Construction of a Decision-making Support System for Proposing Track Maintenance Plans

Current maintenance plans are based on time-based maintenance (TBM). TBM is based on instruction for track maintenance and repair limits. On the other hand, in condition-based maintenance (CBM) the track maintenance plan is determined in consideration of cost-effectiveness and the maintenance level at which reasonable maintenance is possible. The decision-making support system introduced in this paper can propose track maintenance plans using details of track irregularity by analyzing frequently obtained data. Through the construction of the system, realization of high-quality track maintenance and improvement of technical capabilities can be expected. We report on the development and content of the decision-making support system in this paper.

Keywords: Decision-making support system, Condition-based maintenance, Track condition prediction, Maintenance plan
Taking such into account such tendencies by users in evaluation, we believe it best to suggest predictions results as-is, including prediction accuracy.

The decision-making support system thus indicates prediction accuracy (probability) and prediction error too. Fig. 3 shows a part of the screen.

Fig. 3 Example of Prediction Results Screen

3.2 Display of Related Data Needed by Engineers

Track irregularity occurs from different causes, so maintenance planning involves investigation of many factors that might affect irregularity to identify the root cause and making a plan for maintenance of both of track irregularity and the causes of irregularity.

We thus provided a function to display with the system many types of information in parallel. The items and order of display can be flexibly changed as engineers desire. Fig. 4 shows an example of a screen.

Fig. 4 Example of Related Item Screen
3.3 Function for Making Multiple Suggestions and Simulations
The most important feature of the decision-making support system is the function for making multiple suggestions and simulations. That is a function where effects and costs are suggested for different maintenance methods and where a prediction of change in track condition is displayed by inputting a maintenance plan. Fig. 5 shows an example of a screen. As shown, the screen displays a prediction of track irregularity, prediction of track material condition, and suggestion of maintenance methods for the predicted track material condition. The system suggests more than one maintenance method, and it ranks the methods based on maintenance effects and costs. That supports front-line engineers in making decisions based on track condition, maintenance effects and costs, and the like.

The effects of individual maintenance methods could not be simulated with measurement data from the currently used electric and track inspection car (East-i) at a practical level of accuracy. But, analyzing data frequently obtained by track monitoring using trains in operation enabled precise simulation per individual repair site.

3.4 Constantly Upgraded System
The decision-making support system is not a conventional system that is updated or replaced due to obsolescence or lifetime of the machine. It is rather being developed as a system that is upgraded or customized as needed by the worksite at the request of front-line engineers or when a new index or theory that will support decision-making is discovered. This means the system can be introduced before completion of development; the parts completed can be introduced and then gradually upgraded. As the system is constantly upgraded, it does not fall under a concept of being a “complete” system, rather being a “constantly evolving” system.

4 Effects of Introducing the Decision-making Support System
The aim of the system is not to replace work or to reduce work time, so we cannot expect with the system direct reduction of labor cost or other costs where specific figures can be presented. Rather, it may actually involve factors resulting in cost increases initially.

However, rational decision-making using the system and penetration of CBM will generate huge cost reduction effects. Furthermore, upgrading the system will lead to more rational decision-making, further improving cost effects. Those cost effects will be sustainable, rather than temporary, meaning they will increase further into the future.

5 Future Efforts
As a track monitoring system using trains in operation was introduced in the second half of fiscal 2014, we introduced a prototype decision-making support system and started test operation by front-line engineers. We plan to make future improvements to the system taking into account the comments and requests of engineers.

Reference: