# Maintenance Issues for Railway Facilities and Future Prospects in Maintenance

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## 1 Introduction

Concern over the importance of maintaining facilities has increased since the December 2012 collapse of the roof of the Sasago Tunnel on the Chuo Expressway. The Japanese government declared 2013 to be the starting point for increased maintenance, and it has been taking drastic countermeasures against deterioration of infrastructure. One may have an image of maintenance being work to keep something at its current state, but railway maintenance as implemented by JR East goes beyond that narrow interpretation of maintenance. It applies to the entire life cycle of facilities to include improvement, increased functionality, seismic reinforcement, and replacement of existing facilities. Maintenance of wayside equipment makes up about 20% of the business expenses of JR East (Fig. 1). Therefore, one can understand how railway maintenance work is an important keystone of corporate management when considering how its accuracy greatly affects safety and the stability of train operation.

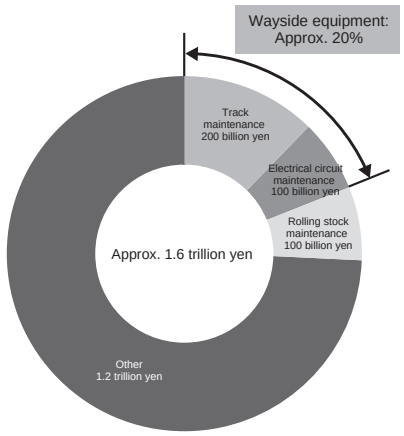
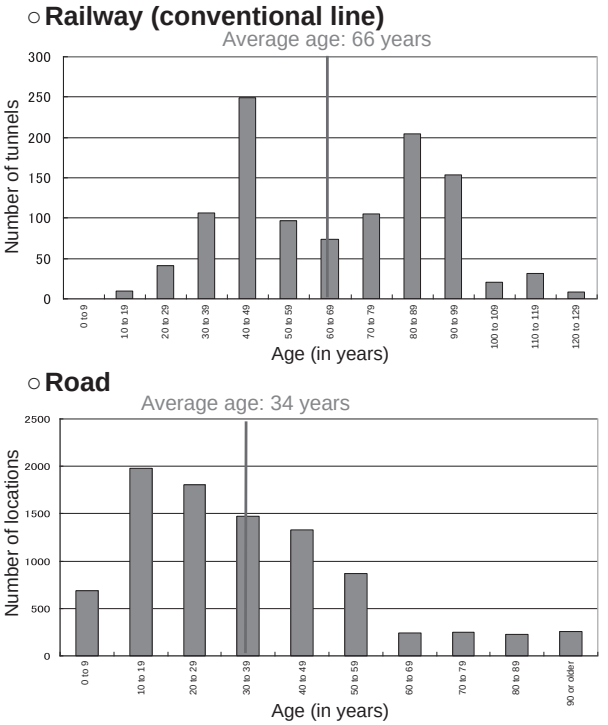



Fig. 1 Track and Electrical Circuit Maintenance Expenses in Overall Business Expenses (Fiscal 2013)

About 140 years have passed since the first railway opened in Japan, and railways have a track record of dealing with the phenomena of troubles and deterioration experienced by infrastructure preceding that of roads as railways were constructed in earnest tens of years before roads (Fig. 2).

Railway maintenance activities, as part of a field playing an important role in nations that are dealing with new issues before others, are gaining the attention of other infrastructure operators as well. We thus see as an important mission that we have to take




*Road structures include national roads (general national roads and expressways), prefectural roads, and municipal roads.
*Compiled from materials of the National Institute for Land and Infrastructure Management

Fig. 2 Comparison of Ages of Railway (Conventional Line) and Road Tunnel Structures

on updating the model for practical maintenance work as needed to fit the social environment, equipment status, generational turnover of employees, costs, and more. This paper gives an overview of the issues faced in facilities maintenance by JR East's departments involved in track maintenance, civil engineering, architecture, and machinery and demonstrates future prospects for those.

## 2 Features of Railway Infrastructure and the Mission of In-house Engineers

There are five major features of railway infrastructure. Those are that (1) facilities are old, but new facilities with increased accessibility are on the increase; (2) alternative routes are difficult to provide and the quality of facility maintenance directly affects safe and stable transport; (3) maintenance can only be done for a few hours a day as it is mainly conducted between runs of trains in commercial operation; (4) trains are heavy and passing tonnage in the greater Tokyo area is more than 20 million tons a year;

(5) maintenance personnel are made up of JR East employees and employees of group and partner companies. In light of these features, it has been suggested that even introducing outside technologies by open innovation requires in-house engineers with much knowledge of characteristics of railway infrastructure to sort out, arrange, integrate, and fine-tune those technologies. In other words, in-house engineers need to have the broad view of identifying outside technical trends that can be applied to the company's maintenance in addition to developing new technologies on their own.

