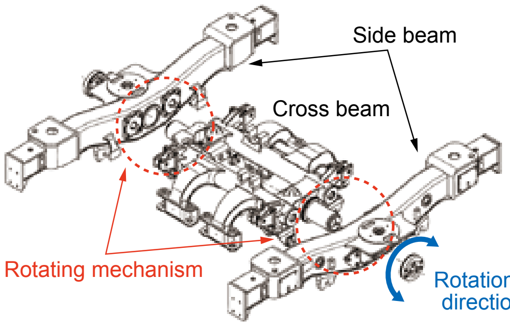
5. Bogie designed to prevent flange climb derailment

- A bogie designed to improve safety by preventing flange climb derailment was developed combining a bogie designed to suppress wheel load decrease and steering assistance.
- Based on the derailment quotient used to determine the level of safety against flange climb derailment in curved section, the newly developed bogie showed a performance improvement of 60% compared to ordinary bogies.

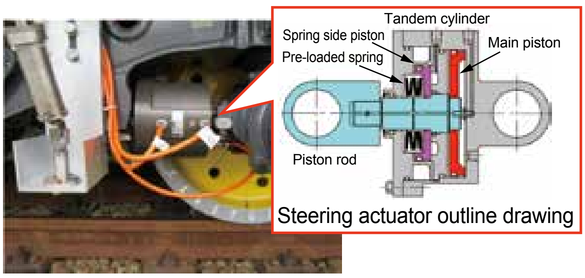
In track sections such as exit transition curves where there is significant horizontal plane displacement track torsion can lead to a decrease in the outer wheel load on the front axle of a railway vehicle. If a large lateral load is added at this stage, wheel climb occurs generating a strong possibility of derailment. Preventing wheel load reduction and mitigating lateral force are both effective means to prevent this from happening.

Consequently, an "anti-derailment" prototype bogie for used on a conventional line was made adding steering assistance to a wheel load reduction suppression bogie. An axle box suspension with a built-in steering actuator which expands with the curve in the track was added to the bogie equipped with a rotary device mounted on the bogie frame designed to follow the torsion in the track and thus control wheel load reduction. The additional steering assistance reduces lateral force (Fig.1). The combined effect of both devices improves safety against flange climb derailment.

In order to verify the basic functions of the "anti-derailment" prototype bogie, running tests were conducted on curved test sections of track outside the facility. Results from these trials confirmed that the newly development bogie's flange climb derailment quotient, which serves as a safety indicator, improved by 60% compared to existing bogies in curves up to a radius of 160m (Fig. 2).



(a) Bogie frame equipped with rotating mechanism



(b) Steering actuator installed on axle box

Fig. 1 Core technology of developed bogie

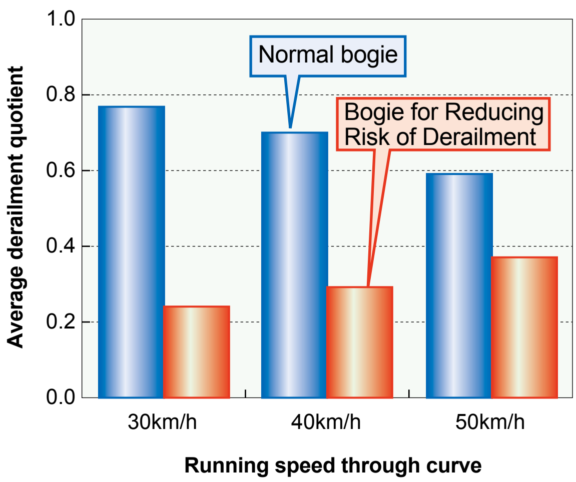


Fig. 2 Positive effect improving derailment quotient (on 160 m radius curve)

6. Method for evaluating running safety in case of punctured air spring

- A method for evaluating vehicle running safety in case of punctured air spring based on wheel lift was proposed.
- This method will allow railway operators to make a preliminary assessment based on curve parameters, of running safety in the case of a punctured air spring, before driving the train back to its shed, or engaging in break down assistance, in order to identify sections requiring particular caution.

Damage to equipment or air piping on a railway vehicle can lead to a punctured air spring. This punctured state may be created on purpose with a view to prevent vertical train set buckling, in case of relief assistance. In these situations, the rigidity in vertical vehicle support increases, while the vehicle's ability to follow the twist irregularity of the track worsens and decrease of wheel load increases. A method was designed therefore to assess running safety in these conditions, in accordance with curve parameters.

The graph in Fig 1 shows the case where either wheel lift is lower than 2 mm or the derailment coefficient is within the admissible limit (modified arc wheel profile 0.95) based on the combined analysis of cant and the cant reduction amplification factor.

When wheel lift is lower than 2 mm, there is only one point of no contact between the flat part of the wheel flange and the rail, which means that rail climb has not begun. On the same graph, in the case of a punctured air spring, even if the derailment coefficient is exceeded, a buffer zone still exists before rail climb begins. As such, a proposal was made to use wheel lift as an indicator to directly determine the level of safety in case of rail climb.

If graphs such as the one in Fig.1 are prepared in advance for various types of vehicle and conditions, railway operators will be able to assess running safety with a punctured air spring. Fig. 2 shows an image of the proposed method where the parameters of curves located along lines to be used for a relief run or empty run back to the shed, have been plotted, and the wheel lift threshold value of 2 mm can be used to determine running safety.

For curves where the safety level is found to be low, tests in RTRI test facilities conformed that friction modifiers or water can be spread or sprayed on the rail head of the inner rail of the exit transition curve in order to mitigate wheel lift.

Application of this method will make it possible to anticipate sections of track where similar measures should be taken in the case of an air spring puncture, during empty runs back to the shed or relief runs.

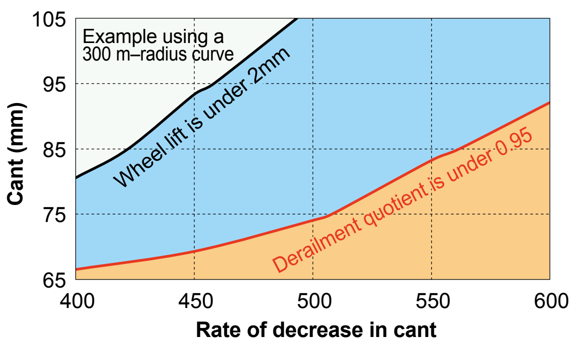


Fig. 1 Difference in running safety evaluation using derailment quotient and wheel lift

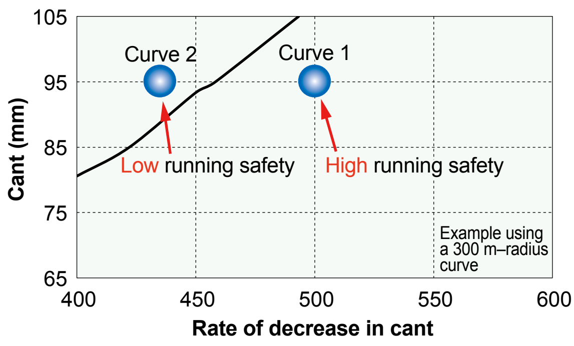


Fig. 2 Example of running safety evaluation

7. Wireless communication network for monitoring of freight car condition

- A system using a 920MHz band has been proposed, in response to the need for information about the status of each freight car in a consist when train compositions are changed; the system automatically composes the network and sends it to the driver's cab on the locomotive.
- This system is able to check the state of a freight car's hand brake in approximately half the time required for a visual inspection, and can also be used to monitor freight car conditions.

Before freight train departs from a station, it is necessary to verify the release status of each freight car's hand brake for safety purposes. Today, these checks are carried out visually, which time is consuming when having to check a whole rake of freight cars. In order to facilitate this verification work from the locomotive or the control centre, a network of wireless sensors between each freight car could be built, however, this would require a flexible means of communication which could adapt to train composition being modified and distinguish between freight cars on different train compositions. It is also necessary to take into account possible interference with other wireless networks and the electromagnetic environment.

A proposal was therefore made for a wireless communications network using a 2.45GHz band for the network between cars on the same train and a 920 MHz band for communication with other cars. A method was developed to build a network offering the necessary flexibility to allow changes in train composition (Fig. 1). The method employs the space beneath the freight cars as the propagation path, then, while the quality of data transmission is verified at each relay device the network builds automatically and collects data. Furthermore, each relay device automatically selects the path requiring the minimum number of transmissions thereby controlling battery consumption by the network connecting cars on the same train.

A prototype was installed on a locomotive and freight cars. Results of tests revealed that the direct transmission distance is approximately 100m. The test assumed a consist of 26 freight cars, and results also showed that it took 6 and half minutes for the network to set itself up and to collect data.

The new system cuts the visual inspection time needed to check freight car hand brake status by about half, and feeds this information back to the driver's cab. In addition it is hoped that this method will help prevent failures to visually identify non-released brakes.

This system can be adapted to general train vehicles, and can also be used for data transmission between vehicles during operation, offering a means of communication to collect vehicle data.

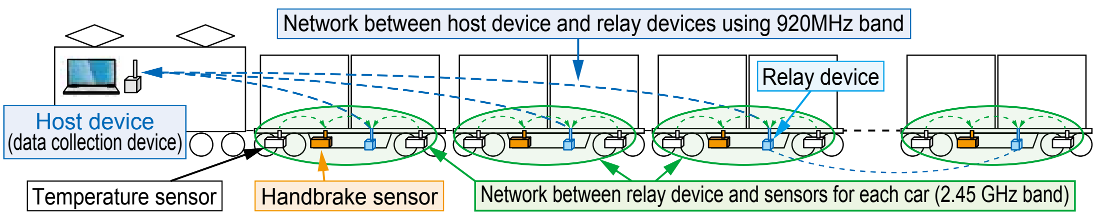


Fig. 1 Diagram of whole system

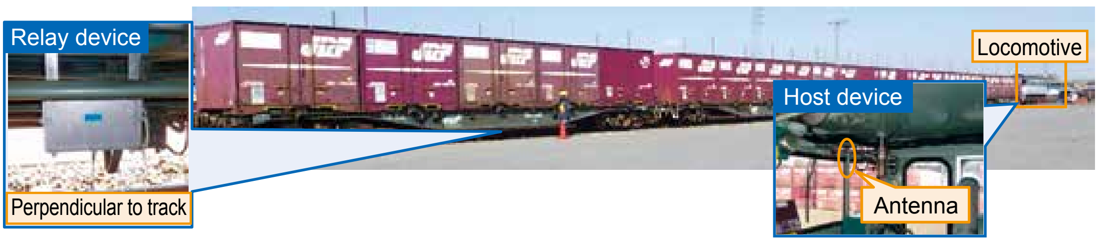


Fig. 2 Temporary installation of prototype device on freight cars

8. Development of a deterrent sound to prevent Deer-Train Collisions

- A deterrent sound including the alarm call of deer has been designed to prevent deer-train collisions.
- Emission of the deterrent sound from a train resulted in a 45% reduction in the frequency deer being observed.
- A method has been designed to select sections where the deterrent sound should be sounded, using the collision map created with the GIS.

Growing deer populations and expanding deer habitats have led to an increase in deer-train collisions. Railway companies have implemented various countermeasures for this, for example fences to keep deer out or deer repellents. These measures were effective to some extent, however they did not ultimately reduce collision numbers significantly. A deterrent sound was therefore designed as a new solution to add to existing measures, which would deter deer from being around the track, and an application to have this sound emitted from trains as a method for avoiding deer-train collisions was proposed.

It is known that deer emit an “alarm call” to signal a danger to other deer. We confirmed that deer paid attention to the direction from which an alarm call came from when we sound alarm call artificially. It is also known that deer avoid dogs, therefore, the deterrent sound was designed with the sound of alarm call and a sound of a dog howl (Fig.1).

The deterrent sound is based on the premise that the first alarm call will alert the deer, while the following howling sound will deter the deer from the track. In order to emit this sound from a train, previous deer-train collisions were mapped out using a geographical information system (GIS) based on actual collision data (Fig. 2) while taking into account features such as vegetation and landscape topography, in order to propose an accompanying method to select areas where the sound should be emitted.

The deterrent effect of the developed sound was evaluated during peak collision periods, i.e. at night time during the winter (Fig. 3), where the deterrent sound was emitted from the front of the train in the pre-selected areas based on the deer-train collision map. The trials proved successful and reduced the frequency of deer observations by 45% (Fig. 4). By inferring that deer were frightened away from the track because of the deterrent sound emitted by approaching trains, these trials confirmed the effectiveness of this new measure.

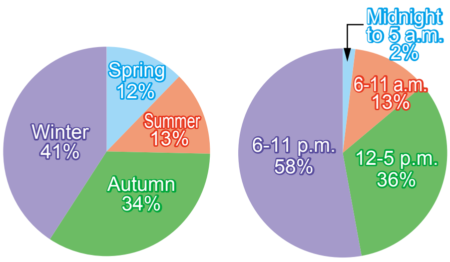


Fig. 3 Proportion of events by season (3070 events) (left) and according to time of day (right)

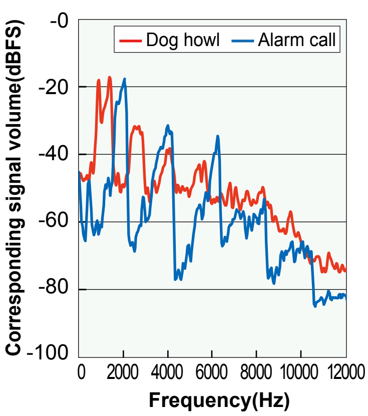


Fig. 1 spectra of alarm call and dog howl used in deterrent sound

Fig. 2 train-deer collision map (the diameter of the ● associates with number of collisions)

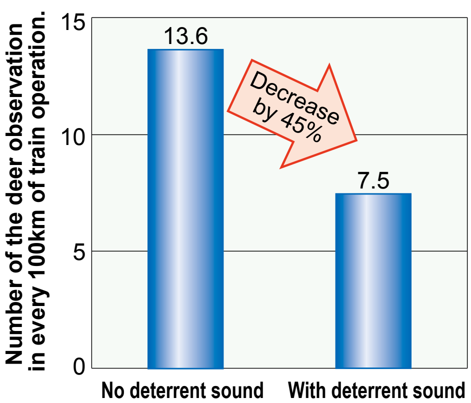


Fig. 4 Decrease in the number of the deer observation by virtue of emitting the deterrent sound

9. Training material to prevent communication errors

- A "Communication error causation model" gathering error factors obtained through incident and accident analyses was designed.
- Practical training material was prepared to respond to railway operation related communication errors.

Communication errors that fail to communicate instructions and notifications correctly, hamper safe train operations and supply of appropriate passenger information. Consequently, using data from railway operation related accidents (1706 items) and near misses (97 items) 23 root causes were identified, and a "Communication error causation model" was created. The model shows the relationship between the causes; for example, the cause for insufficient verification was shown to be "uncertainty about what needs to be checked".

The model revealed, for example, that the main cause for inefficiency of "talkback " and "confirmation talk" procedures was "uncertainty about what exactly needs to be checked", and that the remedy for this kind of communication error was to improve the ability to detect "vague expressions or words". The model also showed that prior learning was required to ensure that "talkback" and "conformation talk" procedures did not become meaningless.

Training material consisting of two steps was drafted. The first step allows the trainee to learn about "vague expressions or words" (Fig. 1) and, the second allows them to understand how to perform "talkback" and "conformation talk" procedures (Fig. 2).

The effectiveness of the training material was confirmed through a trial of 92 test subjects, which resulted in reducing communication errors by half (Fig. 3).

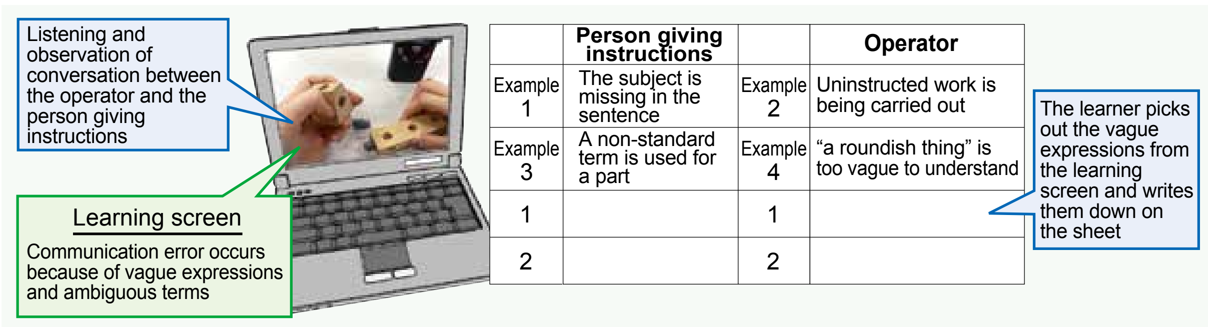


Fig. 1 Learning about vague expressions and words

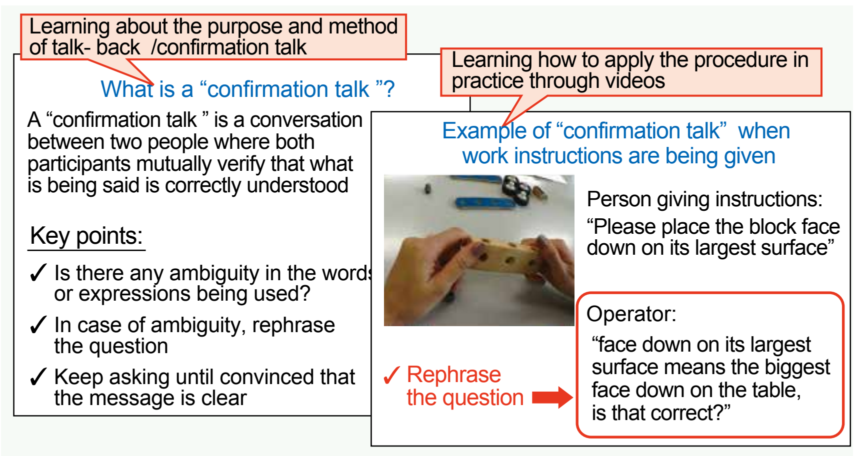


Fig. 2 Learning about cross-check procedures

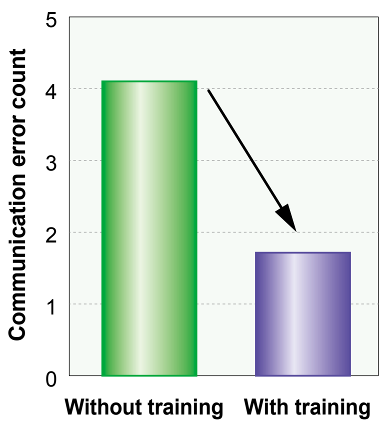


Fig. 3 50% reduction in communication errors

10. Design method for concrete filled tube members with rectangular section

- A method was proposed to estimate the flexural capacity and deformation performance of rectangular CFT members.
- The cross section of rectangular CFT members can be made up to 30% smaller than other existing members.
- Improving the connectivity of these members to building columns in station buildings etc. can reduce construction costs for connection work by 10%.

Concrete Filled Tube (CFT) members, as the name suggests have a relatively simple structure and are made of steel tubes filled with concrete. In addition, even small cross sections have good flexural capacity, and are easy to use in construction. There are already established design standards for circular cross-section CFT members which are already employed extensively in structures, however there are no set standards yet for rectangular CFT members.

Rectangular CFT members are in demand however to improve connectivity with beams, and building columns used in station buildings (Fig. 1).

Loading tests were conducted on a test model, and the results were used to propose a method for estimating deformation performance, flexural capacity and for setting damage levels, based on the principles required for a design standard (Fig. 2). Based on this, rectangular CFT members can be adapted for used on actual structures. The proposed estimation method was used to produce a normal CFT column following the trial design. The result of this trial showed that the rectangular CFT column had a similar section size to that of the circular CFT column, however the cross-section size would be approximately 30% smaller than using reinforced concrete columns (Fig.3).

The present method can be used to design CFT members with the same dimensions as building columns, as early as from the design stage for station buildings. This would mean greater connectivity of these members and allow cost savings for connections of about 10%. These results were taken into account to draft in an inspection handbook and develop analysis tools.

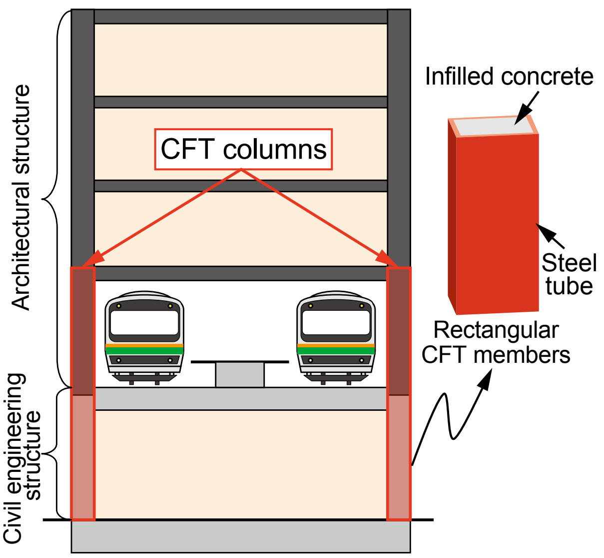


Fig.1 Example of rectangular CFT columns being used on a station building

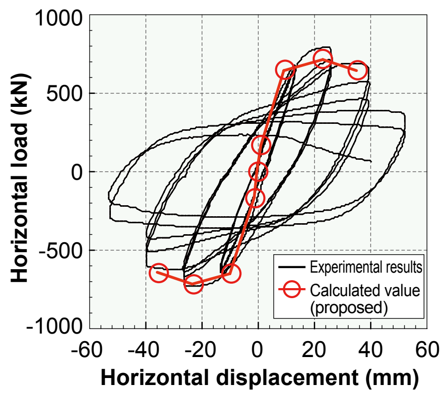


Fig. 2 Comparison of experimental values and those estimated using the proposed method

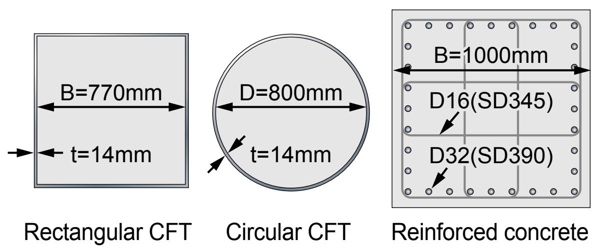


Fig. 3 Comparison of cross-section

11. Tunnel lining crack detection method using deep learning or multi-layer neural network

- A method for detecting cracks in tunnel linings has been developed using multi-layer neural networks offering over 90% successful detection.
- The method's discernment capability is close to that of a human being, allowing automatic generation of maps showing damage progression.

Existing image processing programs to detect structural damage such as cracks required the fine-tuning of numerous parameters and experience-based expertise. Furthermore, with existing systems any change in picture being processed requires time-consuming readjustment of parameters. Another drawback with current image processing is the difficulty in removing any similar looking features, or noise, from the image, such as cables or masonry joints.

A method introducing a 'learning' based image analysis technology has been developed therefore, to distinguish cracks from images applying a deep learning process (multi-layer neural network). Two classifiers were created after learning from a large volume of pictures in two groups - either "presence of a crack" or "absence of a crack". When these classifiers or sorters were presented with a new picture, they recognised the presence or absence of a crack with over 90% successful detection (Fig. 1, Fig. 2). A hybrid detection method was proposed using a color-coded pixelated picture to show the position of probable cracks and which is then analysed focusing on location and direction of the crack. Fig. 3 shows that the level of crack detection using this method is close to that of a human being, making it possible to generate an automatic maps showing damage progression.

This method could be used for other purposes such as detection of leaking water, etc. therefore the next step is to make this system commercially available.

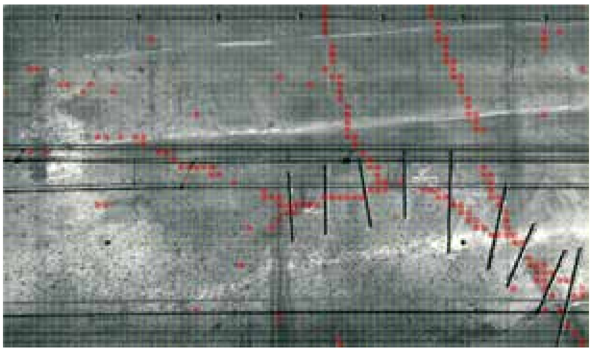


Fig. 1 Mapping of likely cracks (the redder the pixels, the greater the likelihood of a crack)

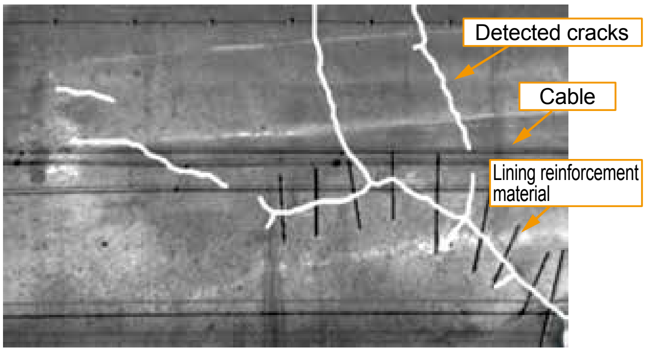
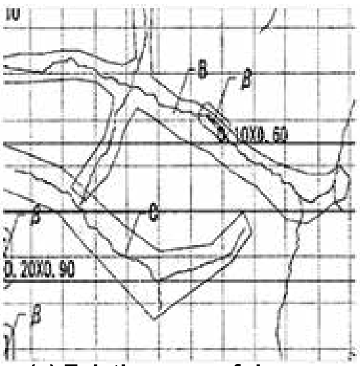
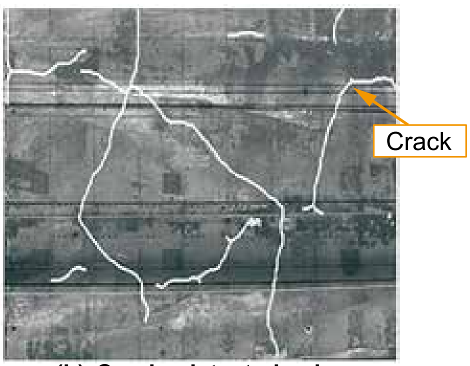


Fig. 2 Image analysis detects only the cracks in the lining reinforcement material



(a) Existing map of damage progression



(b) Cracks detected using the new method

Fig. 3 Comparison with man-made crack damage map

12. Methods to detect and predict rapid localized deterioration of track irregularity

- An effective method has been developed to correct the position of track irregularity waveforms with an accuracy of ±25cm along the railway track, by comparing frequently measured track irregularity waveforms
- By computing the difference between the corrected waveforms, rapid deterioration of local track irregularity can be detected. After this, a method to predict changes of ±1mm, up to fifteen days ahead, was developed.

The collapse or failure of structures beneath a track can lead to roadbed caving or tamping insufficiency during track maintenance, which in turn can cause rapidly deteriorating track irregularity requiring immediate attention (Fig. 1). In order to detect the signs of rapid deterioration, RTRI developed a small, lightweight track inspection device that is mounted on commercial vehicles for high-frequency track condition monitoring. However, the waveforms collected on a daily basis vary in position along the railway track by a few meters. Therefore, although differences in waveforms measured on different days can be compared, it is very difficult to automatically identify which locations are suffering from rapidly deteriorating irregularity (Fig. 2).

A method was therefore developed using characteristics of high-frequency track monitoring data to allow automatic detection of rapidly deteriorating track irregularity by position correction: while shifting the waveform phases the phase with the largest correlation coefficient between waveforms was found, making it possible to reduce positional shift to within ±25cm along the railway track. By computing the difference between the corrected waveforms, a method was developed to automatically extract locations with rapidly deteriorating track irregularity using discrepancies in measured waveforms from different measurement days (Fig. 3).

Next, a method was devised to predict future track irregularity in locations where rapidly deteriorating track irregularity was detected: after each new measurement Bayesian inference is applied to consecutively update predicted track irregularity. The accuracy of the method makes it possible to predict gaps of ±1mm up to fifteen days ahead. This allows for example, early detection of locations subject to rapidly deteriorating track irregularity, facilitating the planning of appropriate maintenance work (Fig. 4). This newly developed position correction method was also integrated as a new function in the track maintenance and management system 'LABOCS'.

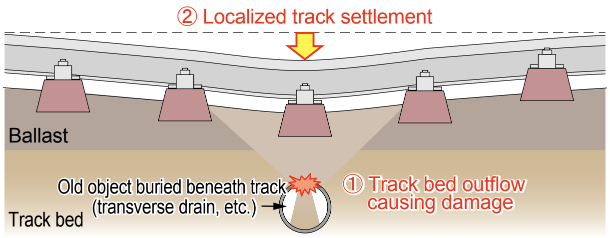


Fig.1 Example of localized rapid deterioration of track irregularity

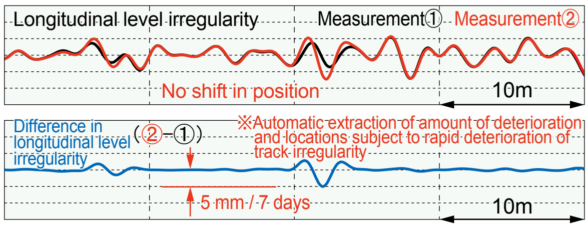


Fig. 3 Cross correlation method used to correct position and extract locations subject to rapidly deterioration of track irregularity

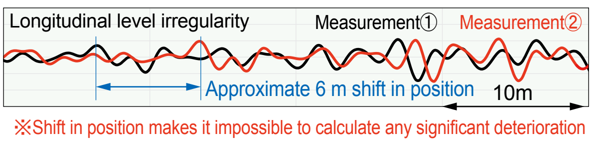


Fig. 2 Example of position correction under previous method

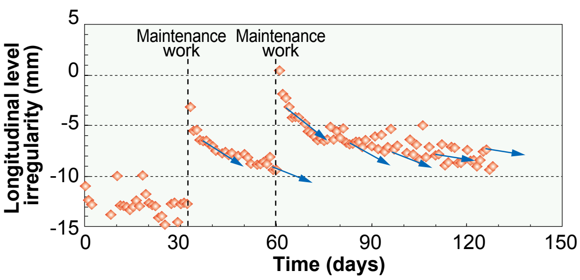


Fig. 4 Example of consecutive update of prediction using Bayes Inference

13. Development of new solid-bed track with resilient sleepers using shear-key to achieve efficient construction work

- Compared to previous structure configuration, this track structure can reduce construction work costs on concrete track beds by 60%.
- By optimizing the configuration of the structure, construction work is 1.7 times faster.

Solid-bed track with resilient sleepers (STR) is one of ballastless track in which the sleeper with under sleeper pads is supported directly by the concrete trackbed. STR not only reduces maintenance work, it also contributes to reducing structure borne noise and ground vibrations, and improves the surrounding environment. STR has already been widely constructed in urban areas, mainly on viaducts. However, there have been demands to increase construction speed and reduce costs.

For that purpose, in the new S-type STR, by introducing protrusions (shear-key) were added on each side of the sleepers to resist lateral loads, and the concrete trackbed was narrowed, cutting building costs (Fig.1). Installation of the concrete form work in this new STR is also easier, and use of short fiber reinforced concrete, removes the need for reinforcement bars. Full scale loading tests and non-linear FEM analyses were carried out to validate this structural design, and results confirmed that the proposed new track structure had sufficient performance to support train loads (Fig.2).

S-type STR was applied in practice by a railway company (Fig. 3) confirming that compared to existing STR(D-type), the concrete trackbed for S-type STR could be built at 60% lower cost, thereby reducing the overall track construction costs by 20%.

In addition, the narrowed concrete trackbed can be laid 1.7 times faster, reducing construction time.

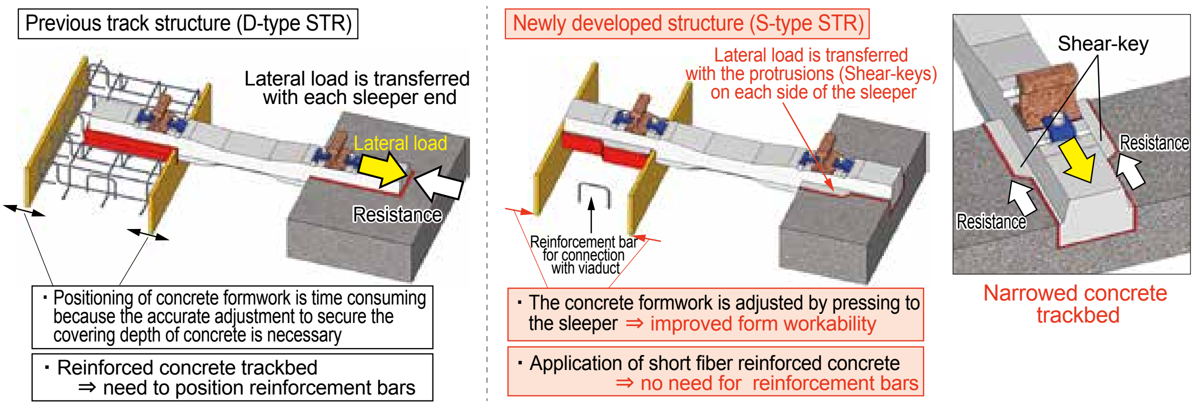


Fig. 1 Structure configuration of STR

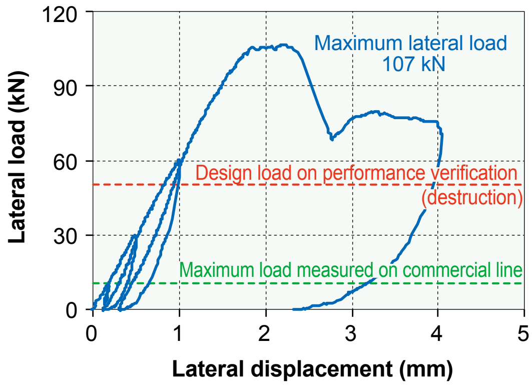


Fig.2 Relationship between load to lateral displacement on lateral loading test

Fig. 3 S-type STR construction site

14. Profiling (through grinding) of aging rails based on X-ray diffraction analyses

- Using X-ray diffraction analyses, it was confirmed that the influence of rolling contact fatigue on a rail had reached a depth of approximately 1.1mm.
- Before grinding ageing rails to 0.1 mm after every 50 million tonnes in passing traffic, a proposal was made to first grind rails to a depth of 0.3mm, and grind them again to a depth of 0.3mm after the next 50 million tonnes in passing traffic.

In order to avoid damage from rolling contact fatigue (RCF), rails are re-profiled (at present new rails are generally ground 0.1 mm before reaching 50 million gross tonnes of passing traffic). In order to find the optimal re-profiling interval and depth, it is first necessary to quantitatively determine the area affected by the RCF layer. As such, X-ray diffraction analysis was used to quantitatively assess the rail in depth from the surface (to obtain dislocation density and X-ray crystallite size which are two indices showing the degree of RCF), and two-cylinder test specimens and a rail RCF layer were evaluated.

After establishing the relationship between micro-cracks in the rail caused by RCF and the evaluation indices obtained through X-ray diffraction analysis, it was found that the threshold for micro-cracks to appear was when dislocation density reached or exceeded 1015/m2(Fig.1)..

Based on this result, analysis of an aging rail (straight section, no profiling, 450 million gross tonnes of traffic) showed that the influence of RCF reached a depth of approximately 1.1mm (Fig. 2), and it was confirmed that the rail surface had reached a condition where micro-cracks were about to appear (Fig. 3). The aging rail was then profiled to a greater depth (grinding to a depth of 0.3 mm), and it took a further 50 million gross tonnes of passing traffic for the rail to reach the stage where micro-cracks were about to appear, which demonstrated that the currently used profiling interval was appropriate (Fig. 3).

Considering the depth of RCF influence on a new rail after 50 million gross tonnes of passing traffic (depth of approximately 0.35mm (Fig. 2)), a proposal was made to grind aging rails twice, based on the premise that it would be possible to minimise the residual influence of RCF on an aging rail if the first profiling to a depth of 0.3 mm was followed by a re-profiling to the same depth before the next 50 million gross tonnes of passing traffic.

By shifting to the currently used re-profiling after this rail grinding, it is expected that RCF on ageing rails can be reduced to the level found in new rails from when they are laid to being re-profiled using the present method. A separate study will have to be made to analyse this principle when applied to curved sections.

