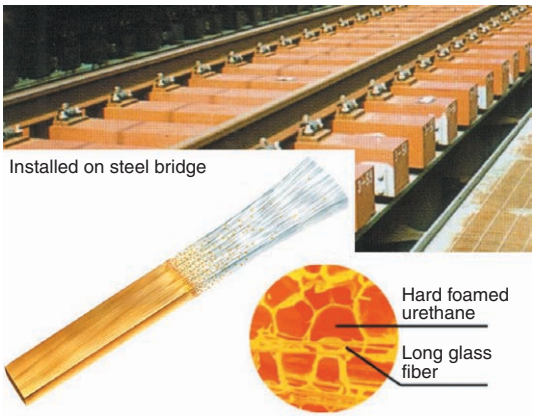
# Japanese Twenty Five Years Experiences and Standardization of Synthetic Sleeper

**Hideyuki TAKAI**
Director, Track Technology Division

Because of the inherent problems of wooden sleepers, especially their lack of adequate durability, synthetic sleepers were developed in Japan in 1980. Over the last 25 years, about 1 million synthetic sleepers have been installed on track, replacing wooden sleepers in turnouts and on steel bridges, and forming part of directly fastened track. About 100,000 synthetic sleepers are now supplied each year.
The synthetic sleepers are composed of long glass fiber and hard foamed urethane, and are superior to wooden ones. They are fabricated automatically in a factory, and tests have verified that they can maintain their physical strength for more than 50 years. Those that have been in service for 25 years still meet quality standards.




Their superior characteristics are as follows: (1) high mechanical strength; (2) high resistance to rot, with little water absorption; (3) little variation in form; (4) high electrical insulation; (5) high fastening force for dog spikes and screw spikes; (6) high durability; (7) long sleepers can also be fabricated with high precision; (8) workability as good as wood; and (9) long life.
The synthetic sleeper has been used for 25 years and its technical qualities have been proven. Because of the increased use of synthetic sleepers, both in Japan and other countries, we are now in the process of registering them under the Japan Industrial Standard (JIS). And as overseas demand increases, we plan to obtain ISO certification.

# Robustness Indices Based on Passengers' Utilities

**Yoko TAKEUCHI**
Researcher, Planning Systems, Transport Information Technology Division

Robustness indices for timetables are discussed. The aims of the paper are:

1. To introduce robustness indices that also take passenger disutility to make connections into consideration
2. To introduce the concept that robustness indices are not only for a timetable but also for an entire rail system, which consists of the system timetable, train rescheduling strategies, and facilities
3. To introduce an algorithm for train schedule adjustments so that passenger disutility to make connections is as small as possible
4. To identify guidelines for the creation of robust timetables

Timetable robustness has been attracting more and more attention recently, and has been the subject of many studies. The studies attempt to define robustness levels using indices related to train delays. This approach has a couple of drawbacks, however. One problem is that the inconvenience caused to passengers is not adequately considered. A short delay does not generally cause much inconvenience, but inconvenience is regarded as great if they miss their connections. In other words, robustness indices measuring only train delays are not enough to indicate how passengers view timetable stability. In this paper, we identify system timetable robustness indices that also take into consideration the extent of passenger disutility to make connections in a timely fashion.
We then introduce an algorithm to automatically reschedule a disrupted timetable, with train connections also taken into consideration. By applying the Monte Carlo simulation methods, in which we iteratively perform the rescheduling algorithm, we identify guidelines to make a given timetable more robust.
For our case study, we used an actual facility and OD data, and established guidelines for the dwell times of trains that are operating on two different lines but have mutual connections. Results are shown in Figure 1. The most robust timetable has a 60-second dwell time for connections.

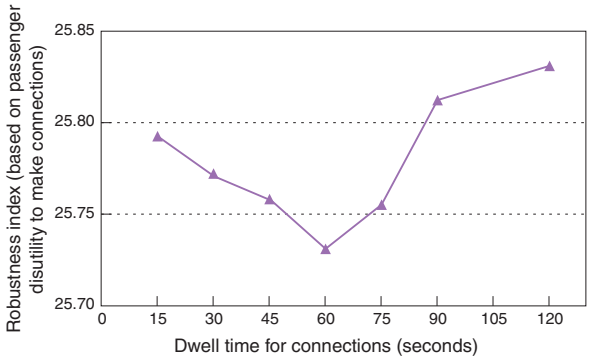



**Figure 1.** Results of Robustness Index