Newsletter on the Latest Technologies Developed by RTRI

Railway Technology Avalanche

June 29, 2007 No. 18

Railway Technical Research Institute
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GENERAL INFORMATION

ARTICLES

International Activities of the Railway Technical Research Institute

Masao UCHIDA
Executive Director (International Affairs)
(Mr. Uchida assumed responsibility for international affairs at RTRI in April 2007.)

Since its establishment two decades ago in December 1986, RTRI has promoted basic and practical research in railway technology, achieving developments and improvements in such areas as railway safety and reliability, high-speed services, ride comfort, cost reduction for rolling stock and infrastructure, noise and vibration reduction along tracks, energy conservation, global environmental protection, and superconducting magnetically levitated transport system (Maglev).

Our R&D activities include joint research projects with railway operators and research organizations in other countries, and we collect and share information with them. RTRI researchers and staff also present papers at international conferences. The following touches on some of our recent international activities and plans.

- We participate on an ongoing basis in joint research projects with the French national railways (SNCF) and railway research institutes in China and Korea. We also conduct joint research with a number of universities overseas.
- We send specialists to participate in conferences sponsored by Japan's Ministry of Land, Infrastructure and Transport — the conferences bring together rail transport specialists from the United States, Britain, China, Korea, India and other countries. We are also cooperating in overseas high-speed railway projects promoted by the Ministry and Japan Railway Technical Service (JARTS).
- We send staff to the International Union of Railways (UIC) to obtain information on global rail transport trends (especially in Europe), to conduct studies and surveys, and to establish cooperative links with specialists and organizations. We also plan to strengthen our ties with railways in other parts of Asia.

- We are assisting in preparations for the 8th World Congress on Railway Research (WCRR) to be held in Seoul, Korea in May 2008, and are actively encouraging staff from RTRI and the JR group of companies to submit papers there.
- We publish this Newsletter and the Quarterly Report of RTRI, both of which are English journals explaining RTRI's achievements in research and development. This information is available online and we invite you to make use of it.

Through these and other international activities, RTRI will continue contributing to the development and advancement of railway technology worldwide.

内田雅夫

RTRI-SNCF Railway Research Seminar and Franco-Japan Railway Technology Symposium

RTRI-SNCF Railway Research Seminar 2007

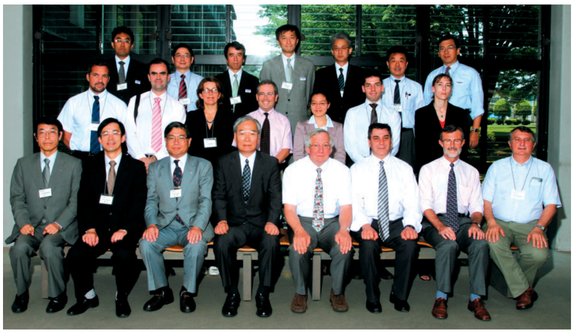
The Railway Technical Research Institute (RTRI) and the French National Railways (SNCF) held a joint research seminar in Japan on May 22 and 23, 2007. SNCF representatives attending were Mr. CLEON, Scientific and Technical Director of the Innovation and Research Department, Dr. Jean-Noel TEMEM, Delegated Director, and nine others.

In the Opening session of the seminar on May 22, Mr. Katsuji AKITA, RTRI President, welcomed all delegates during the opening ceremonies representing 20 RTRI researchers, who are involved in the joint research.

The seminar was held to present reports on joint research projects carried out during the third term, and to establish joint research projects for the coming term. When examining topic options for the coming term, delegates shared information on such subjects as malfunction of shunting, behaviours of overhead contact line pantograph at high-speed running, prevention of derailments, and R&D management issues.

On May 23, delegates visited RTRI's Kunitachi Institute to view test facilities there. The visit was followed by keynote addresses by RTRI Executive Director Dr. Norimichi KUMAGAI and Mr. CLEON of the SNCF, who discussed research and development activities at their respective organizations. After this, delegated researchers reported on individual joint research projects conducted during the third term. SNCF representatives then briefly described one matter of topical interest that had arisen during the seminar, test conditions when the TGV achieved its speed record.