## 3 Issues Faced in Maintenance at JR East

JR East faces issues residing within maintenance departments of the company and those caused by changes to the external environment due to social changes.

The issues residing within JR East include (1) the aging of facilities (deterioration due to age), (2) occurrence of serious accidents due to human error, (3) excessive or insufficient maintenance due to uniform criteria, (4) prompt fostering of engineers to deal with generational turnover, and (5) a weak supply chain. Issues caused by changes to the external environment are (1) heightened social expectations for maintenance, (2) lack of quality workers, (3) increased natural disasters in extreme climates, (4) severe competition with other modes of transportation such as LCC airlines and automobile expressways, and (5) technical innovation such as ICT.

Moreover, it is important to keep a high sense of mission and morale so that the people who deal with those kinds of issues will not tend to be reluctant to change—a common problem in the field of maintenance—and thus lead to lower motivation to take on new challenges.

The following will introduce some of issues that are particularly prominent today.

(1) Qualitative change of maintenance engineers

The labor shortage due to Japan's decline in working age population and total population and increased industrial activity with the economic recovery has become obvious in various aspects. It is thus becoming increasing more difficult to secure new young engineers in the area of maintenance in the construction industry due to potential workers being taken for building venues for the 2020 Tokyo Olympic Games and fewer people wanting to go into maintenance due to the decline in conventional public works construction. Moreover, engineers are tending to have higher educational degrees, with approx. 80% of newly hired professionals at JR East having university or graduate school degrees, so we need to transform the work they do so as to make better use of their high potential technical abilities.

(2) Increased extreme climatic phenomena

Instances of torrential rain in a short period of time, heavy snowfall, earthquakes, wind gusts, lighting strikes, and other abnormal natural phenomena are on the rise (Fig. 3). For example, Japan Meteorological Agency data on rainfall shows that instances of rainfall in excess of 50 mm in one hour have increased by 21.5 instances per 10 years from 1976 to 2013, demonstrating that such phenomena are clearly on the increase. The possibility of disasters in excess of the scale assumed in conventional disaster prevention measures is thus on the increase, so the necessity of revising those measures and making preparations from a new perspective is becoming greater.

(3) Increased expectations from society and customers

Expectations from society and customers increase year after year in areas such as higher levels of safe and stable transport, prompt provision of information on resumption of service when transport disruptions occur, and dealing with increased complaints about noise from maintenance work. This can be called a result of instant sharing of information between customers using SNS and the like as communications devices rapidly came into common use. Customers are thus demanding that JR East promptly provide information on alternative means of transportation and explain incidents that occur as ways of responding to those information needs.

(4) Technical innovation in ICT

Various efforts in computerization are being made in the field of railways in line with the technical advances of ICT. In the inspection and repair stages also, work is being done in increasing efficiency and reducing labor by means such as mechanizing operations previously done manually and consolidating management of data. In particular, constant status monitoring and utilization of big data could bring about change from conventional time based maintenance (TBM) to condition based maintenance (CBM).

Fig. 3 Station Flooding in Extreme Torrential Rain

## 4 Future Directions

The future of facility maintenance will be studied so as to deal with the various internal and external issues. But as maintenance duties are part of railway business, it is only natural that the total costs involved in maintenance (personnel expenses, operating expenses, repair expenses, construction expenses) and limits to the total number of workers taken into account.

Specifically, the method of dealing with the issues will be prescribed based on the combination of line characteristics and target levels (safety, reliability, service level, number of employees). We must aim to achieve the following three points as the basis of discussions on what methods to be taken.

(1) Increase reliability especially in the greater Tokyo area with safety levels greater than at present on all lines as the objective.

(2) Utilize enhancement of facilities, mechanization, and ICT (monitoring technologies, etc.) to restrain the increase in costs accompanying the increased volume and the degradation of facilities and vary the type of maintenance done by individual line rather than conducting maintenance uniformly.
(3) Make details of duties those that can deal with the decrease in the number of and the higher educational of maintenance personnel.

## 5 Specific Present and Future Efforts

(1) Reduction in the volume of maintenance work

As efforts to enhance facilities, we will reduce the volume of maintenance work and improve transport stability by continuing and expanding measures such as introduction of TC-type labor-saving track, next-generation turnouts, continuous welded rail, and low-cost PC sleepers. In standardization of facilities, we conduct efforts such as standardizing materials and construction methods of structures, using pre-cast structures, and standardizing specifications, thereby securing stable quality, shortening construction periods, and achieving cost reductions.