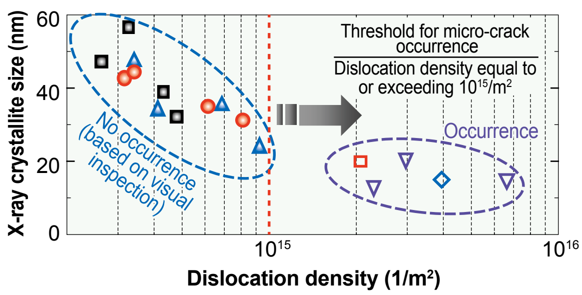


Fig. 1 Evaluation indicators and micro-crack occurrence (two-cylinder test conditions)

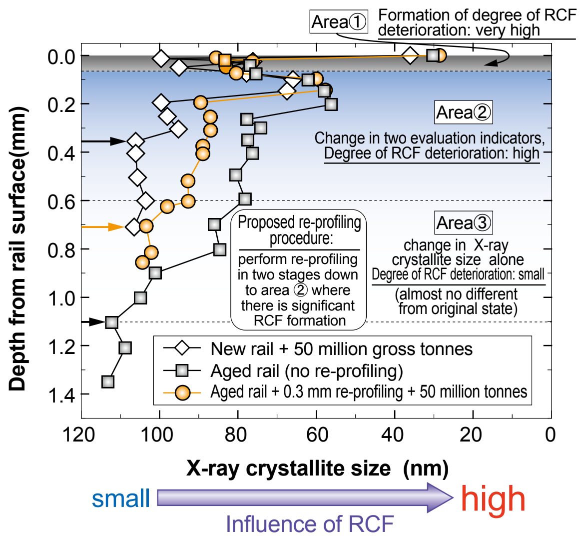


Fig. 2 Proposed profiling procedure for aging rails

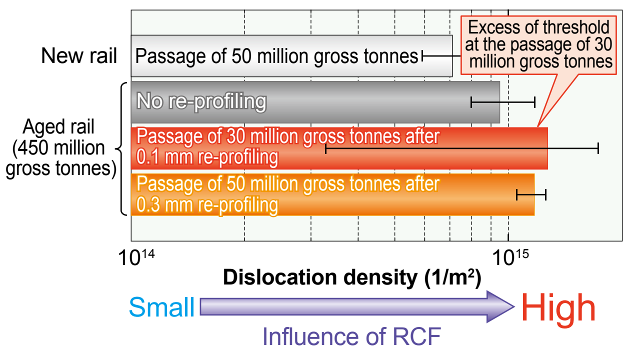


Fig. 3 Profiling depth and rolling fatigue of aged rail

15. Improving OCL connector fatigue resistance

- An OCL connector diagnosis diagram representing fatigue resistance and a set of anti-fatigue design guidelines were proposed.
- A prototype connector was built with a fatigue life in excess of 10 million applications of stress from resonance and relative displacement between contact wires and messenger wires.

Connectors that form an electrical link between contact wires and messenger wires are subject to fatigue damage from the vibrations caused by passing pantographs and so far, no effective solution has been proposed to tackle this problem. As such a set of anti-fatigue design guidelines, and a prototype connector based on these recommendations, were developed.

The main source of fatigue damage on connectors is the relative displacement between contact wires and messenger wires (Fig.1). Furthermore, the damage is particularly stark when resonance occurs between the connectors. Analyses of OCL vibrations on conventional lines, found that the maximum relative displacement was 40 mm, whilst the frequency of precursory and residual vibrations was situated in the 0.8-8.0Hz range. These results were taken as the new criteria for fatigue evaluation.

The natural frequency of the connectors and the fatigue life corresponding to the relative displacement of 40 mm were obtained using finite element analysis, which in turn was applied to determine fatigue resistance (Fig. 2). The proposed anti-fatigue design guidelines recommended a fatigue life in excess of 10 million applications of stress for a relative displacement of 40 mm, and the natural frequency of the connector equalled or exceeded 8.0 Hz, which is above the precursor and residual vibration frequency range.

The prototype connector shown in Fig. 3 was designed using FEM analysis. Confirmation was obtained that the fatigue life corresponding to the given relative displacement 40 mm and resonance was equal to or over 10 million applications of stress. During a six-month trial using the prototype connector on a conventional line there were no cases of ruptured lead wires and it was confirmed that there was no increase in wear on the contact wire.

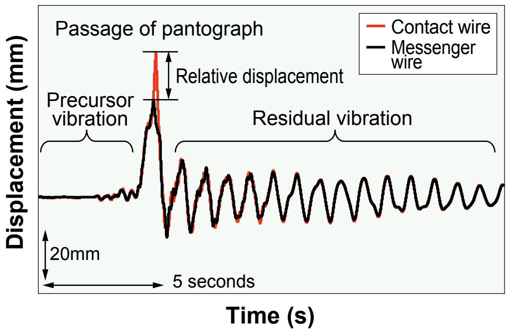


Fig. 1 Overhead contact line vibration waveform

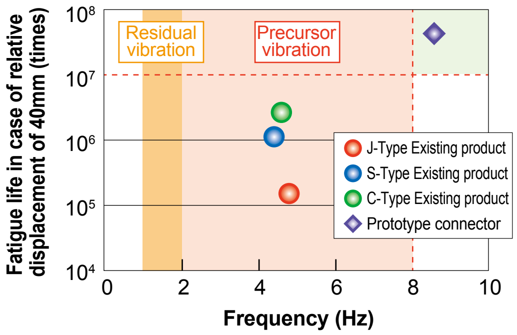


Fig. 2 Connector fatigue evaluation diagram

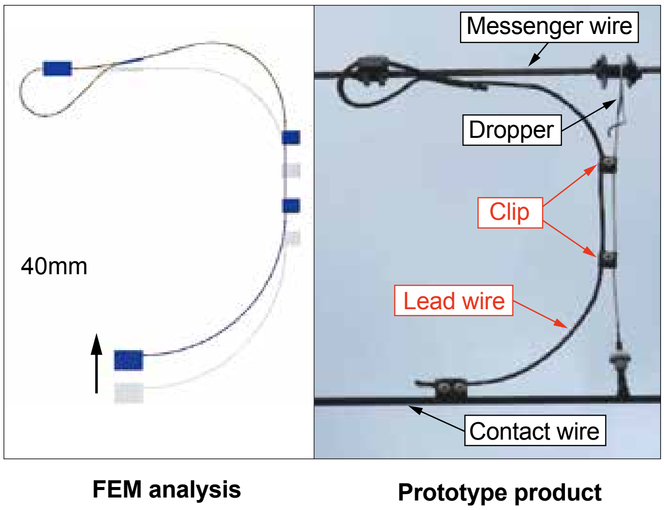


Fig. 3 Connector with fatigue resistance

16. Proposal for light weight high-rigidity car body structure

- An algorithm has been developed to derive body structures through analysis that are both highly rigid and light weight.
- A proposal was made for press-molded body structures that have a 17% smaller mass and 12% greater bending rigidity than existing car body structures.

There are demands today to make railway vehicles not only lighter and more rigid, but also lower cost. Current body structures are mainly built with stainless steel frames and sheets, however, this construction method limits the chances of satisfying the demands just mentioned. As such, the present research adopted press-molding car bodies and developed a structural optimization algorithm to design the press-molded body structures to obtain a lighter more rigid body structure.

First, the stress distribution for a whole single car body was evaluated using FEM analysis, to form the optimal structure base. The result was used as a load condition, and based on the premise that they would be press molded the optimal structure for each part of the car body was found (side windows, doors, roof, etc.), deriving a design that would be lighter and more rigid than current car bodies (Fig. 1, Fig. 2). The derived structures retained a set strength with the surface irregularity obtained analytically. The press-molded parts were then joined to the outside plate to form the car body (Fig. 3). A FEM analysis confirmed that the resulting body structure that was 17% lighter while the higher rigidity of each component increased the overall body structure's bending rigidity by 12% (Fig. 4).

Existing car body construction methods are also based on assembly of different parts, however, with this new approach, everything is press-molding reducing the number of components and therefore significantly reducing the overall cost of the final structure.

This structure optimization method can be used not only as a tool to design body structures that are more energy efficient and conducive to future higher running speeds, it can also be applied to improve ride comfort because of higher rigidity.

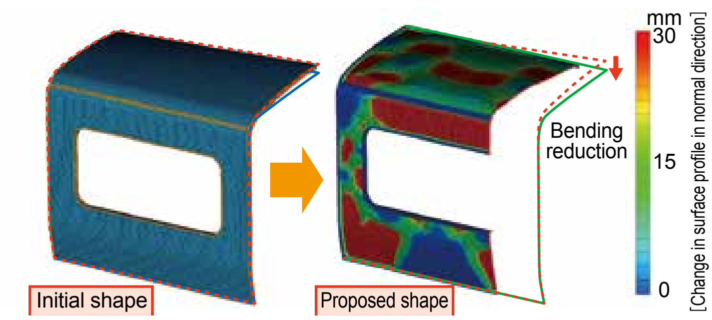


Fig. 1 Changed shape with new proposed method


Fig. 2 Press-molded body structure

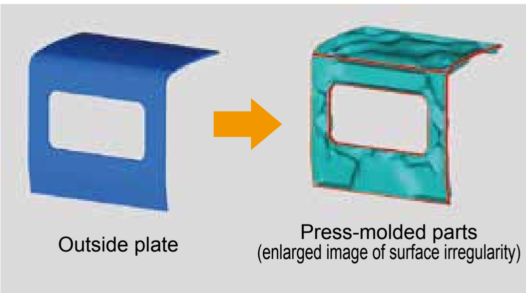


Fig. 3 New structure with press-molded parts

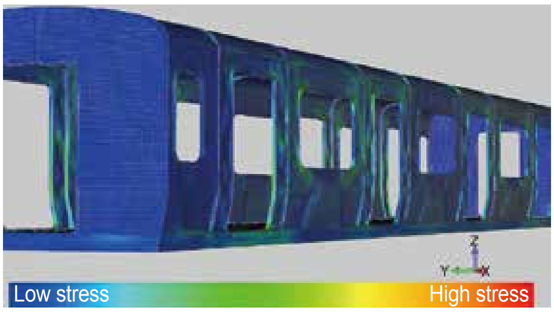


Fig. 4 Distribution of equivalent stress in new body structure

17. Reduction in manufacturing cost of C/C composite pantograph contact strips and clarification of their wear limit

- 20% reduction in manufacturing cost of C/C composite contact strip through halving of carbon fiber content and modifying manufacturing process.
- Clarification of the wear limit for the C/C composite contact strips considering the bolt-fastening force and strength of worn contact strips.
- 50% reduction in usage cost of the C/C composite contact strip through the above two developments.

C/C (carbon fiber reinforced carbon) composite pantograph contact strips have self-lubricating property, resistance to heat, high strength and toughness. Meanwhile, since they contain a large percentage of costly carbon fiber, they are more expensive than conventional carbon contact strips. Consequently, railway operators have been demanding solutions to reduce the usage cost, i.e. price per usable thickness of the C/C composite contact strips.

To meet these demands, RTRI has developed a C/C contact strip which is 20% cheaper to produce by halving the content of the carbon fiber and by simplifying the manufacturing process with a "Preformed Yarn" technique to form a C/C substrate. Material test results confirm that the developed lower-cost C/C contact strips satisfy all the necessary criteria, such as flexural strength. The lower-cost C/C contact strip showed almost same level of wear resistance as existing strips in wear tests on an actual pantograph (Fig. 1).

Although the wear limit (minimum allowable thickness for use) for C/C contact strips is also an important factor affecting the usage cost, it has not been clarified so far. Bolt-fastening force and strength of worn contact strips were taken into consideration to determine the wear limit. Axial bolt force measurements with worn C/C contact strips were conducted to verify changes in bolt-fastening force due to wear. Bending tests with worn C/C contact strips on a pantograph head were also performed to determine the minimum allowable thickness from the view point of durability. The results clarified that the wear limit for the C/C contact strips should be more than 6mm at the bolt-fastening position, and 4 mm elsewhere on the strip.

The combined reduction in manufacturing costs and wear limit clarification made it possible to cut usage cost of these strip by 50%, matching the cost of conventional carbon contact strips (Fig. 2).

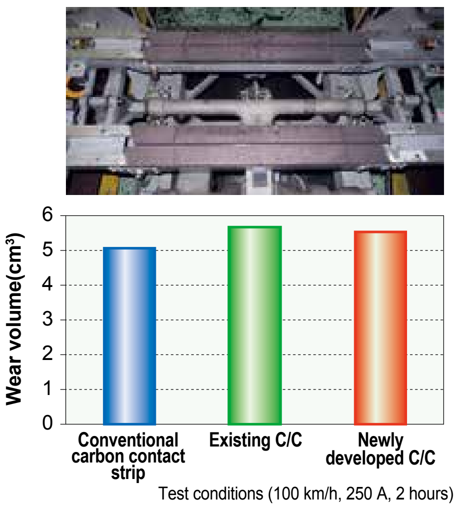


Fig. 1 Comparison of wear volume

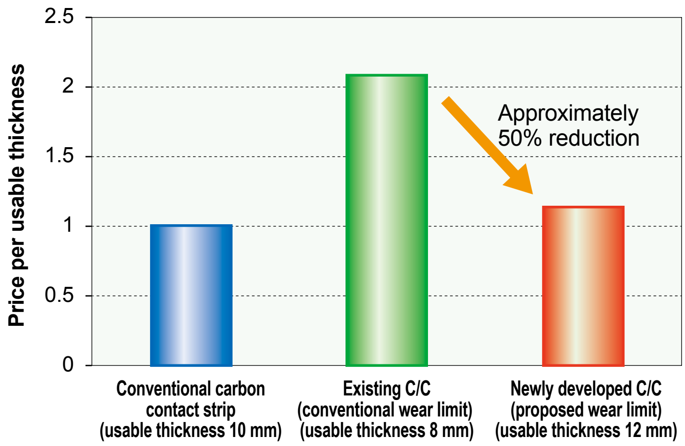


Fig. 2 Comparison of usage cost (price per usable thickness)

18. Method for evaluating serviceable life and deterioration of electronic interlocking equipment

- A method has been developed to determine the serviceable life of electronic interlocking equipment based on their working environment.
- A case study was used to determine the most critical electrical components in the device, and then age-related changes most likely to pose a risk of damage were identified.

Over the past years, a growing number of electronic devices have been used in railway signalling equipment. While there are many factors that make it difficult to understand clearly how electronic devices deteriorate, the problem is particularly acute in the case of electronic interlocking equipment where renewal is not only costly but also time consuming, and therefore there is interest in finding a way to evaluate the optimal time for when this type of equipment needs to be replaced.

As such, an accelerated parts ageing model was developed for each of the electronic components in an electric interlocking equipment, taking into account the invironment in which they are used. The acceleration coefficients obtained through this calculation were then used to develop a serviceable life evaluation method for the whole device.

The serviceable life evaluation method is composed of five stages (Fig.1) to predict the increase in failure rate over time (the 'wear-out failure period' found in reliability studies). Once the most critical component has been identified, the serviceable life of the overall device can be obtained. The most important development was a method to estimate the cumulative failure rate (Fig. 2) based on the reliability compliance test results for each part (accelerated ageing tests conducted by the component supplier), since this makes it possible to omit additional accelerated ageing tests for safety side evaluations. Trials on an electrical interlocking equipment in a small station confirmed that this method was able to identify age related changes posing a risk of failure (number of failures and increase in failure rate), and to determine which electric component would fail first (one failure in approximately 29 years for a device used in 50 stations) (Fig.3).

Following this, a calculation tool was devised to facilitate renewal planning for electrical interlocking equipment.

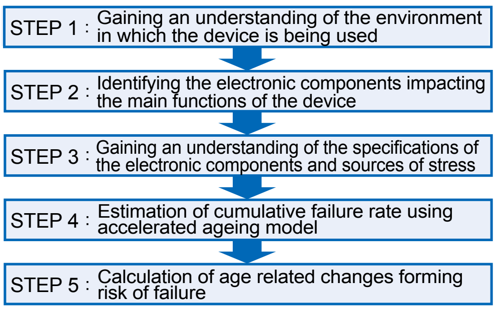


Fig. 1 Stages in the life span evaluation

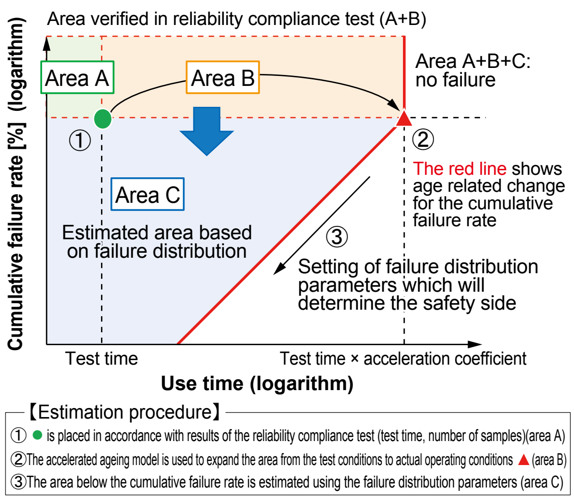
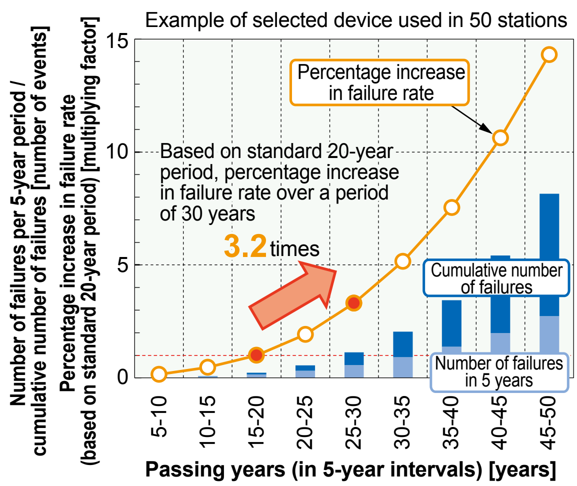


Fig. 2 Method for estimating cumulative failure rate (STEP 4)



※Temperature controlled room(constant 25℃)+ calculations based on assumption that electricity supply is continuous throughout the day

Fig. 3 Example of calculated failure risk (STEP 5)

19. Harmonics analysis modelling and harmonics suppression method for AC feeding systems

- While taking into account the effect of resonance on PWM controlled vehicles, a method was devised to calculate harmonic resonance frequencies and conditions producing resonance.
- The correlation between effective suppression and location of the harmonics resonance suppressor was also clarified.

On AC feeding systems voltage or current harmonic resonance occurs within particular frequency ranges. Measures have been put in place to prevent current harmonic resonance in lower frequency ranges up to several hundred Hz in order to prevent inductive interference with communications lines. However, with the introduction of pulse width modulation (PWM) controlled vehicles, resonance is occurring in the frequency ranges of several thousand Hz, which is emerging as a new source of influence in the electromagnetic environment.