RTRI-SNCF Railway Research Seminar

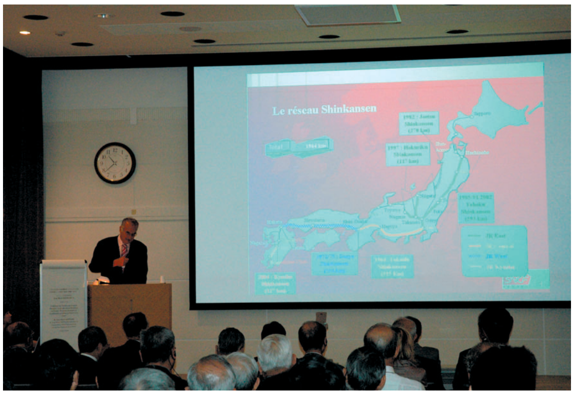

RTRI and SNCF representatives

Franco-Japan Railway Technology Symposium

The Franco-Japan Railway Technology Symposium was held at the Maison Franco-Japonaise in Ebisu, Shibuya, Tokyo on May 25, 2007, under the co-organization of the Societe Franco-Japonaise des Techniques Industrielles, the Embassy of France in Japan, SNCF and RTRI. A total of 160 participants attended, from the Embassy of France, SNCF, Japan's Ministry of Land, Infrastructure and Transport, the JR group of companies, and other organizations. The symposium opened with speeches by Mr. AKITA, RTRI President, and Mr. YAMASHITA, Deputy Director-General for Engineering Affairs at the Ministry of Land, Infrastructure and Transport.

During the morning session, keynote addresses were given by Mr. ARMAND, Counselor for Scientific and Technical Affairs at the Embassy of France in Japan, and Mr. CARON, honorary professor at the Universite Sorbonne, Paris IV. Next, speakers from both countries spoke on the history of railway technological exchanges. During the afternoon session, presentations were given by representatives from RTRI and SNCF (future development of railway technology), East Japan Railway Company (technological developments in the IT sector), Central Japan Railway Company (technological developments in the environmental sector), and Japan Freight Railway Company (technological developments in the freight sector).

After the symposium, Ambassador Gildas LE LIDEC gave a reception at the residence of the Ambassador of France to Japan. Mr. MARUYAMA, Special Advisor to the Ministry of Land, Infrastructure and Transport, and Mr. Shuichiro YAMANOUCHI, formerly Chairman of East Japan Railway Company, spoke at the reception.



Franco-Japan Railway Technology Symposium


Reception hosted by the ambassador of France to Japan

Friction Moderating System To Reduce Wheel/rail Interface Problems at Sharp Curves

Takumi BAN
Senior Researcher, Frictional Materials, Materials Technology Division

When negotiating sharp curves, railway vehicles must generally cope with major lateral forces while depending on the steering performance of bogies . Those lateral forces are a major factor causing problems at the wheel/rail interface. Problems include: wheel flange climb derailment at low speeds; high rail gauge face wear; thin flange wear; low rail corrugations; and squealing. Japanese railway operators are currently working on resolving these problems, in order to decrease maintenance costs and alleviate environmental issues such as squeals, other rolling noise, and ground vibrations, all of which are closely related to low rail corrugations. A friction modifier was developed for delivery between wheels and rails, and examined to determine how it can be used effectively. For its part, the Railway Technical Research Institute (RTRI) has been developing another lubrication system, the Friction Moderating System (FRIMOS) for Wheel/rail Interface, to reduce lateral forces that cause squealing at sharp curves. The purpose of FRIMOS is the same as that of other friction modifiers[1].

We first examined the effect that lubrication at sharp curves, and lubrication on the top of low rails and at the high rail gauge face, would have on lateral forces. These experiments were carried out on a test track and a commercially operated line. Results indicated that lubrication on the top of low rails offers far better performance than the more common lubrication on high rail gauge faces[2]. However, top-of-rail lubrication for low rails entails some risk of wheel slide, since it reduces the coefficient of friction between the wheel tread and the rail top. We therefore adopted a solid lubricant, in the expectation that its traction coefficient would permit the avoidance of wheel slide as much as possible.