(2) More sophisticated monitoring and optimization of maintenance

Trials are currently being conducted on the Keihin-Tohoku Line for frequent monitoring of facility status with track irregularity data and track material image data. We are aiming for maintenance with optimal periods and methods by introducing CBM using that frequently obtained monitoring data (Fig. 4). At the same time, we are pursuing optimal maintenance (asset management) for structures with long services lives by quantitatively identifying current performance and creating individual maintenance records and scenarios. We are also aiming to supplement monitoring of track conditions during rainfall by remote monitoring using industrial television (ITV), reducing dangerous work and speeding up resumption of service by prompt response.

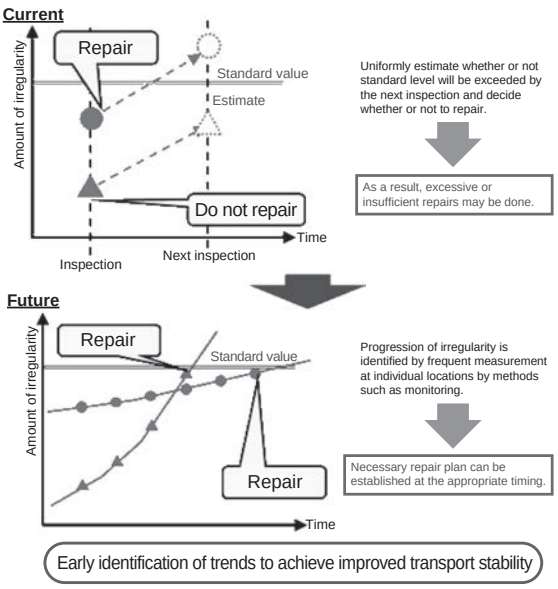



Fig. 4 Image of Repair Utilizing Monitoring

(3) Further movement to computerization and mechanization

Many of the accidents that occur during work on tracks occur at the transition between train operation time and maintenance work time. In other words, they occur due to human errors such as insufficient confirmation of or mistaken work start and end times. As safety systems that do not rely on human attentiveness, we will develop and introduce track closure/maintenance work procedure systems, train approach warning devices using GPS for lines without track circuits, systems to prevent accidental intrusion by maintenance vehicles and road railers, and the like. For maintenance work also, we will proceed with mechanization by road railer-type small machinery with small turn radius and application of robot technologies according the characteristics of the line. By doing so, we will reduce the number of workers needed, taking decline of worker availability into account. A specific example is the achievement a system for rail replacement work that centers on work by machines and achievement of maintenance with a small number of personnel to handle continuous rail replacement due to cumulative passing tonnage of the Tohoku Shinkansen (Fig. 5)

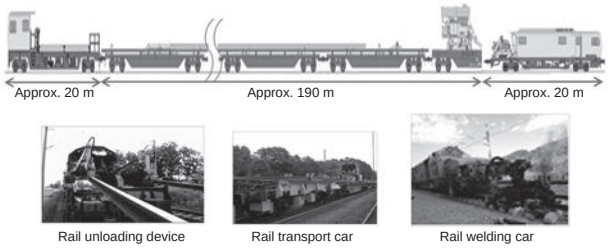



Fig. 5 Image of Trainset for Shinkansen Rail Replacer

(4) Breaking away from uniformity

JR East manages various types of lines including Shinkansen and conventional lines, urban and regional trunk lines, and local lines, so non-uniform maintenance levels according to the characteristics of the line can be set. With the increase in use by elderly passengers and visitors from abroad, we are creating station spaces that are easier to use and give greater customer satisfaction and are monitoring service using networks in locations such as on Shinkansen lines, in the greater Tokyo area, and at sightseeing stations. We are also pursuing adjustment of the volume of facilities according to their rate of utilization and optimization of the system by which work progresses.

(5) Achievement of systematic maintenance for improving transport stability

Transport stability must be improved the greater Tokyo area in particular due to factors such as through service to other lines by the Shonan-Shinjuku Line and Ueno-Tokyo Line and competition with other modes of transport. For that reason we are going forward with a variety of efforts centering on (1) preventing accidents by management of signs that accidents may occur, (2) reducing the occurrence of human errors, (3) promptly restoring service after failures occur, and (4) providing accurate information until service is restored. For providing accurate information until service is restored after a failure, we have already introduced a mechanism that allows dispatchers

to identify the situation at the site of the failure by high-speed data communications and issue real-time instructions and notifications (Fig. 6). In addition to that, we are working on management of signs that accidents may occur by monitoring, achieving more detailed repair planning, and achieving failure recovery with the command center and the front lines working as one.