A new harmonics analysis model has therefore been proposed to evaluate the harmonics produced by PWM controlled vehicles (Fig. 1). Results from on-site tests to verify the applicability of this new analysis model confirmed that the resonance frequency value obtained through the model corresponded to the measured frequency to within a 4% margin of error. Based on the new model, the conditions giving rise to harmonic resonance in a feeding system, such as the position of the vehicle in the feeding system, and the distance between feeder sections, were evaluated quantitatively. Results also provided quantitative clarification of where resonance would occur in the case of large distances (several tens of kilometres) between feeder sections, in several frequency ranges (Fig. 2). The insight gained from this work can be applied to establish resonance control measures on new rolling stock when introduced into service.

In addition, this method confirmed that the harmonics resonance suppressor currently used and located at the extremities of feeding systems would be just as effective for voltage harmonic resonance – with the exception of a few areas where resonance occurs – placed anywhere on the feeding system (Table 1).

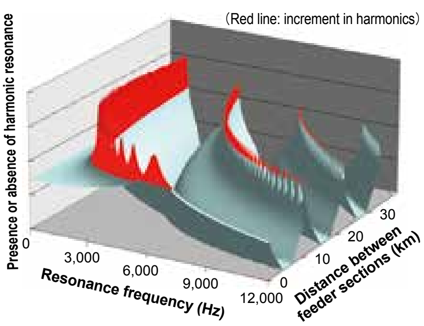
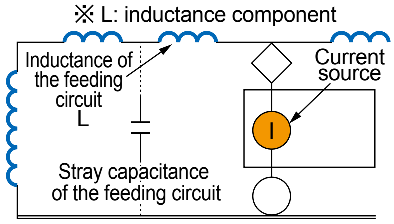
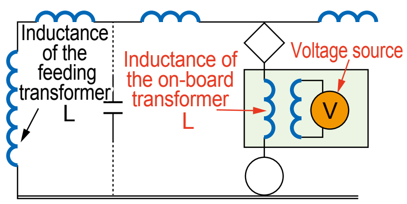


Fig. 1 New harmonic resonance analysis model considering PWM controlled vehicles



(a) existing theory



(b) New analysis model (PWM controlled vehicles)

Fig. 2 Conditions leading to harmonic resonance

Position of the suppressor	Low frequency range	High frequency range
Extremity of circuit	Effective	Effective
Middle of circuit	Effective	Invalid (area where resonance appears in particular)
Transformer side of circuit	Effective	Effective

Table 1 Effectiveness of harmonics resonance suppressor depending on position

20. Development of method for measuring and evaluating low-frequency aerodynamic noise and clarification of noise sources

- A method has been developed to measure and evaluate the low frequency aerodynamic noise generated when a train runs at high speed.
- The source of the low frequency aerodynamic noise was identified as being from the lower part of the vehicle housing the bogie.
- The method could be used to verify the effect of noise mitigating measures through running tests.

In an effort to maintain the trackside environment whilst at the same time gradually increasing the speed of Shinkansen trains, one key task is to contain pressure fluctuations in open sections. Pressure fluctuation is the combination of the aerodynamic effect produced by the middle part of a train (low frequency aerodynamic noise) and structure-borne sound. Until now however there was no clear method to measure and evaluate low frequency aerodynamic noise, and the source of the noise was also not known. Consequently, a method was devised to select appropriate on-site test conditions in order to measure and evaluate low frequency aerodynamic noise using a linear microphone array based on a noise source separation. A test site on an open, flat track section without noise barriers was used to verify the new method. Results of measurements on more than 16 trains demonstrated that it was possible to pick up separate sound sources with an accuracy of ±1dB, and that spatial identification was also more accurate. These tests also helped identify the source of low frequency aerodynamic noise as being in the vicinity of the bogie (Fig. 1).

Further work was carried out to develop a method for conducting tests using a train model launched at high speed to reproduce aerodynamic noise emitted from around the bogie in laboratory conditions. The measurement and evaluation method developed for on-site tests was adapted for the laboratory trial, clarifying that the low frequency aerodynamic noise as observed in on-site tests emanated from the cavity beneath the carbody containing the bogies (Fig. 2).

The successful results obtained in laboratory conditions mean that concrete low frequency aerodynamic noise mitigation measures can be tested with the model. Selected measures can then be verified in on-site tests and evaluated for effectiveness when applied to actual trains.

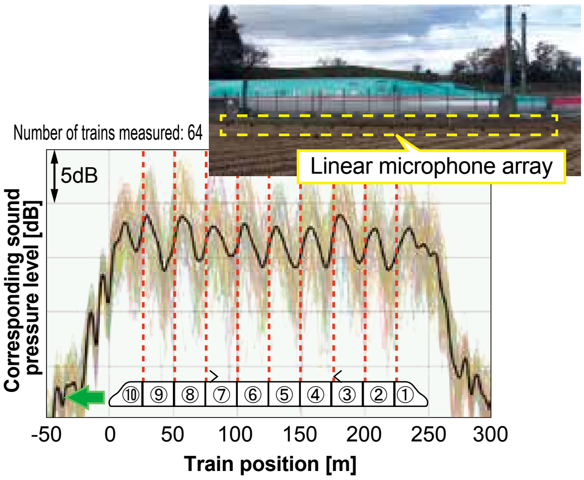


Fig. 1 Measurement and evaluation of low frequency aerodynamic noise emanating from a train (16 Hz on-site test)

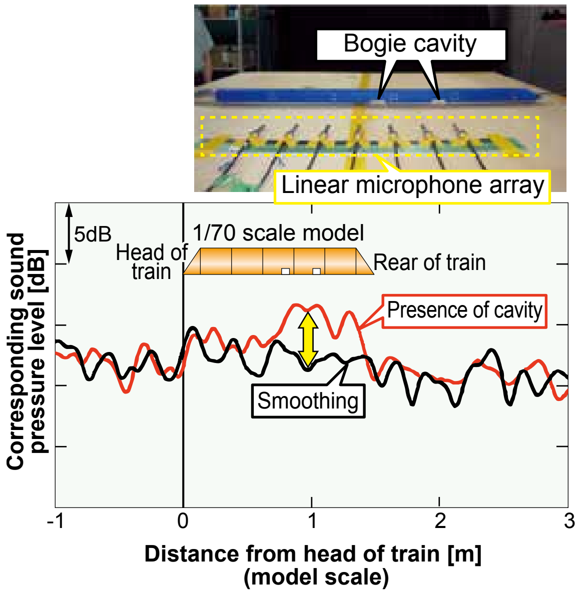


Fig. 2 Aerodynamic noise emanating from the bogie cavity (16 Hz model tests)

21. Passenger crowd density and walking speed in stations

- A method was developed to measure, in detail, passenger crowd density and walking speeds in stations.
- It was discovered that actual passenger walking speeds in a station were slower than the pace found with previous estimation methods.
- Based on walking speed data collected in a variety of different conditions, the newly devised estimation method can be used for current station design.

In order to improve the practical convenience and user friendliness of stations, it is important to identify congestion spots and introduce appropriate measures to avoid this congestion. To this end, passenger flow simulation methods that are increasingly becoming the standard tool for identifying congestion spots require models to represent movement, such as passenger walking speed. With regards to measuring walking speed, although there are methods for analysing images of crowd flows taken by high-angle video cameras, because of restrictions on where cameras can be installed and given that there is no standard method for analysing video images, data is not systematically organised.

As such, a new direct measurement method was developed where crowd density and walking speed are measured by a walking subject located among the crowd (Fig. 1). This new method relies on the analysis of the subject's walking movements at foot level, to calculate speed, whilst a small wearable device is used to measure the distance between the subject and surrounding pedestrians in order to calculate crowd density. This not only removes the need to find a camera location, but also means that measurements can be taken anywhere the subject can walk, allowing the collection of quantitative data.

Results from experiments in a station showed that the actual walking speed of people in the station tended to be slower than the walking pace estimated 40 years previously.

The various conditions associated with walking speed characteristics obtained through this method can be used for station design.

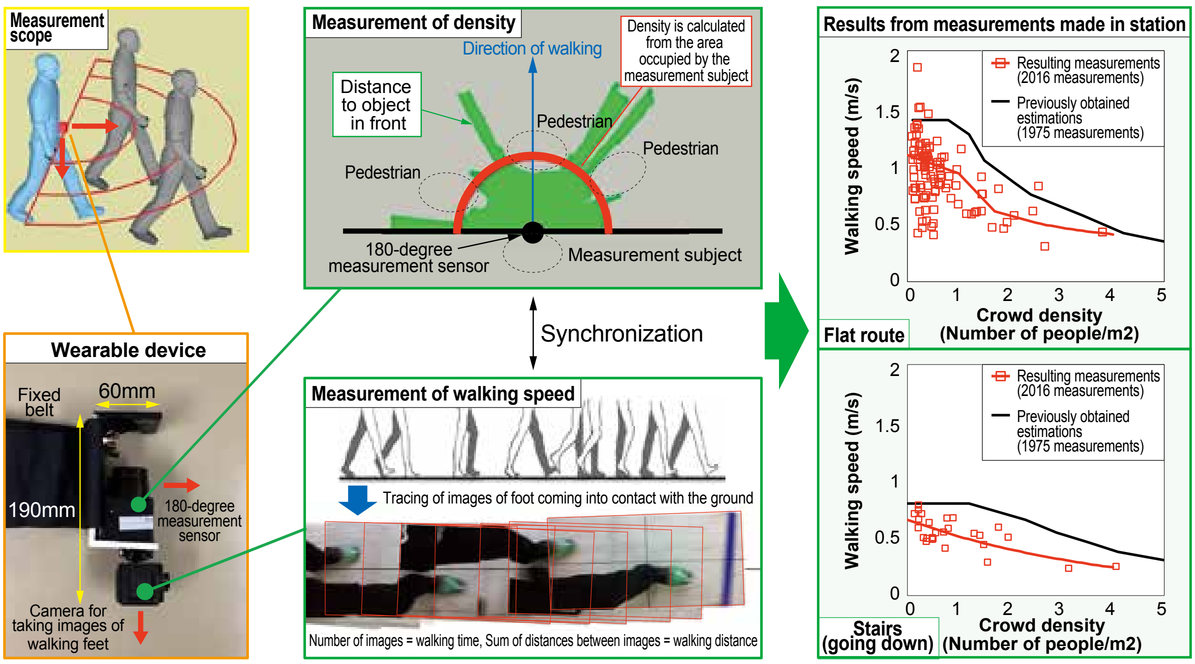


Fig. 1 Method for measuring walking speed and passenger crowd density

22. Wheel slip suppressing control method using difference in current from the traction motors

- A method for early detection and control of wheel slipping has been developed, based on the detection of difference in current from the traction motor.
- The results of water sprinkling tests confirmed that the average rotational speed could be increased by over 5%.
- The developed re-adhesion control method was adapted for use on commuter trains.

Ordinarily, wheel slips are detected using rotational acceleration and difference speed (slipping speed) from the traction motors. Many trains operate using a main traction circuit system where a single invertor will drive multiple traction motors. In the present case, for the main traction circuit control system which drives two traction motors without speed sensors within a bogie, tests on an actual vehicle confirmed that wheel slips could be detected earlier in either of the axles by focusing on difference in main traction current rather than rotational acceleration (Fig.1).

In conditions prone to wheel slipping, such as rain, the front axle in the direction of travel frequently begins slipping before the rear axle due to axle-weight transfer, and a large difference in current occurs before slipping is detected through rotational acceleration (the largest difference in the vehicle used for the present test was around 50A), which demonstrated a strong likelihood that this could be used as a sign of wheel slipping. Based on this result, a method was developed to suppress wheel slip using current difference wheel slip early-detection and reducing main traction motor torque reduction only by a small amount (approximately half the amount required when slip detection is achieved through rotational acceleration) (Fig. 2). Notwithstanding, when wheel slip occurs simultaneously on both wheelsets, the re-adhesion control method previously developed for acceleration detection was applied.

In order to verify the validity of the newly developed method, sprinkling tests were carried out using a suburban train, the average acceleration during slips increased by approximately 5%, whereas the frequency of wheel slip detected through acceleration was cut by approximately 50% (Fig. 3). This new control method which identifies current difference allows main traction motor torque control even when a vehicle is not equipped with a speed sensor (speed sensor-less), and has consequently been employed on new commuter rolling stock.

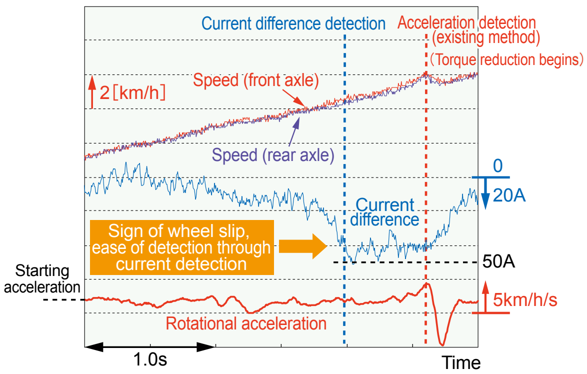


Fig. 1 Change in current when wheel slip occurs (existing)

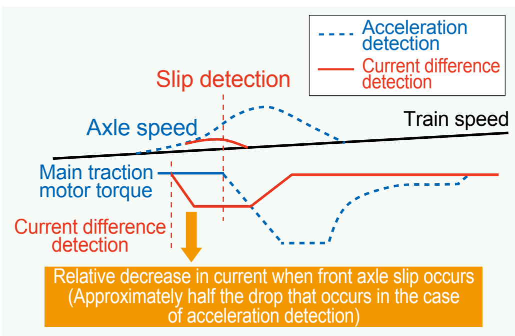


Fig. 2 Main traction motor torque control based on current difference detection

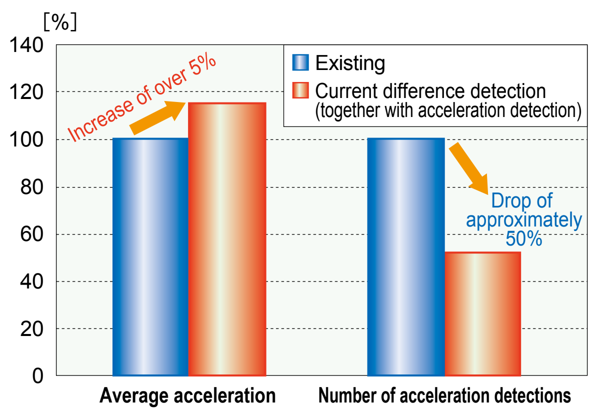


Fig. 3 Increase in acceleration and drop in frequency of detections

23. Method for predicting train delay and train occupancy rate with a lead time of several tens of minutes

- A prediction method for train delay and occupancy rate with a lead time to several tens of minutes has been developed based on neural network.
- Results from verification tests on an actual commuter line demonstrated that train delay can be predicted generally to within 30 seconds.

When train delays occur, train dispatchers predict changes in train delay and occupancy rates with a lead time of several tens of minutes, in order to arrange operations appropriately by adjusting train headways etc. Because these predictions rely on train dispatcher experience, it is not easy to rationalize their decisions. Although some operation control system contain a prediction function, the functions are based on the assumption that the conditions of train delay will continue. Accuracy therefore can be a problem.

In this research, a method based on neural network was developed to predict train delays and occupancy rates with a lead time of several tens of minutes. In the first stage of this method neural networks learn from data about train delays and occupancy rates recorded in the days leading up to when a prediction is made. On the day a prediction is made, with pre-trained neural networks, changes in train delay and occupancy rates up to the time in question are used to predict the situation for the next few tens of minutes.

A prototype system based on this method was built for testing on an actual commuter line, to verify the accuracy of the proposed method. 70 days of train delay and occupancy rate data was used for neural network learning, while data for a period of 9 days was used in the verification test. The result of the verification tests showed that, excluding data recorded when a sudden accident had occurred, the method could predict train delays to within 30 seconds in over 80% of predictions (Fig. 1).

In practice, the method would be applied to operation control systems in the control room. Predicted delays and occupancy rates could then be displayed in the operation control system (Fig.2). Train dispatchers can check the predicted delay or occupancy rate from the display, and rearrange operations appropriately. In addition, these predictions can be used to provide passengers with information about traffic conditions, because large delays and high occupancy rates can be predicted in advance.

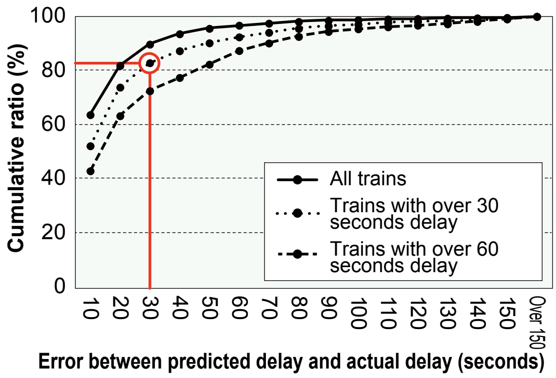


Fig. 1 Cumulative ratio distribution of prediction error

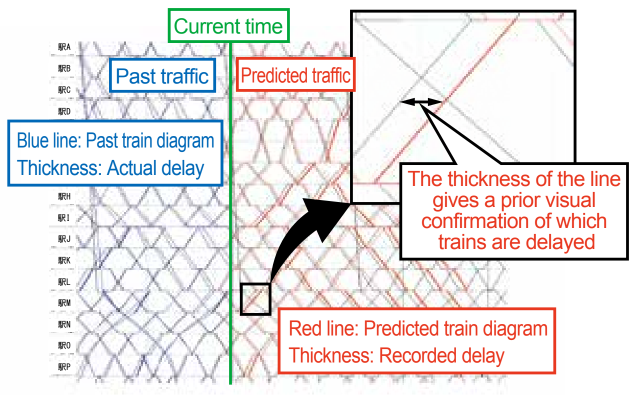


Fig. 2 Screen shot of prediction system of train operation (example)

24. Seismic resistance design method considering unsaturated condition of embankments

- Following severe rainfall, water and air can be found mixed in the interstices of an embankment. Strength tests have shown that the strength of material in an embankment is greater when partially saturated than when fully saturated.
- A method for designing the antiseismic reinforcement of embankments was therefore proposed, considering the unsaturated condition of an embankment.
- A manual was produced and the design was applied in trials, which demonstrated that antiseismic reinforcement work costs could be reduced by up to 20%.

Over the past few years, progress has been made in antiseismic reinforcement of embankments, however, existing design methods for antiseismic reinforcement are based on designs using the results of strength tests on saturated embankment materials. Consequently, there is a dearth of seismic evaluations and much work still has to be done in the field of reinforcement.

The water content inside an actual embankment affected by rain fall was therefore measured over a long period of time. These measurements confirmed the unsaturated state of parts of the embankment and that it was possible to reproduce the behavior of the embankment through seepage analysis (Fig.1).

