Monitoring of wayside equipment by trains in operation from has become practical with the advancement in recent years of technologies such as those for sensing, communications networks and information processing. We thus have expectations for greater improvement of the reliability of railway equipment.

This article will cover maintenance issues, the concepts of a method of preventing accidents where trains in operation continuously identify conditions of equipment to prevent failures by finding predictive signs of failures (condition-based maintenance, CBM) and an overview of monitoring wayside equipment by trains in operation. R&D for the next generation will also be introduced.

1 Introduction

JR East operates as many as 12,600 train runs daily on its commercial network of total approx. 7,500 km that includes Shinkansen and conventional lines. Maintenance staff for rolling stock and wayside equipment is what keeps the infrastructure for rail transport working. And efforts are being made day-in and day-out in appropriate upkeep of the infrastructure to offer customers high-quality services.

Concern about public transport accidents and troubles has been increasing in recent years. A characteristic of such concern can be seen in the higher level of demand for stable transport service. Securing safety that human lives depend on is the matter of the highest priority in railway business. But at the same time, securing stable transport is also an important issue for JR East.

In order to secure safe and stable transport, it is important to gradually replace rolling stock and facilities with those that do not require much maintenance but have to keep their functionality while being used by many passengers. Thus, maintenance such as inspection and repair needs to be done to prevent failures.

2 Maintenance Issues

A decade back, inspection and repair work of rolling stock was done by engineers directly checking on-train devices from under rolling stock. But recently it has become possible to inspect devices installed on rolling stock and identify conditions and failure histories of those from cabs by TIMS (Train Information Management System). This contributes greatly to preventing failure of rolling stock. Inspections of wayside equipment were also done visually by inspectors walking along rails, but now special testing trains (electricity and tracks general inspection cars called East-i) and rail flaw detection cars perform detailed inspections.

Unfortunately, troubles and accidents causing inconvenience to passengers have not been totally eliminated. Analyzing status of inspections at troubles and accidents, we find that they could not be prevented with the content of inspections laid down in standards. Such troubles and accidents include the following:

- Those occurring even though periodic inspections (annual, semi-annual, etc.) had just been completed
- Those occurring from faults being overlooked in visual appearance inspections
- Those occurring suddenly in equipment built in to electrical devices

The inspection methods thus need to be revised to prevent troubles and accidents and improve reliability of railway systems. Possible examples of revising inspection methods are as follows:

- Introducing further mechanization and automation
- Early detection of signs of failure by revising inspection systems from time-based maintenance (TBM) to condition-based maintenance (CBM)

CBM has become feasible with rapid developments in areas such as information technologies, sensor technologies, and data transfer technologies. Monitoring technology advanced starting from the medical field, and that came to be applied in inspection systems of other fields as “health monitoring” inspection methods.

Fig. 1 shows the concept of the above-mentioned accident prevention.
Conventional TBM has the advantage that a maintenance plan can be easily set up since inspection and maintenance work are to be implemented at specific intervals. However, it has a disadvantage in that it cannot deal with sudden troubles and accidents, and there is a danger of limits being exceeded in worst-case scenarios. Fig. 2 shows a comparison of TBM and CBM.

The advantage of CBM is that the utmost safety is more achievable because predictive signs of troubles and accidents can be identified. CBM also can reduce periodic inspections that need to be done manually. Disadvantages are that measuring devices need to be installed or added and that a tremendous amount of data needs to be automatically judged. CBM also can reduce periodic inspections that need to be automatically judged (simplified by recent IT).

We are aiming for a way to monitor wayside equipment that differs from TBM, traditional periodical maintenance such as that done quarterly or annually. Our goal is to deploy CBM where we continuously identify the conditions of equipment from trains in operation to prevent failures by finding predictive signs of failure.

We have been conducting from 2008 function confirmation tests, sensor sensing tests and data transfer tests on various monitoring devices using our MUltipurpose Experimental Train for the conventional lines (MUE-Train). In the future, we will also conduct R&D on making devices more compact, cost reduction of IC tags laid at the worksite and confirmation of IC tag durability.

We are going forward in our vision of the future of maintenance with early detection of predictive signs of accidents exemplified by monitoring of wayside equipment by trains introduced in this article for inspections. For repair, we are proceeding with R&D on application to railways of metal material adhesion technologies such as the cold spray method and on mechanical construction technologies for the upcoming major replacement of Shinkansen rails. Through that R&D, we aim to achieve repair by new technologies and repair by mechanization.