# Measurement of Velocity and Pressure Fluctuations around High-speed Trains Running in Tunnel

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The flow-induced vibration of high-speed trains travelling in tunnel has been studied in Japan for more than 20 years as this is one of the issues affecting ride quality. It is known that flow-induced vibrations of cars featuring a cross-sectional variation such as tail-end cars or cars equipped with large pantograph shields are caused by separation of the air flows arising from the difference in cross-section. In addition, flow-induced vibrations of intermediate cars have been observed even when they do not feature a variation in cross-section. Some work has shown that the aerodynamic forces acting on the intermediate cars of the trains stem from large-scale coherent structures existing in the flow along the sides of the trains.

In this study, air velocity and pressure fluctuations around a high-speed train running in a tunnel were measured simultaneously to investigate the details of the large-scale coherent structures as well as their distribution around the circumference of the cross-section of the train (Fig. 1). In particular, a two-component hot-film probe was placed on the right and left bodysides of the 3rd car from the head end of the 16-car outbound train, i.e., the 14th car of the inbound train, to measure two velocity components in the directions parallel to the rail and perpendicular to the bodysides. Twenty pressure gauges were attached to the right and left sides of the car and additionally to the roof and the underside of the car. It was shown that the large-scale coherent structures spread along the train not only on the left-hand side of the train but also on the roof and on the underside of the cars (Fig. 2). In addition, even on the right-hand side of the train, the large-scale coherent structures could be observed, although these were in antiphase with those on the left-hand side of the train. Correlations between velocity and pressure fluctuations demonstrate that the large-scale coherent structures are composed of rotating air flows. Finally, new car-body designs are being introduced to reduce the effects of the large-scale coherent structures and thus improve ride comfort.

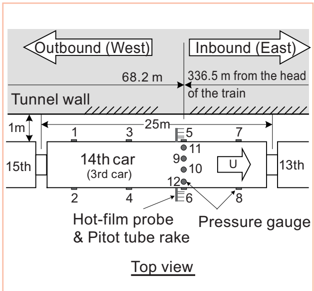


Fig. 1 Layout of equipment on the train travelling through a double-track tunnel

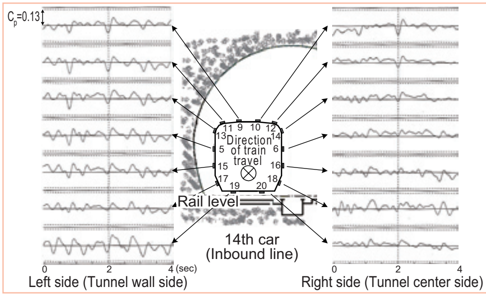


Fig. 2 Time histories of dimensionless pressure fluctuations around the cross-section of the 14th car from the head end of the train

# Development of a Mobile Broadband Telecommunications System for Railways Using Laser Technology

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Having an eye to the laser communications technology that is already proven in the field of fixed section-to-section communications, we have carried out research and development work for a high capacity optical communication system offering practical application of this technology as a means of ground-to-train communication.

The system we have developed, as shown in Fig.1, utilizes a laser beam tracking method. Both the on-train communication device (mobile station) and its ground counterparts (base stations) emit infrared beacon lights as their identifying signals and transmit data between them by sending out a laser beam to each other with their beacon signals as the targets. Even in a situation where the relative positions of the ground and the on-train communication units are changing rapidly, they can keep track of each other through adjustment of their internal movable mirrors. Also, the system contains a handover function to switch rapidly and dynamically from one base station to another in response to the running speed of the train, which enables continuous communication.

As a result of the performance test using a commercial train on a conventional line (Fig. 2), we were able to obtain a transmission rate ranging from approximately 500 to 700 Mbps at a train speed of approximately 130 km/h. The handover took approximately 0.4 seconds due to vibrations of the train. In a bidirectional transmission test with high-definition video, however, little disturbance was observed in the pictures, and by using some protocol, we could see the video without observing any effect caused by the handover.

In similar communication tests conducted on a Shinkansen line, the two devices were able to track each other for a maximum of approximately 0.7 seconds at train speeds up to 270 km/h.

By conducting these tests, we were able to verify the applicability of the system we had developed to railway environments. At the same time, problems that will need to be solved in the future were identified, such as the handover time and the influence of glass in train windows. We intend to continue our efforts to bring the system to perfection in pursuit of its practical application.

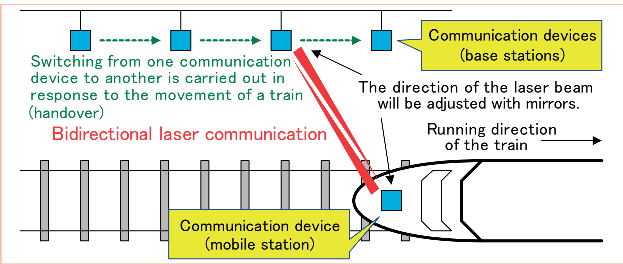


Fig. 1 The concept of the laser beam tracking communication system on a railway line

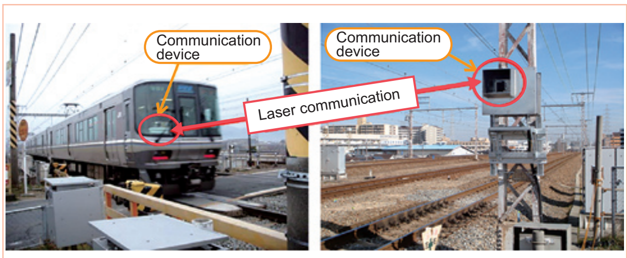


Fig. 2 View of the field test on a conventional line