Strength tests on unsaturated embankment material demonstrated that cohesion was greater than when the embankment was saturated (Fig. 2).

A design method for antiseismic reinforcement considering the unsaturated condition of an embankment was proposed on the basis of this outcome, and a manual was produced setting out the prerequisite conditions, surveying methods and laboratory test and design methods.

Subsequently the proposed method was compared with the existing evaluation method. The outcome showed that the required soil nails could be shortened, reducing the whole cost of work by approximately 20% compared to designs based on the existing method (Fig. 3).

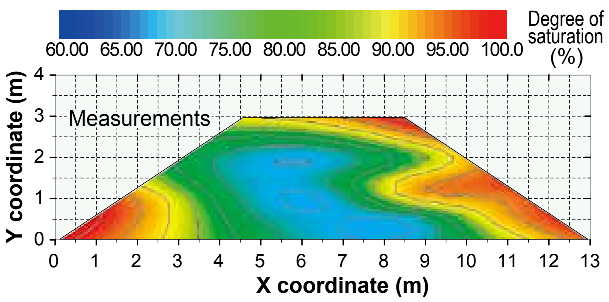


Fig. 1 Distribution of saturation level inside a railway embankment after rain

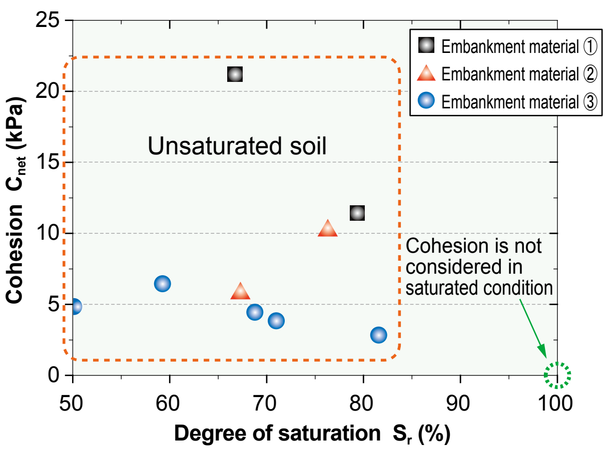


Fig. 2 Cohesion of unsaturated soil

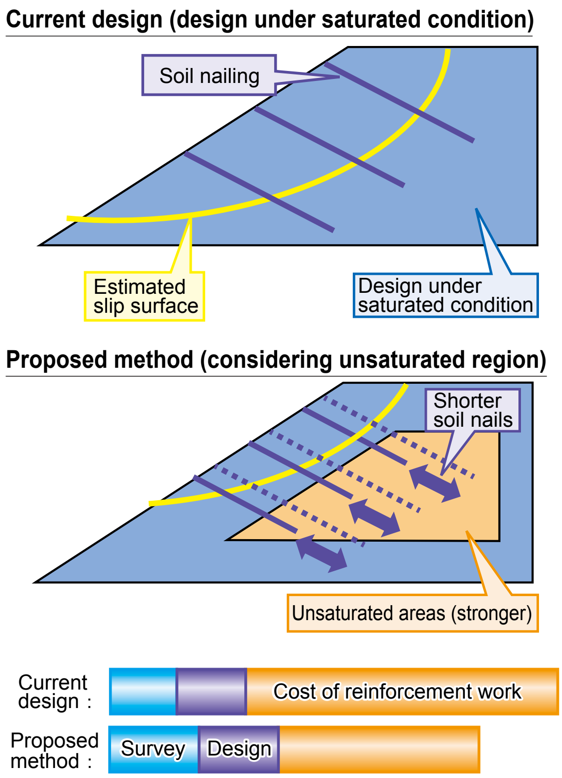


Fig. 3 Comparison of construction cost

25. Method for estimating bridge maintenance indicators by combining measured and analytical values

- A method has been developed to achieve highly accurate estimations of the maximum displacement and natural frequency of a bridge which are required for maintenance, through iterative correction calculation of input values based on measured and analytical values.
- The maximum displacement and natural frequency can be estimated in approximately 5 minutes, which means that health condition of the bridge can be evaluated on site.

The increased running speed of trains and ageing of structures means that the safety of railway bridges needs to be assessed not only frequently but also with a high degree of accuracy. As a result, recent years have seen the generalization of acceleration-based ordinary mobile monitoring which can be carried out on a permanent basis. However, using only the existing wave-form processing from passing trains, it is difficult to accurately determine railway bridge parameters with the required level of precision when trains are passing, such as displacement, impact coefficients, natural frequency, damping constant, etc.

This research therefore developed a new method to accurately estimate bridge maintenance management indicators such as displacement and natural frequency, by combining values obtained through numerical analysis and actual waveforms measured during the passage of trains (Fig. 1 (a)).

In the present method, machine learning is applied in which a calculation correcting an input value into the analysis is statistically repeated comparing the actual measured values and analyzed values. Using this approach, it is possible to effectively estimate the maximum displacement and natural frequency required for maintenance of the railway bridge using the acceleration waveform from just one point. In order to balance the speed and stability of machine learning with the measured values especially, a Bayes estimation algorithm was developed to update parameters used based on statistical decision making for the iterative calculations. The accuracy of the proposed method was verified using numerical analysis and actual measured acceleration waveforms on the bridge when trains were passing. Results of the verification showed that it was possible to estimate the maximum displacement value, which had been difficult to obtain processing measured waveforms alone, within a 5% error margin, while the error margin in natural frequency and damping coefficient estimation was on average reduced to approximately 1 in 50 minutes compared to the existing method (Fig.1 (b)).

Using the new method, it is possible to estimate the bridge's natural frequency and maximum displacement in approximately 5 minutes allowing on-site diagnosis of the bridge's soundness. Adapting the method to acceleration monitoring, will overcome the difficulties met with the existing method using just the acceleration waveform for ordinary observation, identification of weak bridges, and will allow prioritization of repairs and reinforcement.

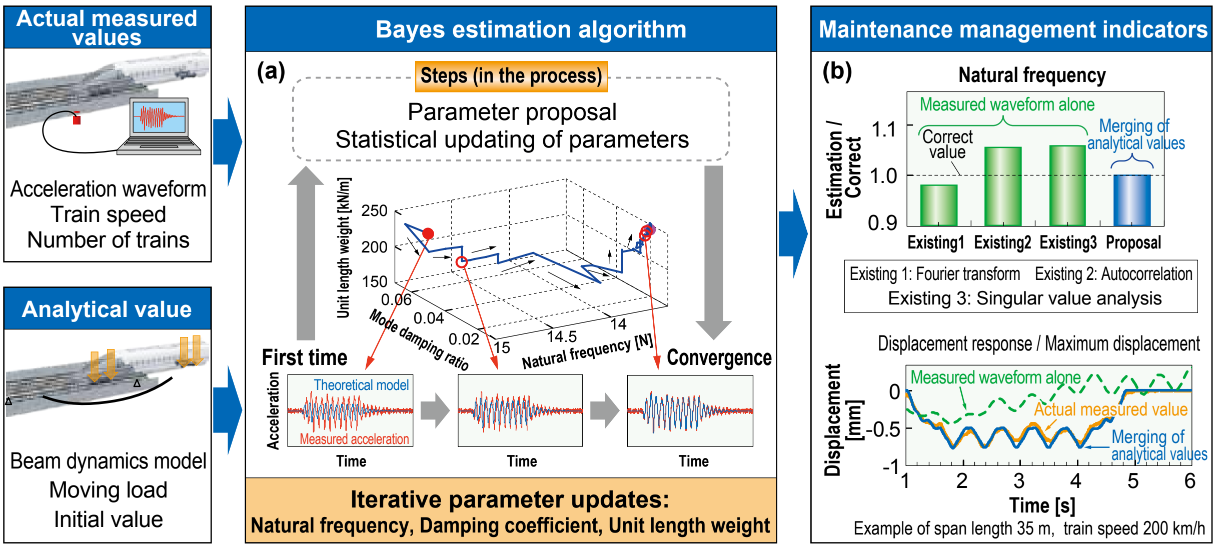


Fig. 1 Method for estimating bridge maintenance indicators by combining measurement and numerical analysis

26. Quantitative evaluation of the impact force on a bogie due to a wheel flat

- Vertical acceleration of the axle box caused by wheel flats is little affected by the wheel radius, but increases with the length of the wheel flat.
- By evaluating the drop in the axlebox and its vertical acceleration, it was found that the place of impact between the flat on the wheel tread and the rolling rig varied according to speed in the circumferential direction.

The appearance of flats on a railway wheel tread generates unusual vibrations and may cause the unwanted result of parts falling from the train.

Consequently, in order to understand the influence of wheel radius and degree of wheel damage on bogie vibrations, a wheel tread was artificially given a flat and rolling tests were carried out on a rig. After analyzing the peak values of vertical acceleration of an axlebox at different speeds, it was established that as speed increases, maximum vibration acceleration occurs at around 30 km/h, and that the length of the flat had a significant influence (Fig. 1). Based on this premise, and judging by vertical acceleration and vertical displacement time-series waveforms of the axlebox, it was confirmed that the flat caused the wheel to drop causing an impact with the roller rig, which was the source of the large increase in vertical acceleration (Fig. 2).

In addition, it was found from the relationship between the speed and time from the beginning of wheel dropping to impact (Fig. 3), that as speed increased the impact point moved to the rear of the flat. Consequently, above a certain speed, the drop in the axle box decreased causing the resulting acceleration to fall also (Fig.4).

These observations can now be used as a means to check the actual shape of wheel damage and to determine the impact of damaged wheel treads on bogies.

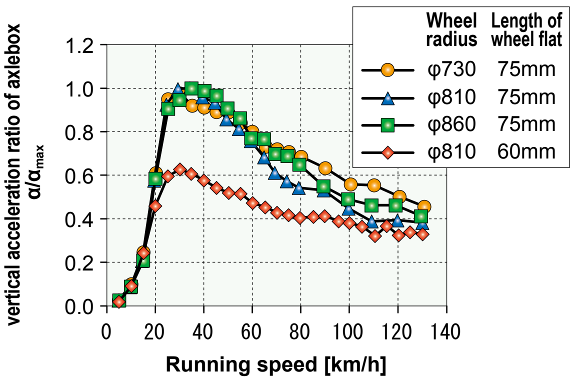


Fig. 1 Influence of wheel radius / length of wheel flat

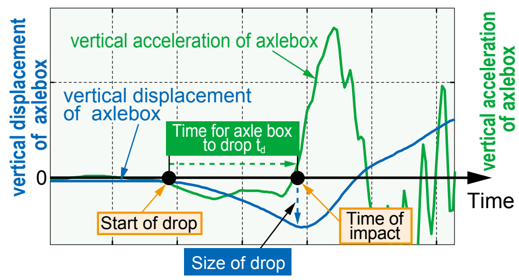


Fig. 2 Evaluation of time where axle box drops by means of vertical acceleration

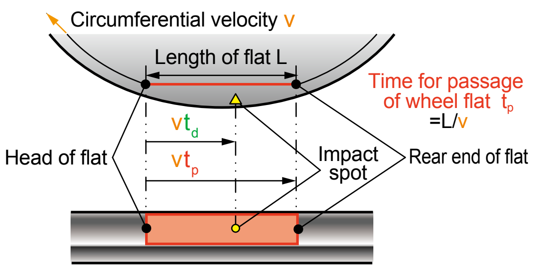


Fig.3 Relationship between passing time of wheel flat and impact position

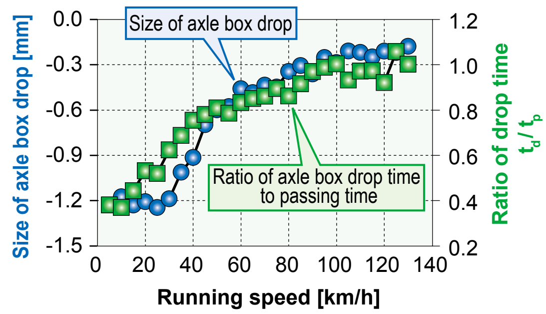


Fig. 4 Estimation of size of axle box drop and impact position (60mm flat)

27. Simulation of hot gas in tunnel fires

- This simulation method can predict the thickness of hot gas layers to within a 10% error margin and temperature rise to within a 20% error margin.
- This method can be used to assess evacuation guidelines and contribute to the design of underground ventilation installations.

In evaluating evacuation guidelines in the case of a train fire in a tunnel, it is important to be able to predict the flow behaviour of hot gas (smoke), which is the main factor hindering evacuation, propagation speed, temperature, and places where smoke will descend. In subway tunnels (underground tunnels) and in the Seikan tunnel (Aomori-Hakodate under-sea tunnel) etc., mechanical ventilation systems determine the direction of the flow of hot gas. However, in ordinary hillside or mountain tunnels where there is no ventilation, the direction of this flow will be influenced by the various factors related to the fire (location of fire source, tunnel incline and natural wind, etc.). Consequently, a simulation method was developed to predict hot gas in case of fire in this type of tunnel.

The method uses a commercial computational fluid dynamics (CFD) tool which has in addition a special feature allowing it to take into account change in temperature and source of fire. Hot gas flows in tunnel fires are turbulence flows with sudden changes in temperature, making accurate calculation difficult. As such, a new model test rig was developed (Fig. 1) and experimental results were compared with calculated results to improve the calculation model for heat transfer to the walls and fire source. Results showed that even though the calculated temperature rise tended to be lower than the experimentally obtained value (maximum error of 20% in the maximum error including temperature measured at other points), the thickness of the hot gas layer more or less corresponded with an error margin of within 10% (blue arrow in Fig. 2), confirming that it was possible to roughly predict the properties of the hot gas flow (Fig. 3).

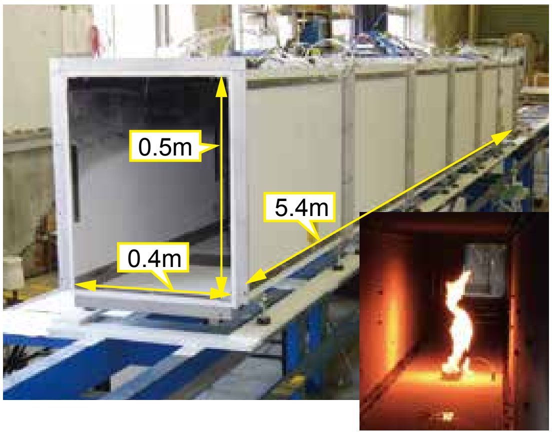


Fig. 1 Scaled 1/10 model rig used to verify accuracy of calculations

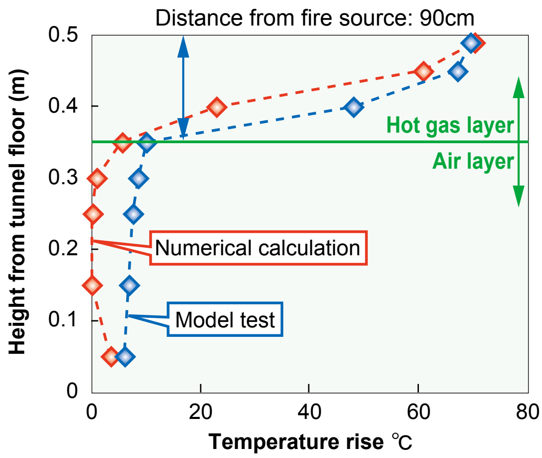


Fig. 2 Vertical temperature distribution at the central section of the tunnel

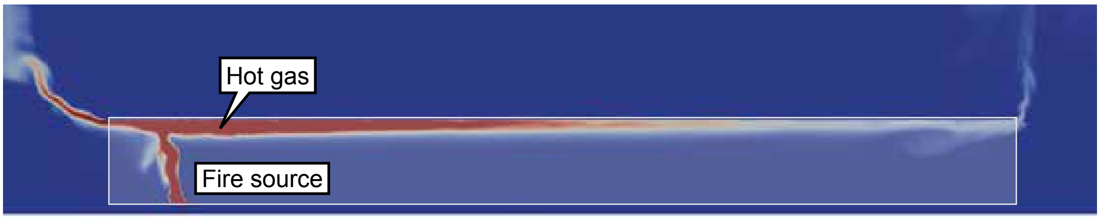


Fig. 3 Example of simulated result

28. Development of decision-making tasks to assess decision-making skills

- Based on information collected about decision-making errors through railway accident analysis, error prone situations can be detected. Following this, a set of decision-making tasks imitating these situations was developed.
- When carrying out the tasks, the part of the subject's brain related to decision making becomes activated, and confirmation can be obtained of the suitability of the task as an exercise.

Decision-making errors (judgement errors) in the railway work environment can sometimes be the cause of an accident.

In order to prevent these errors, it is necessary to give training after having assessed and understood the judgement making tendency of individuals. This said, it is difficult to estimate people's decision-making tendencies in the workplace, therefore a set of PC-based diagnosis decision-making tasks to evaluate decision-makingthese tendencies wasy were developed. In addition, functional Magnetic Resonance Imaging (hereinafter fMRI) was used to confirm activity in the decision-making related area of brain whilst subjects completed the developed tasks.

Following an analysis of the 278 judgement error cases obtained from railway accident analysis data, work situations which led to decision-errorserrors in decision making and judgement tendencies in for each scenario were considered. Results showed that over 60% of the work situations involved decisions requiring final confirmation, whereas over 70% revealed short-sightedness in judgement. Two sets of tasks were therefore developed focusing on the characteristics associated found to lead to errors inwith judgement errors that were observed, with one set reproducing work scenarios where subjects had to decide whether or not to confirm a completed task (Fig.1) and a second set where one group of subjects had to make a decision – based on merit – and were immediately aware of the consequences of their decision, while in others the subjects only gradually realized the impact of their decision. In addition to these two sets, another series of tasks was developed for critical situations, which did not however frequently lead to accidents, reproducing disrupted situations where decisions are difficult to make.

Figure 1 shows the reproduction of a situation with a task requiring confirmation situation, where the subject is supposed to check the presence of repeated specific letters on a screen, and is asked whether they want to reconfirm their checked results. Measurement of brain activity while subjects completed the tasks showed that the decision-making region of the brain (insula) was activated (Fig. 2).

The results corresponded to the content of the tasks, and that the tasks were suitable for reproducing decision-making conditions.