RTRI developed a carbon-based solid lubricant after taking into account the requirements of a system for delivering the lubricant onto the wheel/rail interface. The size of the carbon grains was made appropriate for the device used to deliver the lubricant (similar to a Cerajet system[3]). The main component parts of the device are a nozzle, solenoid valve and jet control system. Fig. 1 shows the schematic structure of FRIMOS. The traction characteristics of the carbon-based lubricant, which is called a friction moderator, has less of a positive slope than a friction modifier. Fig. 2 shows the appearance of the friction moderator. Fig. 3 is a photo of FRIMOS installed on the test vehicle.

To ensure proper functioning of the track circuit, the friction moderator must not impede wheel-to-rail shunting, but at the same time it must not reduce insulation performance at the insulation rail joints, even when the moderator is applied at amounts a little greater than usual. These opposing electrical-related functions of the friction moderator were examined on an actual track, and acceptable results were obtained.

In addition, one of the main requirements of the friction moderator, to have little impact on vehicle braking performance, was verified through laboratory simulations using a test stand, and through running tests using a test vehicle with FRIMOS installed. Acceptable braking distance test results were obtained.

The effect of the friction moderator in reducing squealing from the wheel tread/top-of-low-rail interface was verified through track site measurements during running tests, using a vehicle with FRIMOS installed. Fig. 4 shows the results of A-weighted sound pressure level measurements obtained at a location 2.1 meters from track gauge center. In the figure, the A-weighted sound pressure level reduction obtained from the friction moderator is readily apparent. The ability of the friction moderator to reduce lateral forces was also verified by track site measurements[4].

The FRIMOS system has been installed by a railway operator, in order to conduct further studies on the capability of the friction moderator to prevent low rail corrugations. Because the test results indicate a reduction in lateral forces, it is expected that the friction moderator will prove to be effective.

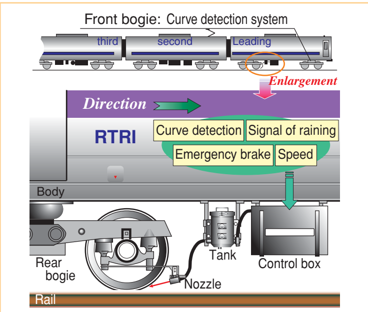


Fig. 1 Schematic structure of the Friction Moderating System (FRIMOS) for wheel/rail interface

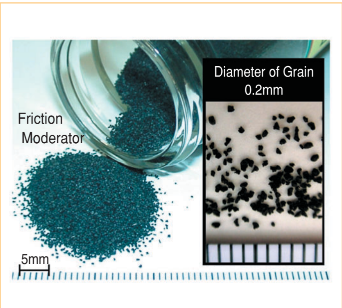


Fig. 2 Grain diameter

References

[1] Ishida, M. and Aoki, F., Effect of Lubrication on Vehicle/Track Interaction, Quarterly Report of Railway Technical Research Institute, 45-3, 2004, pp. 131-135.

[2] Eadie, D.T., Kalousek, J. and Chiddick, K.C., The Role of High Positive Friction (HPF) Modifier in the Control of Short Pitch Corrugations and Related Phenomena, Wear, 253, 2002, pp.185-192.

[3] Ohno, K., Ban, T. and Obara, T., Improvement of Adhesion Between Wheel and Rail by Ceramics Particle Injection, Journal of Japanese Society of Tribologists, Vol. 41, No. 12, 1996, pp.124-129.

