Newsletter on the Latest Technologies Developed by RTRI

Railway Technology Avalanche

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WCRR 2006 Special Edition

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Foreword

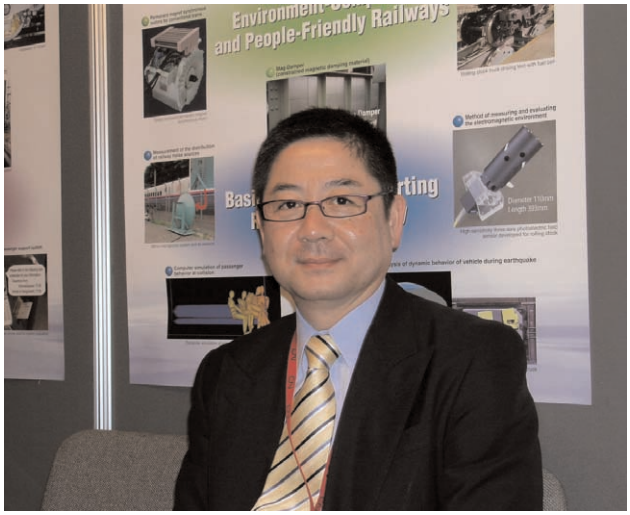
Hiroshi TANAKA
Director, International Affairs Division

2006 WCRR Montréal
PROGRESSING TOGETHER
Le progrès, ensemble

7th World Congress on Railway Research

June 4 – 8, 2006
Fairmont Queen Elizabeth Hotel
Montréal, Canada

The 7th World Congress on Railway Research (WCRR 2006) was held in Montréal, Canada from June 4 to 8, 2006. The congresses' roots go back to when our Railway Technical Research Institute (RTRI) hosted the International Railway Research Seminar in Tokyo, in October 1992. The first WCRR was held in 1994 in Paris (France). Subsequent Congresses were held in 1996 in Colorado Springs (United States), in 1997 in Florence (Italy), in 1999 in Tokyo (Japan), in 2001 in Cologne (Germany), and in 2003 in Edinburgh (United Kingdom). RTRI has helped plan and organize every Congress to date.
The main theme for WCRR 2006 was "Progressing Together." This theme expressed the conviction that research promoting railway development in the 21st century will have to take a more global approach and encourage cooperation and opinion sharing among railway players worldwide. It is our hope that participants came away from the highly successful Congress convinced that this is true.
This Newsletter introduces some of the material RTRI presented at WCRR 2006.
The next Congress, WCRR 2008, is scheduled to be held from May 18 to 22, 2008, in Seoul, South Korea.



A Report on WCRR 2006

Hisashi TANAKA
Deputy Manager, International Affairs Division

The 7th World Congress on Railway Research (WCRR 2006) welcomed about 750 participants from 41 countries, including 33 participants from our Railway Technical Research Institute (RTRI). Presentations featured 288 items (including posters), and of these, RTRI presented 23. Papers presented during the Congress covered a wide range of subjects, including Network Capacity, Service Design and Reliability, System Optimization, Security and Safety, and the Environment. The table below lists papers presented by RTRI.

RTRI's participation at the Congress also included two of its members chairing sessions: the T2.1.1 Track Maintenance session was chaired by Masao UCHIDA, the T2.6.1 Information Technology session by Takahiko OGINO.

During the evening banquet on June 6, RTRI's Kiyoshi KAWAGUCHI was given the Best Paper Award in Rolling Stock sessions by Chul LEE, president of Korea Railroad Corporation (Korail), the award's sponsor (see photo on page 3).

In addition to the presentation of papers, there were technical exhibits organized by 45 groups. Our institute's exhibit introduced the JR Group with pamphlets, posters, video and models.

During the closing session, RTRI President Katsuji AKITA brought the Congress to a close with a speech, "R&D Strategies for the Future of Railways." He listed four goals for railways: attractive services, efficient and low-cost railway management, high safety levels, and mutual coordination.

The RTRI booth at WCRR 2006. From left: Hisashi TANAKA, Koichi GOTO (General Manager, International Affairs), and Toru MIYAUCHI (Manager, International Affairs)

