RTRI Researchers Receive MEXT Commendation for Science and Technology

Two researchers of the Railway Technical Research Institute (RTRI) have been awarded the Fiscal Year 2025 Commendation for Science and Technology (Research category)* by the Minister of Education, Culture, Sports, Science and Technology (hereinafter referred to as the MEXT Commendation for Science and Technology). The award ceremony was held at the MEXT Auditorium (Chiyoda-ku, Tokyo) on April 15, 2025.

1. Award winners and award-winning research

- **Award winner:** Dr. Masaru Tomita
  Director, Head of Maglev Systems Technology Division
  The award-winning research: Application of High-Temperature Superconducting Materials to Power Transmission for Implementation in Railway Feeding Systems

- **Award winner:** Dr. Susumu Nakajima
  Senior Chief Researcher, Head of Foundation and Geotechnical Engineering Laboratory, Structures Technology Division
  (Awarded jointly with Professor Kenji Watanabe, Graduate School of Engineering, The University of Tokyo)
  The award-winning research: Failure Mechanism and Reinforcement Method of Retaining Walls and Ground during Large Earthquakes

2. Summary of research

- **Dr. Masaru Tomita, Director, Head of Maglev Systems Technology Division**

  High-temperature superconductors can be cooled with liquid nitrogen and are expected to be applicable for power transmission. However, material evaluations have shown that, although the intrinsic performance values of the materials are promising, there are challenges in applying these properties under actual operational environments. In contrast, DC railway feeding systems present the issue of transmission losses caused by electrical resistance, resulting in voltage drops over distance. To resolve this issue, substations are installed every few kilometers.

  In this research, we have proposed a system in which high-temperature superconductors are used as power transmission cables and connected from substations to existing feeder wires, allowing the current to flow through the superconductors and enabling the voltage supplied by the substation to be maintained regardless of the transmission distance. In the process of applying high-temperature

superconductors to power transmission cables, research has been advanced both in material science and in practical application. This included conducting overcurrent evaluations by simulating railway fault currents, performing drum winding and transportation, and assessing flexibility during installation. Through these efforts, we ensured that the potential of the materials could be maintained all the way through to actual deployment. To further optimize the system, we have worked to prevent tension on the superconducting material, suppress heat exchange, and reduce pressure loss, thereby building a superconducting power transmission system that includes a reliable cooling mechanism. Using train running tests on various railway lines, we confirmed the technical compatibility of superconducting technology with railway operations.

As a result of this research, the technology for power transmission using high-temperature superconducting materials was able to comply with technical standards, obtain government approval for commercial installation, and initiate the world's first verification of commercial operation using superconducting power transmission. Currently, this system supplies electricity to approximately 28,000 trains.

These achievements are expected to contribute to addressing labor shortages, such as by downsizing of substation facilities and implementing labor-saving measures, as well as to energy conservation through the reduction of power transmission loss.

- **Dr. Susumu Nakajima, Senior Chief Researcher, Head of Foundation and Geotechnical Engineering Laboratory, Structures Technology Division**

In Japan, one of the world's most earthquake-prone countries, large earthquakes have caused human casualties, isolated communities, and disruption of infrastructure due to the collapse of retaining walls, making the seismic reinforcement of these structures an urgent issue.

In this research, we elucidated the deformation and failure mechanisms of retaining walls and the surrounding ground through experiments utilizing our proprietary measurement techniques and developed a seismic residual displacement calculation method for retaining walls during earthquakes. Additionally, we have proposed a seismic earth pressure calculation method considering soil cohesion, enabling more rational evaluation of earth pressure acting on retaining walls during earthquakes. Furthermore, by elucidating the dynamic interaction mechanism between the backfill soil and retaining wall failures in existing retaining walls after reinforcement, we developed a more rational reinforcement technology.

Through this research, we have moved beyond the conventional seismic design approach based on force equilibrium, enabling rational seismic design of retaining

walls using residual displacement as an index. By reflecting these achievements in technical standards, we have established the world's first performance-based design method for retaining walls. For the seismic assessment and reinforcement of retaining walls, we utilized the seismic earth pressure calculation method along with the reinforcement technology tailored to site conditions and required performance levels. Thus, we were able to achieve dramatic rationalization and cost reduction in railway seismic retrofitting.

This achievement is expected to contribute not only to the railway structures, but also to the rationalization of reinforcement projects for retaining walls in roads, residential areas, and public facilities such as schools, thereby helping to ensure public safety.

*The MEXT Commendation for Science and Technology consists of five categories: Development, Research, Science and Technology Promotion, Technology, and Public Understanding Promotion. The Research category honors individuals or groups who have conducted original research or inventions that are highly likely to contribute to the advancement of science and technology in Japan.
(Quoted from an article on the Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology on the MEXT website)

Photo: Award Winners
Dr. Masaru Tomita (left) and Dr. Susumu Nakajima (right)

Reference: Ministry of Education, Culture, Sports, Science and Technology (MEXT) - Announcement on the Selection of Recipients for the Fiscal Year 2025 Commendation for Science and Technology

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