[4] Ishida, M., Ban, T. and Ogata, M.: Friction Moderating System for Wheel/rail Interface To Reduce Lateral Forces in Sharp Curves, IHHA 2007 Kiruna, 11-13, Sweden, June 2007 (submitted)

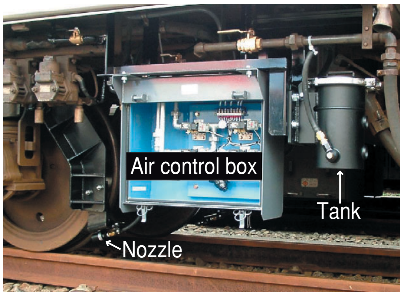


Fig. 3 FRIMOS installed

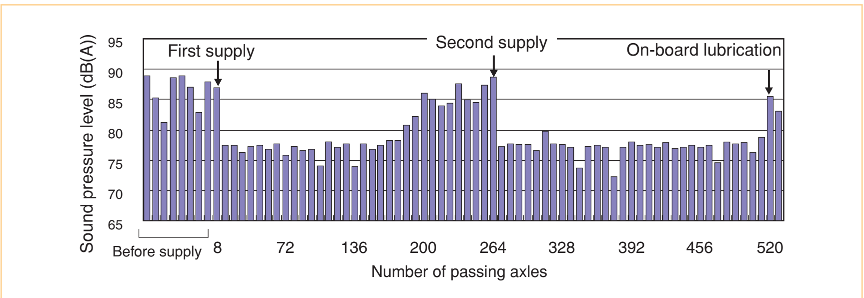


Fig. 4 Effect of the friction moderator in reducing rolling noise, measured at 2.1 m from center of track gauge

Mechanisms Causing the Deterioration of Concrete Tunnel Lining

Hiroshi UEDA
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Railway tunnels in Japan were first lined with concrete around 1910, so some of those tunnel linings will soon be 100 years old. Many are still in use, and the tunnels and their linings must of course to be maintained for many years to come. Old concrete used to be considered subject to age-related deterioration, but some concrete liners still remain in good condition after nearly 100 years, so deterioration is not due only to age.

We therefore conducted research to identify mechanisms that cause the deterioration of concrete linings. After taking samples of concrete from many old tunnels (see Fig. 1), we determined that there are a number of such mechanisms.

(1) The most common type of deterioration occurs when acid acts on the concrete. Acidic substances in the soot and smoke emitted from steam locomotives decades ago adhered to the tunnel wall, then corroded the concrete surface. The adherence of soot and dust, the decomposition of the cement paste, the concentration of chemical constituents, and the flaking of weakened concrete are all typical factors promoting discoloration to black, white, brown and other colors (see Fig. 2). In a very few tunnels, we also discovered places where similar deterioration had occurred due to the action of acidic groundwater.

(2) In some tunnels, sulfate ions in groundwater had penetrated into the concrete, forming blisters that cracked or corroded the concrete. Sulfur has a tendency to con-cen-trate along interfaces between carbonated and non-carbonated areas (see Fig. 3), and in such places we dis-covered a ten-dency for cracks to form and surface flaking to occur.

(3) Some linings were made with a concrete mixed with diatomaceous earth or a similar cement substitute, in order to cut costs at a time when cement was expensive. Concrete including such substances was found to have deteriorated and weakened near the surface. In cases where the cement had been mixed with large quantities of diatomaceous earth, it was evident that carbonation had reduced the compressive strength of the concrete (see Fig. 4), and it can be assumed that this action also caused deterioration.

Thus, a number of different mechanisms are responsible for concrete lining deterioration. Accurately understanding these mechanisms will make it possible to determine whether patching is necessary and identify the most suitable patching method. This, in turn, will help ensure safe rail transport. We are continuing our research to ensure that concrete that is almost 100 years old will continue to effectively serve its purpose.