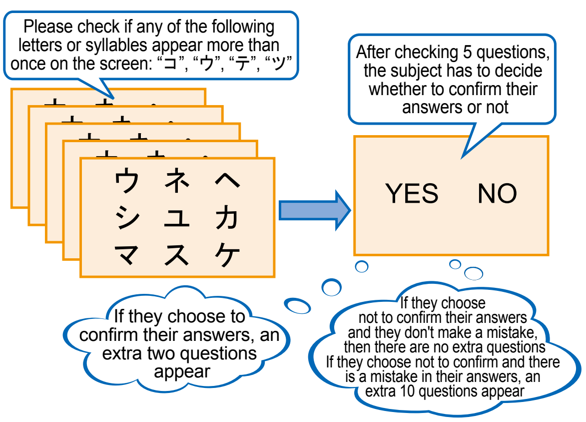


Fig. 1 Task reproducing situation requiring confirmation

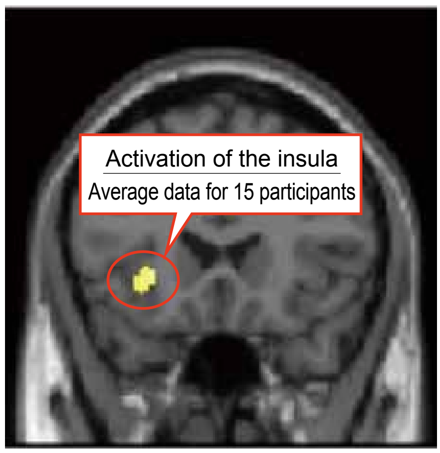


Fig. 2 fMRI image of subject whilst carrying out the task illustrated in the figure on the left

29.Demonstration of vibration resistance and magnetomotive force of Yttrium-Barium-Copper-Oxide high temperature superconducting coil

- A full-scale Yttrium-Barium-Copper-Oxide superconducting coil was produced, and evidence was gathered to demonstrate that the generated magnetomotive force of 750 kA at 32 K.
- It was also demonstrated that heat generated by the coil under maximum acceleration of 15 G stayed at +12% compared to its non-accelerated state, confirming that there was no loss of rigidity or of current characteristics.

In evaluating evacuation guidelines in the case of a train fire in a tunnel, it is important to be able to predict the flow behaviour of hot gas (smoke), which is the main factor hindering evacuation, propagation speed, temperature, and places where smoke will descend. In subway tunnels (underground tunnels) and in the Seikan tunnel (Aomori-Hakodate under-sea tunnel) etc., mechanical ventilation systems determine the direction of the flow of hot gas. However, in ordinary hillside or mountain tunnels where there is no ventilation, the direction of this flow will be influenced by the various factors related to the fire (location of fire source, tunnel incline and natural wind, etc.). Consequently, a simulation method was developed to predict hot gas in case of fire in this type of tunnel.

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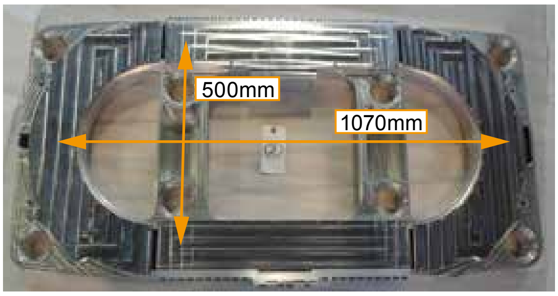


Fig. 1 Image of the YBCO superconducting coil

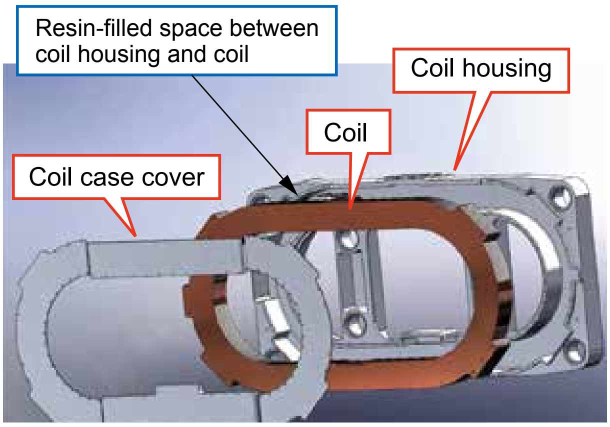


Fig. 2 Internal structure of the coil

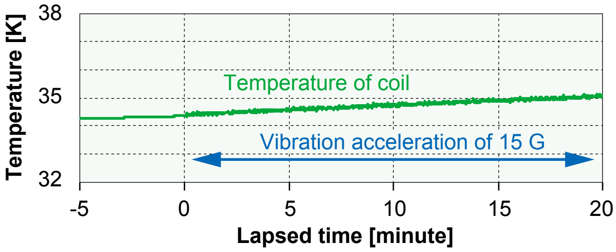


Fig. 3 Rise in coil temperature when being vibrated

1. RTRI's Expert Takes Office of ISO/TC269 Subcommittee Secretary

Three new subcommittees have been set up in ISO/TC269, a technical committee for railway applications for which Mr. Yuji Nishie of RTRI has served as chairperson. Japan has become the secretariat country for one of the three subcommittees and RTRI's Mr. Kiyotaka Seki took office of secretary. In addition, RTRI takes the responsibility of a Japanese national mirror committee for all the three subcommittees.

In March this year, the following subcommittees were set up in ISO/TC269:

ISO/TC 269/SC 1 Infrastructure
ISO/TC 269/SC 2 Rolling stock
ISO/TC 269/SC 3 Operations and services

Japan has been chosen as the secretariat country for SC3 "Operations and services" and Mr. Kiyotaka Seki, Deputy Director of the Railway International Standards Center of RTRI, assumed the role of secretary.

Following the setup of the three subcommittees, RTRI applied for an approval from the Japanese Industrial Standards Committee of the Ministry of Economy, Trade and Industry to take up the role of a Japanese national mirror committee for all of them, and was authorized on April 12, 2016.

The Railway International Standards Center of RTRI has been acting as a Japanese national mirror committee for international railway standards including the activities of ISO/TC 269. Its purposes are to ensure the safety of railway transport in Japan, to develop railway industries, and to contribute to the development of Japanese society and economy by fulfilling the responsibility to cover the entire tasks of reviewing international railway standards. Through the activities as the Japanese national mirror committee for these subcommittees, RTRI will be able to commit to the review processes at an early stage and take initiative in order to propose strengths of the Japanese technical standards and design concepts and provide better international standards. Fully utilizing this opportunity, RTRI will develop international standards activities more strategically.

2.WCRR 2016 Held in Milan

WCRR is an international congress which has been hosted and managed by the WCRR Organizing Committee composed of UIC, SNCF of France, DB of Germany, RSSB of U.K., Trenitalia of Italy, TTCI of U.S.A., and RTRI.

Nearly 1,000 participants from 38 countries took part in this 11th WCRR congress and about 100 people attended from Japan. Under the main congress theme "Research and Innovation from Today Towards 2050," three plenary sessions and 8 technical sessions were held, and at the technical sessions, a total of 312 oral presentations (66 from Japan) and 140 poster presentations (26 from Japan) were delivered. At the oral sessions, the presentations were made in two different categories, "Today's Research" for challenges that railways are currently facing and "Vision & Future" for research projects aiming for the medium- and long-term visions.

At this congress, two new approaches for presentations, the e-Poster (digital displays for posters) and Proof-Of-Concept-(POC)-type presentations were introduced to the technical sessions.

[Plenary sessions]

- Customers, Market & Competition
- Technology & Innovation
- Research from Different Perspectives

[Themes of technical sessions]

- Rolling Stock
- Infrastructure
- Railway System
- Passenger Mobility from door to door
- Freight Logistics
- Sustainability
- Economics and Policy
- Operations and Safety

On May 30, the opening ceremony was followed by Plenary Session 1 entitled "Customers, Market & Competition" and Masaki Ogata, Vice Chairman of JR East joined the discussions as one of the panelists. Vice Chairman Ogata explained that JR East has been able to do business on sound financial footing by systematizing and streamlining their business, not by resorting to fare increase or governmental subsidies, and stressed that ICT, information and communications technologies have played significant roles in order to attain healthy management. He also spoke about the further advancement in recent years in applying ICT to customer-oriented services and in providing a wider variety of services, taking an example of "Suica," the smart card ticketing system by JR East. He went on to say that the ICT including IoT (the Internet of Things), artificial intelligence and big data which will be developing exponentially in the years ahead perfectly fits

Opening Ceremony

to industries such as railway operation, which require a tremendous amount of infrastructure and facilities and provide services to a vast number of customers. He concluded his speech by saying that, in order to further promote the use of ICT in railway operation, it will be increasingly important to address not only the traditional types of in-house innovation but also open innovation including international collaboration.

In Plenary Session 2 on May 31, "Technology & Innovation," RTRI's President Norimichi Kumagai joined the panel discussion. President Kumagai stated that, from the standpoint of a research organization which provides technical solutions to railway operators, it is important to swiftly provide the market with quality outcomes which will flexibly meet the needs of customers and society. He stressed that, for that purpose, it is essential to increase the efficiency of R&D and to combine a wide variety of research techniques including advanced simulation technologies in a well-balanced manner. He also referred to the importance of digitalizing railways and pointed out that the advanced technologies such as artificial intelligence, image processing and big data analysis will be able to greatly contribute to labor conservation and automation of railway operations. Furthermore, he mentioned the significance of quantifying human decision-making processes, using the latest brain measurement technologies. Finally he stressed the necessity of further improving the advantages of railways in high energy efficiency and low carbon emission, and introduced the latest research efforts of RTRI.

At the technical exhibition which was open in parallel with the presentation sessions, 29 companies and organizations participated. From Japan, JR East and Hitachi Ltd., participated as well as RTRI and other JR group companies.

Plenary Session 1

Plenary Session 2

From left to right: Maurizio Manfellotto (CEO, Hitachi Rail Italy), Masaki Ogata (Vice Chairman JR East, and President, UITP), Sergio De Luca (Board Member, Mermec), Cinzia Farisè (CEO, Trenord)

The awards for outstanding research papers were given to eight oral presentations, one for each of the eight research fields, one poster presentation and one Proof-of-Concept presentation, and a special award for young researchers was given to one researcher under the age of 30. From among Japanese researchers, Yoshikata Tanabe of JR Central won the award for outstanding research papers in the field of "Operations and Safety."

The next WCRR congress is to be held at the end of October 2019 in Tokyo. At the Closing Ceremony in Milan, RTRI's Executive Director Fuminao Okumura replaced Marco Caposciutti of Trenitalia as the Chairman of the WCRR Organizing Committee. Executive Director Okumura expressed his thanks and respect to the efforts of the Italian Organizing Committee which successfully completed WCRR 2016. He referred to the significance that the next WCRR congress will be held in Asia, a region showing rapid progress in economy and railway technologies. Furthermore, he expressed his hope that many people will come to Tokyo from around the world and sense how vital a role railways have been playing in the Japanese economy and society.

From left to right: Norimichi Kumagai (President, RTRI), Carlo Maria Borghini (Executive Director, Shift2Rail Joint Undertaking), Josef Doppelbauer (Executive Director, European Railway Agency (now: European Union Agency for Railway)), Anson Jack (Professor, University of Birmingham)

Mr. Yoshikata TANABE of JR-Central, the award-winning speaker, at the oral session

Fuminao Okumura, Executive Director, RTRI, was handed the WCRR plaque

3. RTRI Develops a New-Type Bogie for Reducing the Risk of Derailment

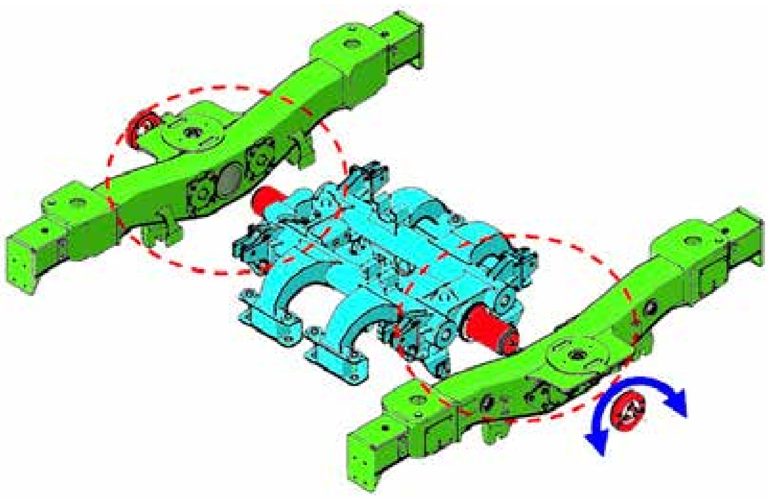
RTRI developed a new-type bogie in order to enhance the running safety of conventional line trains. The newly-developed bogie is equipped with a mechanism to prevent wheel load loss and to reduce lateral force, and is currently undergoing running tests to confirm its performance and durability at the MIHARA Test Center of Mitsubishi Heavy Industries, Ltd., toward commercial application.

A flange-climbing derailment, one of the derailment phenomena for a railway vehicle, is likely to occur when the lateral force against rail extremely increases and, at the same time, the wheel load, a force pressing wheels downward onto rail, decreases. As an indicator to assess the safety against the flange-climbing derailment, the quotient of lateral force divided by wheel load, what we call “derailment coefficient,” has been used. Since 2011, RTRI has been working for the development of the new bogie in order to get rid of flange-climbing derailments.

This newly-developed bogie has a mechanism to rotate side beams of a bogie around a cross beam.

With this mechanism, not only the wheels but the entire bogie frame can negotiate the horizontal torsion of rails and prevent loss of wheel load (Figure 1). Moreover, its axles can be steered by an actuator on curves and reduce the lateral force by reducing the attack angle of wheels against rail (Fig.2: Steering assistance mechanism).

Since May 2016, at the test track of the MIHARA Test Center of Mitsubishi Heavy Industries, Ltd., we have been conducting running tests of a test vehicle equipped with the new-type bogie in order to confirm its performance and durability. As the result of these tests, it has been confirmed that the rate of wheel load loss for this bogie is roughly 30 % smaller than that on ordinary types of bogies (Fig.3). We have also confirmed that, if the steering assistance function works, the lateral force is reduced to 1/2 or 1/3 on 120 m-radius curves (Fig. 4). As the result, it has been confirmed that the average derailment coefficient of this bogie is approximately half the value of the bogies with ordinary structures, which means the safety against flange-climbing derailment has been greatly improved (Fig.5). The targeted running distance of the durability tests prior to commercial operation is 5,000 km and the tests will be completed on July 27, this year.



Mechanism of controlling decrement of wheel load

4. RTRI presents its latest R&D outcomes at InnoTrans 2016, Berlin

RTRI will exhibit its R&D outcomes at InnoTrans 2016 from 20th to 23rd September, 2016 in Berlin.

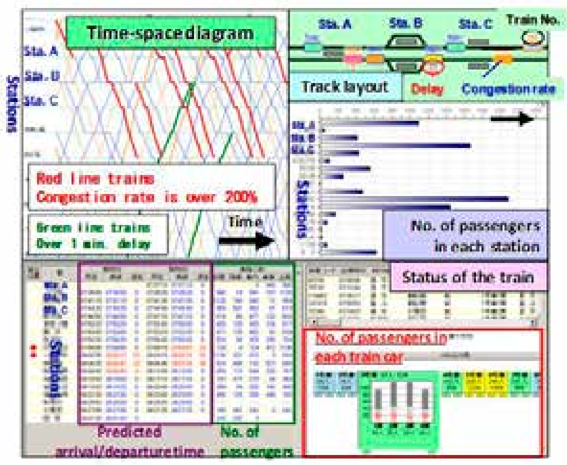
Railway Technical Research Institute in Tokyo, Japan(RTRI), will exhibit at InnoTrans 2016, which takes place from 20th to 23rd September 2016 in Berlin, Germany and is the biggest trade show in the railway industry. The last InnoTrans in 2014 had more than 130 thousands visitors from 146 counties.

RTRI will take advantage of this opportunity to disseminate its leading edge technologies and the unique outcomes of its R&D activities to the world.

At its booth in Japan pavilion in the Hall 7.2A, RTRI will make presentation on the following topics under the theme of “Leading edge of railway technologies: for the implementation of sustainable railway”:

1. general information on RTRI,
2. RTRI’s latest outcomes of R&D activities including
   - Environmental assessment techniques: estimation and evaluation method for aerodynamic noise from car bodies,
   - Technologies for ride comfort improvement: vibration suppression system using variable vertical dampers and
   - Analysis technique for improvement of convenience: train operation and passenger flow simulator, and
3. Railway International Standards Center in RTRI and RTRI’s activities for international standards.

Vibration Suppression System Using Variable Vertical Dampers which suppresses vertical car body vibration and improves riding comfort



Screen shot of train operation and passenger flow simulator which can be utilized for evaluation of train timetable from passengers’ viewpoint

5. RTRI organized International Workshop on Contact behavior in Railway Systems

RTRI organized International Workshop on Contact Behaviors in Railway System on September 12th, 2016.

The Railway Technical Research Institute in Tokyo, Japan (RTRI) organized International Workshop on Contact Behavior in Railway Systems at RTRI to discuss the direction of research in both experimental and analytic approaches about contact behaviors between wheels and rails and between overhead contact lines and pantographs. This workshop had 88 participants from nine companies/organizations including universities in Japan and abroad and railway companies.

Semih Kalay, Senior Vice President, Technology, Transportation Technology Center, Inc. (TTCI) provided the keynote lecture titled “North American Research and Technology Innovation Program to Improve Safety and Efficiency” in which he explained the current situation and the future vision of development of railway technologies in North America, as well introduced TTCI initiatives on the wheel/rail interface management. His lecture was followed by six other presentations on analytic modeling approach of rolling contact between wheels and rails and on measurement and evaluation methods of various phenomenon in wheel/rail interface caused by rolling contact. There were questions on ranges of applicable fields of the simulation software and other relevant topics.

The workshop also had other two presentations on the mechanism and prediction of abrasion of overhead lines and pantograph shoes caused by sliding contact between overhead lines and pantographs, and participants discussed the differences with respect to wheel/rail rolling contact.

At the end of the workshop, there was a round table discussion on “Future Way of Research on Contact Behavior” with four panelists. The discussion reached the consensuses that it is necessary to conduct experiments, field observation and numerical analysis in moderate balance to solve contact problems on a practical level, that collaboration between researchers and railway operators would be essential for balanced R&D, and that international research collaboration would be quite effective as a practical structure.