RTRI President Katsuji AKITA speaking at the WCRR 2006 closing session

Presentations from RTRI

Session	Presenter	Paper title
T1.2.1 Network Capacity	Kazuki TAMURA	Improvement of the Conventional Rail Freight Station for Intermodal Transport
T1.4.2 Scheduling II	Yoko TAKEUCHI	Robustness Indices Based on Passengers' Utilities
T2.1.2 Rolling Stock Maintenance	Kiyoshi KAWAGUCHI	Development of WSP System for Freight Trains
T2.2.1 Track Components	Hideyuki TAKAI	Japanese Twenty Five Years Experiences and Standardization of Synthetic Sleeper
T2.3.2 Infrastructure Condition Monitoring	Naoki TACHIBANA	Tunnel Monitoring System using the Optical Fiber Sensor or the Electric Conductible Paint
T3.2.2 Pantograph Dynamics	Shunichi KUSUMI	Characteristics of Contact Force Waveforms and their Application to Diagnosis of Overhead Line
T3.2.3 Wheel/Rail Profile Design and Maintenance	Makoto ISHIDA	Effect of Lubrication on Vehicle/Track Interaction and Performance of Friction Modifier
T3.5.1 Enhancing the Understanding of RCF	Makoto AKAMA	Study on the Growth Rates of Rolling Contact Fatigue Crack in Wheel/Rail Steel
T3.5.2 Managiment of RCF	Makoto ISHIDA	Influence of Surface Roughness of Rail Formed by Rail Grinding on Rolling Contact Fatigue
T6.1.1 Pollution Control and Remediation	Hiroyuki SAKAI	Inspection and Management of Fuel Leakage from Rolling Stock to Create the Safe and Comfortable Environment for Customers
T6.2.1 Noise and Vibration Control I	Makoto AKAMA	Analysis and Design of Low-Stress and Low-Noise Lightweight Wheel
T6.2.2 Noise and Vibration Control II	Mitsuru IKEDA	New Designing Procedure for Pantograph of High-speed Trains
T6.3.1 Energy Efficiency	Tekemasa FURUYA	A Feasibility Design and its Evaluation of Fuel Cell Powered Train
T6.4.1 Electro-Magnetic Compatibility	Masateru IKEHATA	Evaluation of Biological Effects of Complex Environmental Magnetic Fields with Various Frequency Components
T6.6.1 Environmental Impact	Atsushi IDO	Development of Tecchnologies for Minimizing Environmental Impacts
IP1 Track Maintenance Planning	Yuya OIKAWA	Evaluation of Remaining Service Life of Aged Rails
IP2 Rolling Stock Maintenance and Components	Minoru TANAKA	Development of Electromagnetic Vibration Apparatus for Ground Coils of Maglev
IP2 Rolling Stock Maintenance and Components	Makoto ISHIGE	Development of Wheel Bearings with a Grease Supply Mechanism
IP3 Environmental Strategies	Takashi YONEYAMA	Specifications and Schedule of a Fuel Cell Test Railway Vehicle
Poster	Akihito KAZATO	The Next-Generation Tilt Control System Using Electro-Hydraulic Actuators
Poster	Ruji TSUCHIYA	Supporting Intermodal Travelers by Agent-based Information Integration
Poster	Shogo KAMOSHITA	GPS Based Position Detect System for Next-Generation Tilting Train
Poster	Shuichi MYOJO	Daily Estimation of Passenger Flow in Large and Complicated Urban Railway Network

Development of WSP System for Freight Trains —Best Paper Award in Rolling Stock Sessions, WCRR 2006

Kiyoshi KAWAGUCHI
Senior Researcher, Traction Control, Vehicle Control Technology Division

The most commonly used equipment of a freight railroad business is freight cars, and much of the maintenance of freight cars is concentrated on the wheel-sets. It is therefore important for a freight railroad operator to decrease wheel-set maintenance. Wheel locking in freight cars results in wheel flat, which causes various other problems. For these reasons, we developed a new, practical Wheel Slide Prevention (WSP) system for freight cars (see Fig. 1). The main advantages of this WSP system (also called ABS "Antilock Brake System") are long life, reduced maintenance, low cost, and high reliability. And, in order to solve other problems seen in conventional equipment, we also developed a low power dump valve, a long life electric double layer capacitor (EDLC) for freight cars, and other devices.

(1) Long life EDLC for freight cars

We developed the first-of-its-kind electric double layer capacitor (diluted sulfuric acid solution-based electrolyte, 24V, 5 F; see Fig. 2, left). By sealing 28 cells in an oblong ceramic vessel, we were able to achieve high reliability, long life and high voltage under varying outdoor temperature conditions. Homogenous cells are stacked in the form of sheets to eliminate the need for a cell balancing circuit and thus cut EDLC production cost. The results of accelerated durability tests show that the EDLC life cycle is much longer than the development target, which was 8 years, and is now actually estimated at more than 30 years.