Fig. 1 Obtaining concrete samples

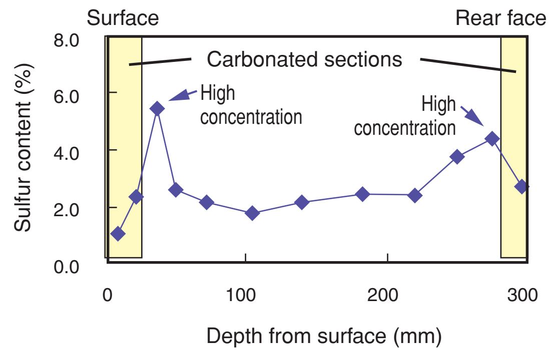


Fig. 3 Distribution of sulfur within typical concrete sample

Fig. 2 Concrete surface deterioration due to acidification

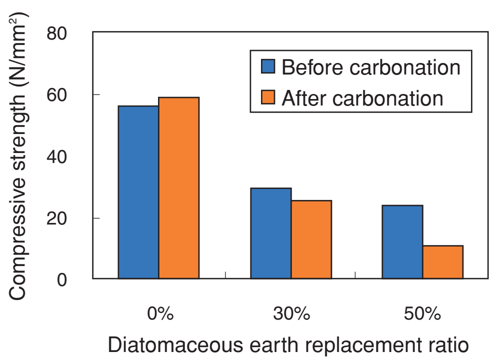


Fig. 4 Compressive strength variations, before and after carbonation in concrete containing diatomaceous earth

A Method To Assess the Safety of Complex Electromagnetic Fields

Masateru IKEHATA
Senior Researcher, Biotechnology, Environmental Engineering Division

The International EMF Project of the World Health Organization (WHO) is presently assessing health and environmental effects of exposure to static and time varying electric and magnetic fields (EMFs) in the frequency range 0 - 300 GHz. The project's main task is to collate scientific knowledge regarding possible health risks, and support national and regional authorities in their development of any needed mitigation measures. The project is being pursued in collaboration with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and other international organizations, with a view to implementing any required internationally recognized countermeasures. The circumstances leading up to the launch of this major project deserves treatment in monographs of environmental health criteria for extremely low frequency and radiofrequency field at a later date.

When equipment and devices transmit or use electricity, they leak an electromagnetic field of a certain intensity into the environment. Electric railways are no exception. The leaked EMFs may at times interfere with the proper operation of electronic devices. Because EMFs are invisible to the human eye, and because there is little information regarding safety levels at different intensities of exposure in the actual environment, there is a tendency to regard the issue with some concern.

In the actual environment in which electric trains operate, EMFs exhibiting a range of spectra are generated with complex spatiotemporal characteristics. Most research into the biological effect of EMFs has examined exposure to single frequency components, but a suitable method to adequately assess risk in an actual environment has not been developed. Therefore, during our research, we made on-site measurements of environmental EMFs, evaluated induced currents as indices for exposure intensity, and assessed biological effects under actual complex EMF exposure conditions. After collating scientific knowledge made available to date, and considering typical exposure situations in actual environments, we developed an appropriate method to assess the effect of EMFs (see Fig. 1), basing our research on specific scientific data.

Our studies use the numerical calculation model for Japanese people exposed to EMFs, which was developed by the National Institute of Information and Communications Technology (an independent administrative agency under the Japanese government). We apply this model to estimate induced current in a human body during exposure inside a passenger vehicle of an electric train. Sample calculations are shown in Figure 2. We made a device that induces exposure to complex magnetic fields (see Figure 3) and replicates exposure conditions close to those in an actual environment. We are presently acquiring a wide range of biological data by using the device to expose a variety of life forms, from bacteria and cultured cells to mice. And, to obtain our own background data, we have conducted exposure experiments for single frequencies using static , extremely low-frequency , and intermediate frequencies magnetic fields. We believe these efforts will make it possible to determine the electromagnetic environment of locations where a risk assessment is required, and to assess that risk from the point of view of frequency and spatial distribution, following procedures that are grounded on a scientific basis.

The European Parliament's directive 2004/40/EC obliges EU Member States to introduce measures, no later than April 2008, that provide for the risk analysis of EMF exposure in the workplace. This, too, indicates that concern over EMF health risks may rise once more.

There is therefore a need to be able to explain, in easy-to-understand terms, the safety of electromagnetic environments, in order to reassure passengers, trackside residents and workers that EMFs generated by electric trains are safe. We intend to promote this aim by presenting a scientific method to assess the safety of EMFs, and to provide the required scientific data and information on the methodology to support the method.