Ikuo WATANABE, Executive Director of RTRI, providing the opening address

Semih KALAY, Vice President of TTCI providing the keynote lecture

Program

1.Opening address

Ikuo WATANABE, Executive Director, RTRI

2.Keynote lecture

- North American Research and Technology Innovation Program to Improve Safety and Efficiency
  Semih KALAY, Senior Vice President, TTCI

3.Oral presentations

- Analysis of Rolling Contact Behavior between Wheel and Rail
  Masakazu TAKAGAKI, Laboratory Head, Computational Mechanics, RTRI
- Experimental Approaches to Evaluating some Wheel-Rail Contact Problems
  Motohide MATSUI, Laboratory Head, Frictional Materials, RTRI
- Multibody Dynamics with Experimental Observation on Wear Development
  Yoshiaki TERUMICHI, Professor, Applied Dynamics Laboratory, Sophia University
- Research Project for Rail/Wheel Contact – JSCM activities
  Yoshihiro SUDA, Professor, Institute of Industrial Science, Advanced Mobility Research Center, The University of Tokyo
- A Three-dimensional Finite Element Solution of Wheel-Rail Rolling Contact
  Xin ZHAO, Associate Professor, State Key Laboratory of Traction Power, Southwest Jiaotong University
- Adhesion between wheel and rail under wet conditions
  Hua CHEN, Laboratory Head, Track Dynamics, RTRI
- Wear Simulation of Contact Wire of Catenary
  Collina Andrea, Professor, Department of Mechanical Engineering, Politecnico di Milano
- Wear Mode Map of Contact Wire and Strip
  Chikara YAMASHITA, Senior Researcher, Current Collection Maintenance, RTRI

4.Round table – "Future Way of Research on Contact Behavior"

Panelists

- Xin ZHAO, Associate Professor, State Key Laboratory of Traction Power, Southwest Jiaotong University
- Yoshiaki TERUMICHI, Professor, Applied Dynamics Laboratory, Sophia University
- Masakazu TAKAGAKI, Laboratory Head, Computational Mechanics, RTRI
- Collina ANDREA, Professor, Department of Mechanical Engineering, Politecnico di Milano

Moderator

Mitsuru IKEDA, Director, Railway Dynamics Division, RTRI

Panelists at the round table discussion
At the right table, from left to right: Yoshiaki TERUMICHI, Xin ZHAO
At the left table, from left to right: Mitsuru IKEDA, Collina ANDREA, Masakazu TAKAGAKI

6. Railway Technical Research Institute Has Signed a Cooperation Agreement with University of Birmingham

Railway Technical Research Institute (RTRI), Tokyo, Japan has signed a cooperation agreement for collaborative research with the Birmingham Centre for Railway Research and Education (BCRRE) at the University of Birmingham, in Birmingham on September 23, 2016.

1. Purpose

Under the agreement, both parties aim to contribute to development of science and technology, in particular, railway technology through sharing their research capabilities and resources in advanced and practical research and development and in personnel exchange and development of the next-generation human resources.

2. Background of the agreement

BCRRE inherited part of the technologies owned by the former British Railways and has been dedicated to research and education on railway technologies. Its annual budget is about 5 million pounds, and it covers research fields of vehicle aerodynamics, condition monitoring, train operation systems, weather disaster mitigation, geotechnical engineering, energy management, big data analysis, environment, and safety. Both organizations have already started exchanges of researchers.

As we wish to further promote personnel exchanges and joint research in many fields for the purpose of developing railways, science, and technologies, RTRI signed a cooperation agreement with BCRRE to strengthen their relationship.

3. Content of the agreement

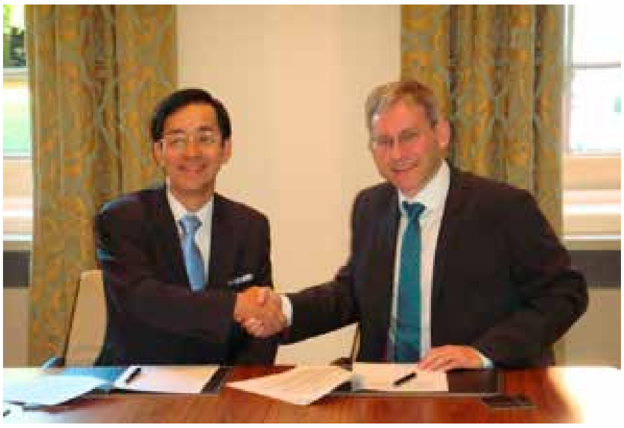
The following activities are expected to be fulfilled under the agreement:

1. Collaborative research projects.
2. Annual meetings and collaborative research seminars.
3. Exchange of researchers.
4. Other relevant cooperation and collaboration to accomplish the purpose of the agreement.

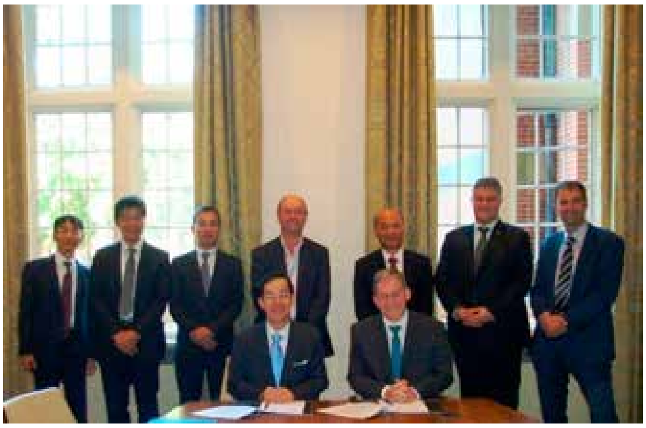
4. Upcoming collaborative research projects

Both parties will start the following two collaborative research projects under the agreement:

- Development of smart materials and reliability-based service-life assessment for railway concrete sleepers.
- Study on vehicle aerodynamics characteristics under crosswind.



Professor SCHOFIELD, and President KUMAGAI signs the agreement



At the signing ceremony Front, left to right: President KUMAGAI, Professor SCHOFIELD Back, left to right: Mr. Tsuchiya, Mr. Ikeda, Dr. Nagakura, Professor jack, Dr. Watanabe, Professor Roberts, Professor STERLING

5. Comments of both parties

Andy SCHOFIELD, the University of Birmingham:

"I really welcome this agreement and the visit of our friends from Japan. The University and its Centre for Rail Research and Education has a history of reaching out to fellow researchers in important countries and this agreement with RTRI, who are highly respected across the globe for their railway research, is an important part of our strategy. We expect to see this cooperation grow and enhance the railways of both countries as a result."

Norimichi KUMAGAI, RTRI:

"I am so pleased to conclude this cooperation agreement with the University of Birmingham. UK created railways for the first time in the world and has greatly contributed to their development, while Japan started full-fledged high-speed passenger rail services. I hope two major research organizations, representing the two countries, will collaborate more closely for further development of railways and the realisation of a better society."

6. Signing ceremony

The signing ceremony of the cooperation agreement took place in the following manner.

1. Date and time:
   12:00, 23 September, 2016
2. Venue:
   The Carnegie Room in the Aston Webb Building, University of Birmingham
3. Attendees:
   Professor Andy SCHOFIELD, Pro-Vice-Chancellor and Head of the College of Engineering and Physical Sciences, University of Birmingham
   Professor Anson JACK, University of Birmingham
   Professor Clive ROBERTS, University of Birmingham
   Professor Mark STERLING, University of Birmingham
   Dr. Norimichi KUMAGAI, President, RTRI
   Dr. Ikuo WATANABE, Executive Director, RTRI
   Mr. Ryuji TSUCHIYA, Director, International Division, RTRI
   Mr. Koichi TAKEUCHI, Associate Director, Research and Development Promotion Division, RTRI
   Mr. Mitsuru IKEDA, Director, Railway Dynamics Division, RTRI
   Dr. Kiyoshi NAGAKURA, Director, Environmental Engineering Division, RTRI

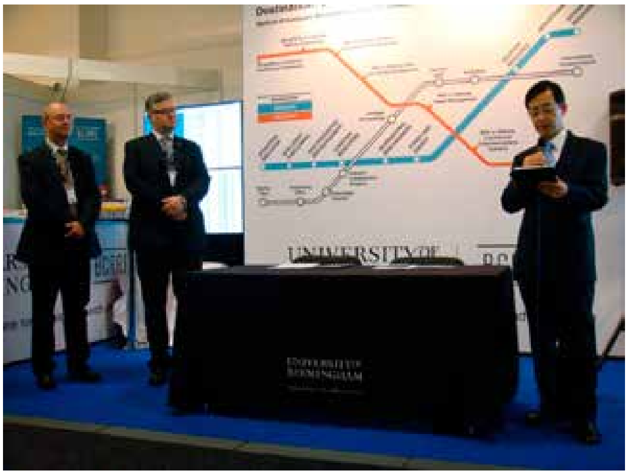
7. About BCRRE

BCRRE has over 130 academics, researchers and professional support staff, and has been delivering world class research and thought leadership within railways, and offers an expanding portfolio of high-quality education programmes.

8. InnoTrans2016

Both RTRI and BCRRE participated in the InnoTrans2016 held from September 20 to 23 this year, in Berlin. On September 21 at the booth of BCRRE, President Kumagai and Executive Director Watanabe of RTRI and Professor Roberts and Professor Jack of U. of Birmingham had the signing ceremony.

We had a meeting on railway research management as well as the signing ceremony and shared views on how to proceed with our research cooperation. We agreed to have an annual meeting.



President Kumagai delivering a speech at the signing ceremony for cooperative research agreement at InnoTrans2016 trade show. From left to right: Professor Anson Jack and Professor Clive Roberts of U. of Birmingham

7. 7th RTRI-SNCF Collaborative Research Seminar Held at RTRI

Railway Technical Research Institute, RTRI, held the 7th RTRI-SNCF collaborative research seminar from October 11 to 13, 2016.

RTRI concluded an agreement on collaborative research with the French National Railways (SNCF) in 1995 and has implemented joint research projects in various technical fields. The purposes of this research seminar are to have discussions on R&D management and to give reports of the results of joint research projects. From SNCF, eight people including Ms. Carole Desnost, Vice President Research and Innovation, and from RTRI, 45 people including Dr. Takai, Executive Vice President, participated in this seminar. Mr. Sébastien Codina, Chief of the Engineering, Energy and Environment Division of French Embassy in Japan joined this seminar as well.

On the last day of the seminar, thanks to the cooperation by the Metropolitan Intercity Railway Company, the SNCF delegation had a technical tour to the main depot and substation of the Tsukuba Express Line.

At this seminar, RTRI and SNCF agreed to further promote research collaboration through close communication and to have the next seminar in 2018 in France, and signed the minutes.

[Meeting on R&D Management]

Management persons of RTRI and SNCF shared views on R&D management, focusing on “application of ICT, big data analysis in particular, to railway operation.”

RTRI made a presentation on its research into technologies to quantify, by using ICT, what people have ruled so far, based just on their experience and what we cannot see with eyes. By quantifying various human behaviors, RTRI aims to enhance safety and efficiency in railway maintenance and energy consumption.

SNCF introduced their projects to raise railways’ competitiveness by improving productivity by utilizing ICT, to reduce overall maintenance cost by using preventive maintenance technologies, and to apply technical outcomes achieved by other industries to railways. At this meeting, they agreed to start sharing information on high-precision train position detection technology.

Ms. Carole Desnost and Dr. Takai signing the minutes

Meeting on R&D management

[Speeches by representative persons]

On the 2nd day, RTRI's Executive Director Dr. Okumura made a presentation and Ms. Desnost introduced the research strategy of SNCF.

Presentation by Dr. Okumura

He gave an overview of RTRI's research activities and introduced RTRI's major research projects in the fields of safety improvement, utilization of ICT, energy saving, and efficient maintenance.

In particular, he emphasized the significance of the research into resilience against natural disasters and prevention of human errors. He also stated that it is important to propose solutions for energy issues, to raise competitiveness of railways by cutting cost and to achieve technical breakthrough using digital technologies.

Presentation by Ms. Desnost

She introduced SNCF's technical innovation program "TECH4RAIL" and explained the outline of the technical development attained under this program. Specifically, SNCF are aiming to achieve innovation in railway systems which will "destroy" existing systems by utilizing robot technologies, 3D printing and AI. She also added that It is necessary to cut the cost of railway operation by introducing self-driving train and efficient maintenance systems, and to enhance competitiveness against other transport modes. She said, in order to achieve this goal, it is essential to introduce new technologies.

[Collaborative research seminar]

At the collaborative research seminar, the researchers made presentations on the outcomes of five projects of the 7th-phase research collaboration implemented between October 2014 and September 2016. The outcomes of each project are as follows:

- **Superconducting feeding cable**

On DC-1500V lines in France, extreme voltage drop can affect trains' smooth acceleration. But it has been found that superconducting feeding cable is able to be a solution to this issue.

The effects and versatility of using superconducting feeding cable under the conditions different from Japan was also confirmed.

- **Energy storage systems to supply power for railways**

Case studies of railway energy storage systems were conducted. The data of Japanese energy storage systems and SNCF's research tools were used to compare different power storage systems, such as super capacitors and batteries, and to evaluate the impacts of on-board energy storage systems. Through the research, the performance of the system for railway power feeding under conditions very similar to actual train operation. The results obtained in this project will be utilized in designing energy storage systems.

Dr. Okumura

Ms. Desnost

● Dynamics of new-type railway bridges

Specifications of representative types of bridges in Japan and France were compared. As the result, it was found that the difference between the specifications of high-speed railway bridges did not greatly differ between Japan and France. In addition, it was confirmed that a simulation model is capable of accurately reproducing dynamic response of actual structures when Young's modulus is set at 1.2 time of the design values and modal damping ratios are set at the design values. These findings will be utilized in the dynamic response analysis of railway bridges.

● Inspection and preventive maintenance strategies for overhead catenary systems

Information was shared regarding inspection methods and predictive maintenance technology for contact wire and fatigue of contact wire. Research into the wear mechanism of contact wire was implemented as well. A diagnosis method to detect troubles and failures of catenary systems was developed and its effectiveness was confirmed. The research will be continued in order to apply this method to monitoring methods and preventive maintenance strategies.

● Simulation models of ballasted tracks

RTRI built a simulation model similar to the analysis model for ballasted track tamping made by SNCF, and conducted analysis. RTRI and SNCF obtained similar results from these analyses and the effectiveness of RTRI model was confirmed. The research and development will be continued toward building a real-scale simulation model of ballasted tracks.

RTRI and SNCF agreed to implement following two joint research projects and six information-sharing projects in the 8th-phase period of the research collaboration, from October 2016 to September 2018.

Joint research projects

- Inspection and preventive maintenance strategies for overhead catenary systems
- Evaluation of ballasted track maintenance methods using discrete element models

Information-sharing projects

- Analysis of train-track interaction to enhance running safety
- Development of high-precision train position detection technology
- Others

In addition, RTRI proposed to start a new project on the topic "a method to predict deformation based on changes in monitoring data of railway infrastructure."

Outcomes of 7th-phase projects reported

8. 16th China-Korea-Japan Railway Research Technical Meeting

Railway Technical Research Institute (RTRI), China Academy of Railway Sciences (CARS), and Korea Railroad Research Institute (KRRI) held the 16th China-Korea-Japan Railway Research Technical Meeting from November 1 to 3, 2016, in Suwon, Korea.

RTRI, CARS and KRRI concluded an agreement on research collaboration in 2001 and have implemented joint research projects and information sharing in diverse technical fields. This year's technical meeting was organized as one of the events celebrating the 20th anniversary of the founding of KRRI. Vice Executive President Takai and 12 researchers from RTRI, Vice President ZHAO Youming and 10 researchers from CARS, and President Ki-hwan KIM and 15 researchers from KRRI joined the meeting.

On the first day, the summit meeting and group discussions on each of the research projects were held and the participants joined the tour to KRRI's test facilities. At the summit meeting, views were shared on damage mitigating measures for natural disasters including earthquakes and use of ICT for train operation, and it was confirmed that they will focus on both fields.

On the second day, keynote speeches were made and progress of each research project was reported. Topics for the next-phase collaboration were introduced as well. The keynote speeches were delivered by the following persons:

"'Rail Mobility 4.0' for the Era of the 4th Industrial Revolution" by Mr. Ho-sung JUNG, KRRI

"The Construction and Financing of China High-speed Railways" by Mr. WANG Huaixiang, CARS

"Earthquake Disaster Prevention" by Mr. Shinji SATO, RTRI

The progress of five ongoing projects was reported at the project report session and it was announced that information sharing among the three institutes will be newly started on the topic "Comparative Research on China, Japan and Korean Railway Transportation Standards."

On the last day, a technical visit was organized and the participants were able to join the test ride on Suseo High-Speed Rail Line, between Suseo and Cheonan-Asan stations.

The three parties agreed to have the next technical meeting in Japan, and signed the minutes. Furthermore, they signed a revised agreement on the three-country research collaboration which has improved its confidentiality provisions.

Participants to the technical meeting

Signing ceremony

9. RTRI's New Magazine Ascent launched

On November 30, Railway Technical Research Institute (RTRI) launches the first issue of its new semiannual magazine written in English, *Ascent*, which introduces research and development activities of RTRI in a timely manner.

[Goal of *Ascent*]

In recent years, high-speed railways and urban transit systems have been playing more and more important roles in the world's transportation scene and it is expected to be even more important to use technologies and expertise developed and accumulated by RTRI in order to further improve railways in the world. From this viewpoint, RTRI's new magazine *Ascent* has been launched in order to deepen the understanding of RTRI's activities among the world's rail-related people of diverse fields.

[Why *Ascent*?]

The word "ascent" means rising or enhancement. In December 2014, RTRI publicized its "VISION: RISING" message that described its mid- and long-term goals and strategies. This vision reads "we will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society." Since the launch of this magazine fits the policy described by this vision, the magazine title "*Ascent*" was chosen to express our determination to keep enhancing our R&D capabilities in order to attain our vision.

[What makes *Ascent* different?]

RTRI already has another English-language magazine, Quarterly Report (QR), a technical journal containing detailed research papers written by RTRI's researchers. Meanwhile, *Ascent* is targeting a broader base of readers including management people at rail-related companies in the world. Therefore, its contents are easier-to-understand and more appealing to the readers who are not necessarily experts in railway technologies. *Ascent* is published semiannually and also available on RTRI's website in PDF format as well as other RTRI's publications.

Table of contents of the first issue
Message Pioneering Cutting-Edge Technologies for the World's Railways RTRI: Its Activities
Interview Driving Railway's Innovation
WCRR The Origin and the Evolvement of WCRR WCRR- From Milan 2016 to Tokyo 2019 Japan and RTRI Enlivened WCRR2016
R&D of RTRI / Energy issues Commitment to Developing Solutions to Energy Issues Aiming at Non-Fossil-Fuel Railways: Development of Fuel Cell-Powered Trains
International Activities Overview of RTRI's International Activities

The first issue of Ascent

10. The 3rd Japan-UK Track Maintenance Workshop Held at RTRI

On November 25, 2016, Railway Technical Research Institute (RTRI) hosted the 3rd Workshop of Track Maintenance between Japan and United Kingdom.