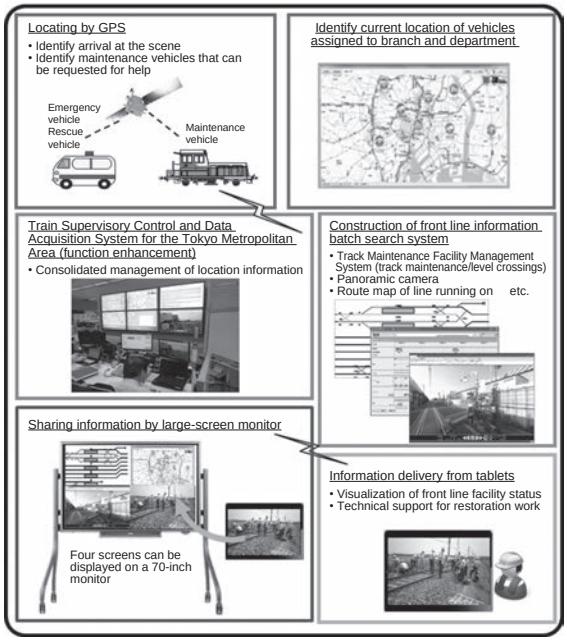



Fig. 6 Command Center and Front Lines Working as One to Recover from Failure

(6) Internalizing total maintenance abilities in the group

The experience and know-how of veteran employees needs to be supplemented due to the rapid generational turnover of employees. For that reason, JR East is enhancing hands-on learning facilities at venues such as technical training workshops (Fig. 7) and changing to a facilities management style whereby tablets are distributed to front-line employees and GIS and GPS are utilized (Fig. 8). Moreover, we are distributing many manuals and videos to tablets as e-learning functions and creating work standards by individual duties handled at each technology center. In the future, we will work to internalize total maintenance abilities by improving the work environment and enhancing areas such as human interaction while sharing values between group and partner companies and companies in the supply chain.

## 6 Conclusion

In the area of technical development, monitoring devices forming the core of CBM decision-making support systems, and other aspects are under development as are asset management methods. In computerization, track closure/maintenance work procedure systems, train approach warning devices using GPS for lines without track circuits, systems to prevent accidental intrusion by maintenance vehicles and road railers, and the like are under development with the sections involved. In the future, the results of that technical development will be put into practical use and introduced in front-line areas. In the stage of putting them into practical use, we will exchange ideas and opinions with technology center personnel and employees of partner and group companies, making corrections and enhancements as we go. We also believe that efforts need to be taken in introducing new technologies in a concentrated manner in advance and verifying their viability.

Fig. 7 Rail Bucking Re-creation Device
(JR East General Training Center: Shin-Shirakawa)

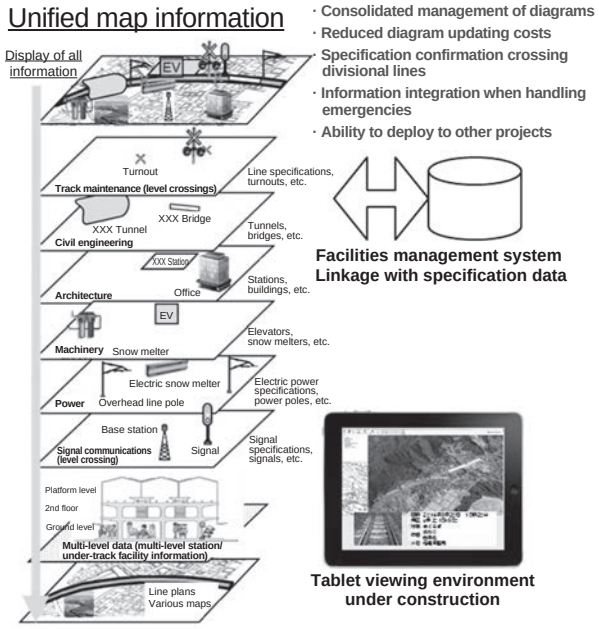



Fig. 8 Map Information Platform System (Using GIS)

We intend to come up with and achieve on our own the optimum maintenance work system overall that meets the demands placed on us by factors such as social changes and generational turnover of employees. This will be done by means including development the aforementioned and other new technologies, introduction of ICT including GIS and tablet computers, mechanization, and maintenance policy optimization. We also believe that these latest styles of maintenance will lead to effective resources for the advancement of our overseas business as well. Striving after new technologies and transformation of how work is done are tasks with no end. We will thus work as one with all those concerned so that we may provide customers with even safer and more stable transport.