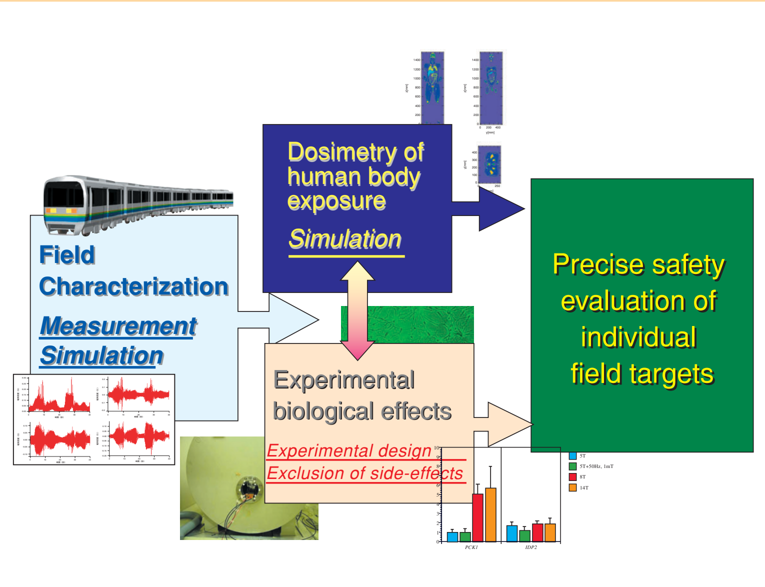


Fig. 1 Strategies promoting awareness of safety

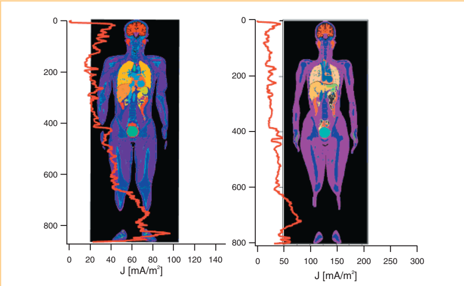
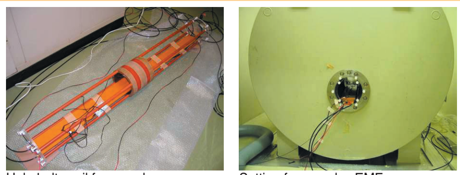


Fig. 2 Maximum induced current in standing heterogeneous voxel models exposed to magnetic field generated by line current under the floor



Helmholtz coil for complex exposure in DC and ELF magnetic fields

Setting for complex EMF exposure experiments

Fig. 3 Complex EMF exposure device

Behavior Analysis of Seated Passengers at a Train Collision

Koji OMINO
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Injuries sustained by passengers on a bench seat

Rail transportation safety measures take a variety of approaches, but always focus on either preventing an accident, or on reducing injuries and preventing a domino effect of injuries if an accident does occur. Research into reducing injuries in the event of a train collision examines not only the primary impact of the vehicle collision, but also the secondary impact caused by the force of the collision hurling passengers against part of the compartment interior or against other passengers. Primary impact studies examine the car body structure, while secondary impact studies examine occupant kinematic factors. Our previous numerical simulations of secondary impacts indicated a pattern in which passengers on bench seats may sustain injuries to the chest area after striking a divider, but these results required confirmation through actual collision experiments. We therefore conducted such experiments, using an impact test dummy to identify passenger kinematic injury patterns. The experiment results provide one perspective on the degree of safety obtained from dividers in the event of a collision.

Collision experiments and results

To experimentally re-evaluate the above-mentioned injury patterns, we seated an impact test dummy "passenger" on a bench seat next to a divider. A collision force was applied to generate a secondary impact in which the dummy was hurled against the divider. Assuming that the most severe injury pattern would involve fractured ribs, we examined the amount of buckling in the chest area to evaluate the degree of safety offered by dividers.

Tests included two types of dividers, a panel type and a tubular type. One dummy was placed in a seated position first beside one type, then beside the other. Three structures taking the place of ribs were installed in the dummy's chest area, one each to represent the upper, middle and lower part of the chest. Devices to measure the extent of chest buckling during the secondary impact were incorporated in the "ribs." Figures 1 and 2 show the secondary impact against the tubular and panel dividers, respectively. Results obtained from measurements of chest buckling are shown in Fig. 3. The most severe buckling was observed after a secondary impact against the tubular divider. That buckling was nearly twice as severe as when the impact was against the panel divider.