In 2013, RTRI started to hold Japan-UK workshop on ballasted track maintenance in order to explore issues shared by Japan and UK and to develop them into future joint research projects. At this year's workshop, the third one, have covered slab track and others as well as ballasted track, and 44 people participated from two universities in the UK, two Japanese universities and railway operators.

At the workshop, one of the two keynote speeches was given by Prof. Powrie of the University of Southampton on the performance of ballasted railway track under high-speed train running. Prof. Powrie described possible issues regarding ballasted tracks for high-speed lines based upon simulation data and the data obtained in on-site measurement.

The other keynote speech was delivered by Prof. Woodward of Heriot-Watt University with the title "Critical Velocity: Prediction and Modelling." Prof. Woodward introduced a case of predicting critical velocity on a ballasted track by implementing three-dimensional analysis of wave propagation of track bed.

In addition, five presentations were made on the research into ballasted tracks, methods of data measurement and analysis, and simulation.

At the panel discussion, Prof. Ishikawa of Hokkaido University and Prof. Powrie raised issues for the research into ballasted track. During the following discussions, the necessity to pay attention to the change with age in ballast conditions was pointed out and one of the participants introduced current maintenance work using track maintenance machinery. Furthermore, Japan and UK finally shared a view that we need to be able to predict the progress of track displacement finally and, in order to attain this goal, we will have to continue systematic research composed of tests, analysis and on-site measurements.

Program of the Japan-UK Workshop of Track Maintenance

Date: 25th November 2016
Venue: Railway Technical Research Institute

1. Opening Address
Dr. Hideyuki Takai
Executive Vice President, RTRI

2. Keynote 1
"Performance of ballasted railway track at high train speeds"
Prof. William Powrie, University of Southampton

Prof. Powrie delivering keynote speech

3. Presentation 1
"Scaled model tests on evaluation of lateral resistance characteristics of ballasted tracks under various conditions"
Prof. Kimitoshi Hayano, Yokohama National University

4. Keynote 2
"Critical Velocity: Prediction and Modelling"
Prof. Peter Woodward, Heriot-Watt University

5. Presentation 2
"Basic study of vibration-reducing slab track under high-speed operation"
Mr. Shota Fuchigami, Researcher, Track Structures and Geotechnology, RTRI

6. Presentation 3
"The importance of track support stiffness and methods of determining it from trackside measurements"
Dr. Louis Le Pen, Senior Research Fellow, University of Southampton

7. Presentation 4
"Application of axle-box acceleration to track condition monitoring"
Mr. Hirofumi Tanaka, Assistant Senior Researcher, Track Geometry and Maintenance, RTRI

8. Presentation 5
"Development of the dynamic granular elastic-body analysis models for sleeper-ballast structures by the FEM (FrontISTR) and Elastic-DEM (QDEM)"
Dr. Akira Aikawa, Chief Researcher, Track Dynamics, RTRI

9. Panel discussion
"What kinds of research topics are required for the ballasted tracks in the future?"
Moderator:Prof. Ishikawa
Panelist: Prof. Peter Woodward, Heriot-Watt University
Prof. William Powrie, University of Southampton
Dr. Louis Le Pen, Senior Research Fellow, University of Southampton
Prof. Kimitoshi Hayano, Yokohama National University
Dr. Katsumi Muramoto, Director, Track Technology Division, RTRI
Dr. Yoshitsugu Momoya, General Manager, Track Structures and Geotechnology, RTRI

Q&A following Prof. Woodward's keynote speech

11.Four of RTRI's Researchers win the UIC Global Research & Innovation Awards 2016

In 2012, UIC started to provide the Global Research and Innovation Awards to outstanding rail engineers and researchers. UIC's International Rail Research Board (IRRB) took initiative in creating these awards in order to develop and enhance railway transportation at the global level and make it more attractive, cost effective and sustainable. The review committee for these awards consists of IRRB members and the awards are given to researchers and engineers for their innovative work in six main categories of "Safety and Security," "Sustainable Development," "Rail system," "Passenger Service," "Rail Freight Service," and "Cost Reduction." In addition, the Award for the Best Young Researcher and Award for Lifetime Achievement in Research & Innovation are given to a researcher of the age under 30 and to a person who has contributed to railway services for many years.

This year's award ceremony took place on December 1 at Vitebsk Station in Saint Petersburg of Russia and four of RTRI's researchers were given the awards.

Award Ceremony

Date and time:December 1, 2016 20:00

Venue:Vitebsk station in St. Petersburg, Russia

Award winners from RTRI

○ Safety & Security Award
"Development of the Earthquake Disaster Simulator for Railways against Mega Earthquakes"
Jun Izawa
Senior Researcher, Soil Dynamics and Earthquake Engineering, Center for Railway Earthquake Engineering Research

○ Sustainable Development Award
"The Development of a Fuel Cell Train"
Takamitsu Yamamoto
Director, Vehicle Control Technology Division

○ Passenger Service Award
"Development of Vertical Vibration Control System for Improving the Ride Comfort of Railway Vehicles"
Yoshiki Sugahara
Chief Researcher, Running Gear, Vehicle Structure Technology Division

○ Cost Reduction Award
"Development and Practical Application of the Ladder Track Systems"
Tsutomu Watanabe
Assistant Senior Researcher, Structural Mechanics, Railway Dynamics Division

Award ceremony(copyright:RZD)
Mr. Izawa (left end), Mr. Yamamoto (second from the left), Mr. Nishie, proxy for Mr. sugahara (third from the left), Mr. Watanabe (7th from the left)

Outline of Activities FY 2016

Railway Technical Research Institute

1 Basic policies

To contribute to the advancement of railways and help bring about an affluent society, RTRI actively promotes R&D activities geared towards railway innovation, delivering high-quality results by fully deploying its comprehensive capabilities.

In addition, to fulfil its social responsibilities as a public interest incorporated foundation, RTRI is active in promoting engineering and legal compliance and carrying out neutral activities, such as providing technical support in the event of a disaster or an accident, based on technical knowledge and experience. Moreover, in order to be the leader in global railway technologies, RTRI helps with the effective deployment of Japanese railway technology in foreign countries, simultaneously increasing its presence in the global market.

To achieve these goals, RTRI adopts the following basic policies:

(1) Dynamic R&D to encourage railway innovation

RTRI should respond to the changing times and the various needs of society and carry out innovative technical development as a matter of urgency. It should strongly promote advanced R&D and R&D in new fields, including enhancement of simulation technology and active use of information and communications technology, by allocating more resources to such activities. Also, it should steadily pursue basic research that can be a source of innovative technology.

(2) Achieving high-quality results by fully demonstrating its comprehensive capabilities

RTRI should rigorously accumulate know-how and pursue the development of human resources in preparation for solving various problems in the railway industry and developing innovative technology, and at the same time combine the strength of researchers and experts in different fields. Together with these actions, the organization's original facilities and equipment for research should be rebuilt or revamped.

Building on these measures, RTRI should achieve high-quality results and disseminate them widely around the world.

(3) Trusted activities based on technical knowledge and experience

RTRI should accumulate deep insights across the railway industry and carry out investigations into the causes of accidents and the damage caused by disasters, presenting methods to guard against their reoccurrence, and formulating technical standards based on its technical knowledge and experience as an independent third-party specialist organization.

(4) Support for overseas deployment and enhancement of the Japanese presence in the international railway sector

To become a leader in the field of railway technologies, RTRI should effectively support the overseas deployment of Japanese railway technology and simultaneously enhance its global presence by disseminating information and building close relationships with foreign railway operators and research institutes. It should also actively propose the adoption of international standards from Japan.

(5) Ensuring that the working environment allows all employees to be highly motivated

RTRI should foster an environment where free-minded researchers and experts can perform to their full potential and produce results that will bring a sense of accomplishment. It should also promote a pleasant workplace culture that allows unfettered discussions while respecting diversity in terms of age, sex, culture differences and other considerations.

2 Business Activities

(1) Research and development

(a) Basic principles of R&D

RTRI pursues the improvement of safety by developing better measures to prevent or mitigate the effects of major natural disasters and implementing derailment prevention measures. It also seeks to reduce the cost of maintenance and other elements of the rail business, to attain harmony with the environment by using energy more efficiently, and to enhance the convenience of rail travel thanks to further increases in train speeds. Drawing on these activities, RTRI will create innovative technologies that can contribute to railway advancement while solving various problems confronting the railway industry today. These challenges constitute the four "R&D Objectives" that RTRI should follow.

R&D Objectives

- Improvement of safety
- Cost reduction
- Harmony with the environment
- Improvement of travelling convenience

In order to promote R&D, resources should be augmented in leading-edge technical fields such as advanced simulation and information and communication technologies, as well as in specific technical fields relating to safety, energy, and faster running, and in other new areas.

In addition, in order to deliver high-quality results, original facilities and equipment for research and testing should be enhanced; studies should be carried out across various specific areas; accumulated know-how and data should be actively used; and the ability to offer a comprehensive service should be leveraged through networks with railway operators and domestic and overseas universities and research organizations.

Furthermore, aiming at reaching a balanced distribution of resources and achieving effective R&D, the following three agendas are adopted as the "Pillars of R&D" (Figure 2-1-1).

Pillars of R&D

- R&D toward the future of railways
- Development of practical technologies
- Basic research for railways

(b) Research and development toward the future of railways

With the objective in mind of achieving practical applications in 10 to 20 years' time, research topics should be carefully selected according to the following principles:

- ◯ Respond to the needs of the JR companies and other railway operators, and respond to social trends
- ◯ Point to advanced R&D and the future of railways
- ◯ Leverage RTRI's expertise in fields and areas where RTRI has higher R&D capability and unique features
- ◯ Pave the way for practical R&D and solve critical problems in practical R&D, and encourage research staff to make academic contributions.
- ◯ Pursue challenges that will have a large spin-off effect when put to practical use

In FY2015, RTRI will start to implement the four major challenges: "Pursuit of Safer Railway Systems," "Revolutionizing Railway Systems with Information Networks," "Speed-up of the Shinkansen," and "Construction of Railway Simulators." In each major challenge, two or three individual R&D projects have been set. Within each of these there are two or more detailed R&D projects. There will be links between the individual R&D projects so that they are implemented in a logical and systematic way (Figure 2-1-2).

(c) Development of practical technologies

Research issues affecting the railway business that will yield rapid results should be tackled so as to achieve a practical outcome in a timely and satisfactory way.

(i) R&D designated by JR companies

R&D that can contribute to the on-site solution of problems should be carried out, in response to various requests from JR companies and for which they have specific requirements. In R&D,

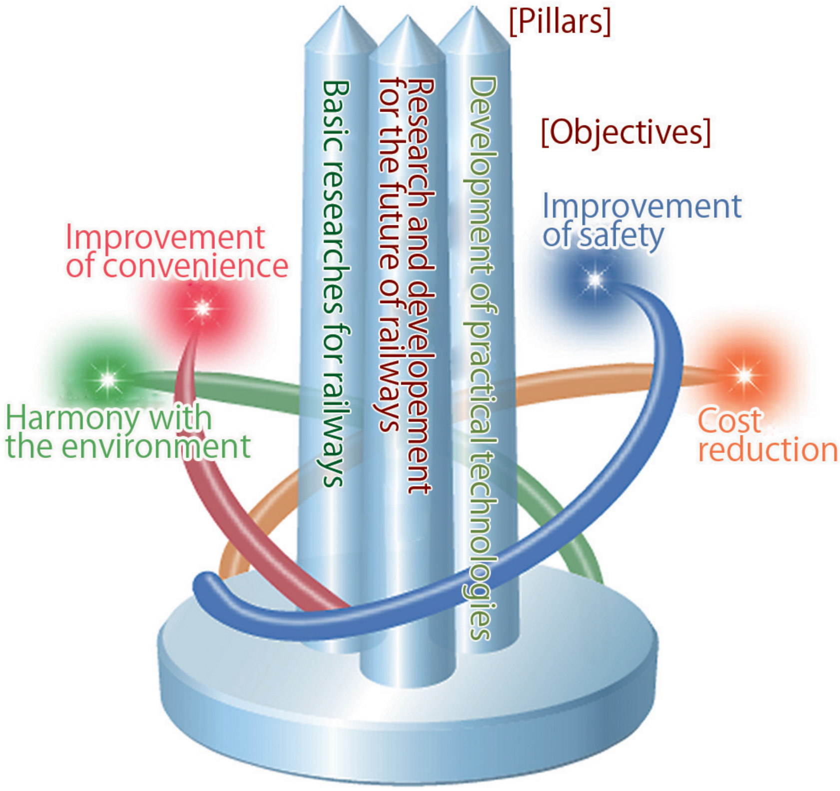


Figure 2-1-1

sufficient resources should be mobilized so as to meet the needs of the railway business and to ensure that results are provided promptly.

(ii) R&D initiated by RTRI to investigate technology for practical use

R&D into novel technology should be pursued, taking fully into account the needs of railway operators, leveraging RTRI's specialist facilities and analysis technology, and aiming at practical application in actual fields of the railway business.

In addition, for dealing with issues that require an immediate response, such as accidents or disasters, an organization should be formed to manage two or more issues so that it has an overview of the situation, and solutions should be proposed quickly.

(iii) R&D commissioned by the Government or the public sector

R&D commissioned by the Government or the public sector should be undertaken in order to put results to practical use and make them widely available.

(d) Basic research for railways

In order to solve various railway problems and address challenges related to sources of innovative technologies, basic research for railways should have high-level backing and support. It should include the following objectives: clarification of mechanisms and phenomena; establishment of analytical, experimental, and evaluation methods; development of sophisticated simulation technology; and the development of new technologies, new materials and of different approaches to research.

In the process of promoting research, the following five items should be allocated higher priority, while research in new areas such as brain science is pursued.

- Prediction, detection, and prevention of phenomena that cause disasters
- Clarification of dynamic phenomena caused by rail travel
- Elucidation of deterioration/damage mechanisms
- Improvement of the environment along railway

Figure 2-1-2

lines and the global environment

- Improvement of safety with a focus on human factors

(e) Facilities and equipment for research and testing

Original facilities and equipment for research should be replaced where necessary; the selected facilities should be directly connected to R&D activities in fields where RTRI intends to introduce innovative technologies. In addition, where the performance of test facilities has declined over time so that they no longer meet R&D needs, they should be improved or renewed, in addition to construction of new buildings for experiments.

(2) Investigation of railway technologies and science

RTRI should grasp social, economic and technological changes, and then collect and analyze various types of information generated in Japan and foreign countries that is needed in order to contribute to the technical development of the railway business. Once this has been completed, the results of such activities should be transmitted to the parties concerned. RTRI should also predict the future status of railways and conduct investigations necessary to choose technical issues for its R&D objectives.

(3) Preparation of drafts of railway technology standards

In accordance with the rising importance of the management and maintenance of society's infrastructure and the Japanese Government's movement towards performance specification of technology standards, RTRI should promote the formulation and arrangement of design standards, maintenance management standards, and design calculation examples of infrastructure. Technical fields, such as vehicles, where new technical standards should be formulated, and therefore where systematization is needed, should be clarified. This should ensure that tasks such as the formulation of design standards in these fields can proceed smoothly.

(4) Collection and release of railway-related documents, materials and statistics

RTRI should collect and collate information on Japanese and foreign railway technologies. It should also leverage various channels, such as mass media and the Internet, and transmit R&D results and activity status in a planned and timely manner. It should play a role as a source to send timely and precise railway technical information to the public.

(5) Publications and lectures to raise the profile of railway technologies and science

RTRI should expand the contents of its periodicals, such as the RTRI Report and RRR, lecture presentations, and technical forums. Through these instruments, the results of RTRI's R&D work should be offered widely to the public. The courses of lectures on railway technology and other lecture presentations should be systematic, and designed to meet the needs of all, from beginners to experts.

(6) Diagnosis, advice and guidance on railway technologies and science

RTRI should respond precisely to requests from railway operators to continuously and positively carry out its mission. Especially in offering a consulting service in response to a disaster or an equipment failure, a quick response should be agreed in a tie-up with the railway businesses or operators involved. Furthermore, consulting services for local railway companies should be enhanced by making site visits and giving technical advice.

(7) Drafting of original plans and proposals for standardization with regard to international railway standards

RTRI should promote, in a strategic way, activities related to the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). In particular, RTRI should actively participate in the operation of TC 269 (Railway Applications), newly established in ISO in April 2012. It should also strengthen its resources, and press on with projects such as "rail project planning" which Japan proposes. At the same time, RTRI should exercise leadership in standardization activities in the fields of operations and services where Japan has technical predominance.

(8) Authorization of qualifications with respect to railway-related science and technology

With a focus on accreditation tests for Professional Railway Design Engineers, RTRI should build up and arrange improvements in examination opportunities for applicants through overall verification of the tests, thereby contributing to the enhancement and maintenance of the level of technical expertise of railway engineers.

(9) Railway Technology Promotion Center

RTRI should contribute to an improvement in the level of technical expertise in the railway industry by promoting related business while taking, as pillars, systematization of technologies and problem solving, enhancement and maintenance of technical capabilities, and technical information services. For this purpose, it should tackle new research and study topics that are useful for systematization of vehicle technology, and simultaneously offer technical support to local railways and encourage technology succession by positively applying the knowledge of "Rail Advisers." In addition, the contents of the safety database should be enriched through intensified research and analysis activities in the human factors field.

(10) Railway International Standards Center

RTRI should promote strategic activities aimed at introducing Japanese technical specifications and concepts into international standards. It should actively exchange information with European and Asian standardization bodies and intensify its partnerships with them, and also boost educational activities on international standards for the parties concerned and human resource development activities.

(11) International activities

For the purpose of further improving the technical capabilities and presence of RTRI, joint research programmes with foreign universities and research bodies should be expanded. Exchange of researchers should be promoted by sending more RTRI researchers abroad and receiving more foreign experts in Japan. RTRI should actively take part in the World Congress on Railway Research (WCRR) as a member of the Organizing Committee, going ahead with preparation and management of the WCRR meeting to be held in Tokyo in 2019. RTRI should also aspire to organize international workshops and join various types of international conferences to exchange information on the latest railway technologies. RTRI researchers should be sent overseas to investigate global railway conditions and technologies.

RTRI should contribute to the wider application of Japanese railway technologies across the world by providing active support for railway operators and related businesses, assisting overseas deployment of intellectual property, and offering guidance to engineers in foreign countries.

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