(2) Energy-saving dump valve for freight cars

Two effective ways to cut freight train WSP costs are to significantly reduce the power requirement and capacity of both power supply and charge units. Reducing the power consumption of the dump valve is the most effective method. We therefore developed a new energy-saving control method and a new valve structure (Fig. 2, right). We reduced power consumption of the dump valve to 2.2 W per set. This is much lower than the development target, which was 1/10 that of a conventional valve - actual power consumption is 1/60 that of a conventional valve. This ensures a maintenance-free period of eight years, which was our development target. (Reference: Development of a WSP System for Freight Trains: WCRR 2006 Proceedings, Montréal, June 2006)

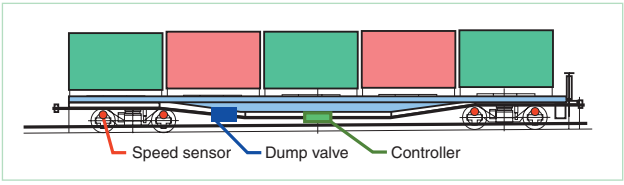


Figure 1. Wheel Slide Prevention (WSP) system mounted on a container freight car

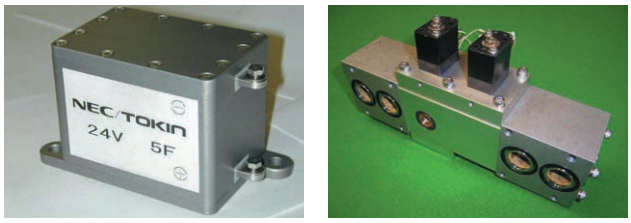
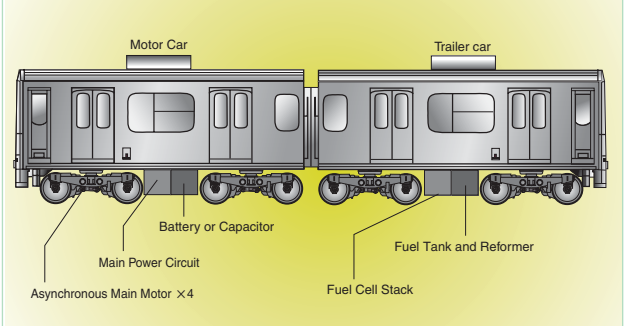


Figure 2. Electric double layer capacitor (EDLC, left) and dump valve

A Feasibility Design and its Evaluation of Fuel Cell Powered Train

Takemasa FURUYA
Researcher, Drive Systems, Vehicle Control Technology Division

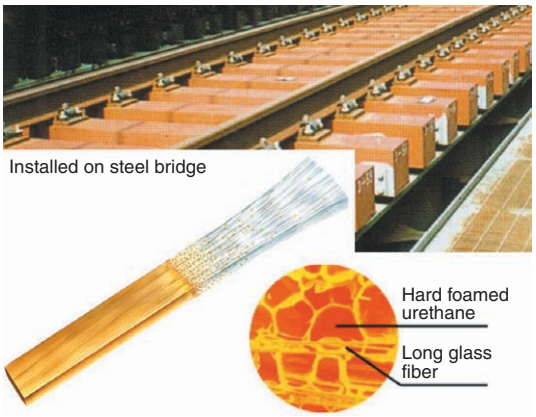
The paper has three main parts. First: The electrical characteristics of a proton exchange membrane type fuel cell (PEMFC), and results obtained during motive bogie operation with induction motors . In the case of the PEMFC, output voltage varies widely with the load current, and its operating points during output current surges and declines are along the same characteristic curve . Thus the PEMFC can be regarded as a normal linear power source characterized by wide output voltage fluctuations. Second: Results of feasibility design work for fuel cell powered vehicles (FC trains). I show FC and super capacitor (SC) specifications for regenerative brake energy accumulation, and estimate the weight and required space for equipment needed for this type of train. Figure shows a rough sketch of a proposed FC commuter train. Equipment configuration for a FC train is feasible. Third: Evaluation of FC train characteristics, including fuel cell stack price and energy efficiency. Calculations of the energy efficiency of fuel cells do not generally take into account the energy used to produce the hydrogen. An FC train equipped with a DC-DC chopper circuit system has many semiconductor switches, so it is also important to improve the energy conversion efficiency of traction equipment on board. We believe it is more important for an FC train to have greater total conversion efficiency than a conventional electrical train, and any discussion of FC train energy efficiency should also include consideration of the hydrogen generation process.



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.

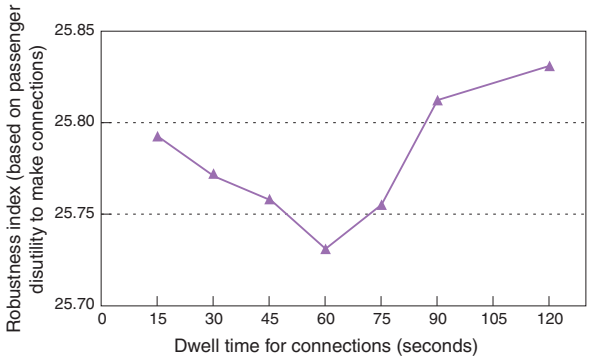


Figure 1. Results of Robustness Index