Experiment results compared with results from numeric simulations

The collision experiments reproduced conditions that had previously been hypothesized in numeric simulations. The numeric simulation results are shown in Fig. 4. In the collision experiments, the buckling in the chest area as a whole was less than that indicated by the numeric simulations. However, results of the collision experiments and the numeric simulations were in agreement that the maximum amount of chest buckling during a secondary impact tends to be less against a panel divider than against a tubular one. Furthermore, results from both the collision experiments and numeric simulations were also in agreement that, when the secondary impact was against the tubular divider, buckling occurred most in the lower chest area. The collision experiment results support data from the numeric simulations which show that chest injuries are less likely to occur upon impact with a panel divider than with a tubular one, and that a panel divider is therefore preferable from a collision safety standpoint.

(This research was subsidized by the Ministry of Land, Infrastructure and Transport.)

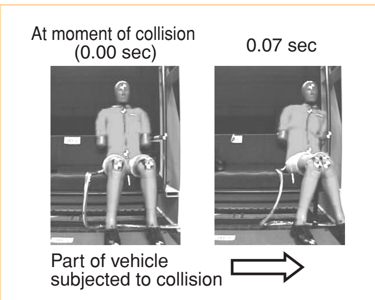

Fig. 1 Collision experiment with tubular divider

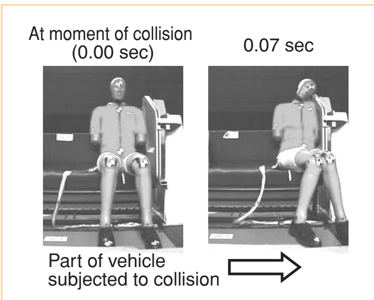

Fig. 2 Collision experiment with panel divider

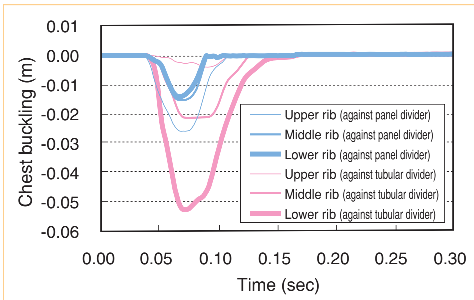

Fig. 3 Data indicating extent of rib buckling in an impact test dummy

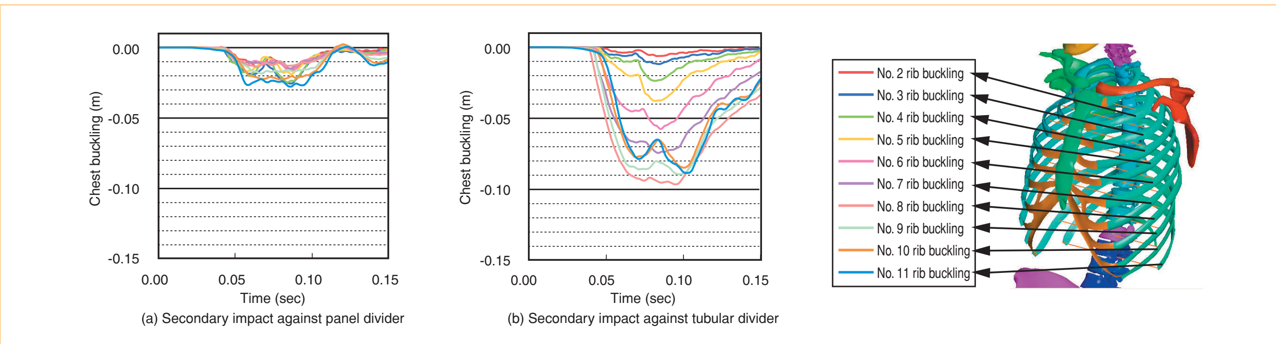

Fig. 4 Extent of chest buckling inferred from numeric simulations