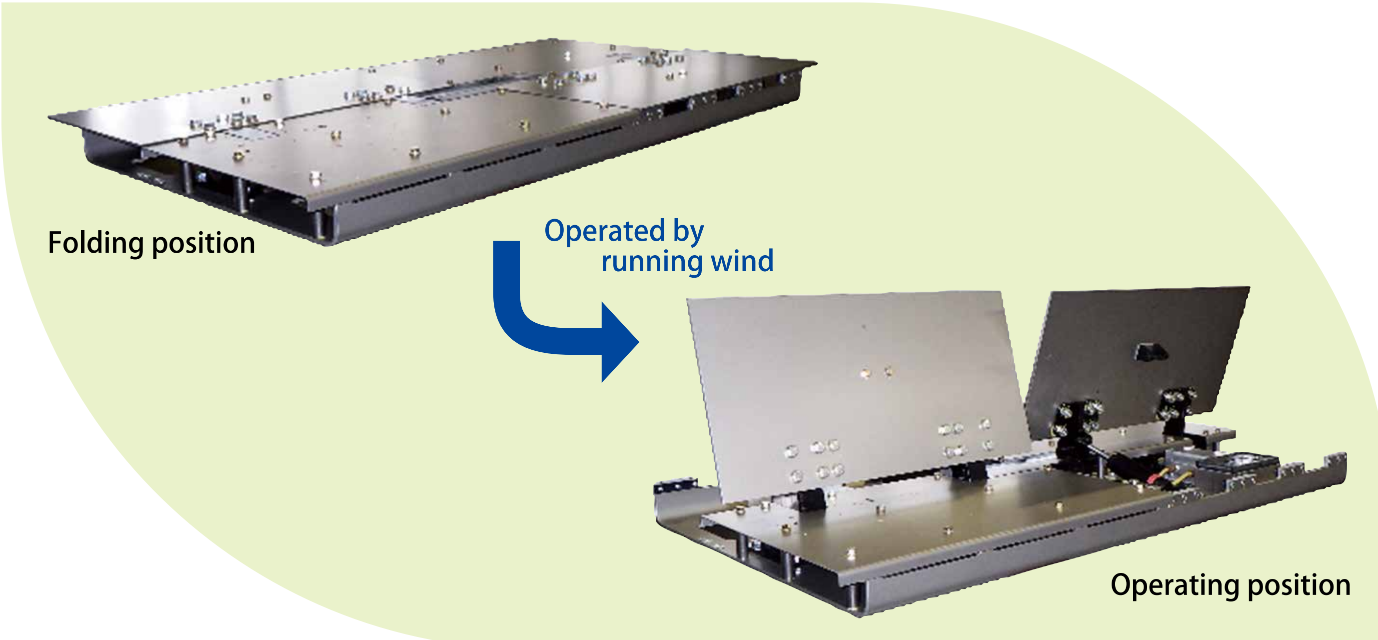


Aerodynamic brake device

# Vehicle Aerodynamics Laboratory

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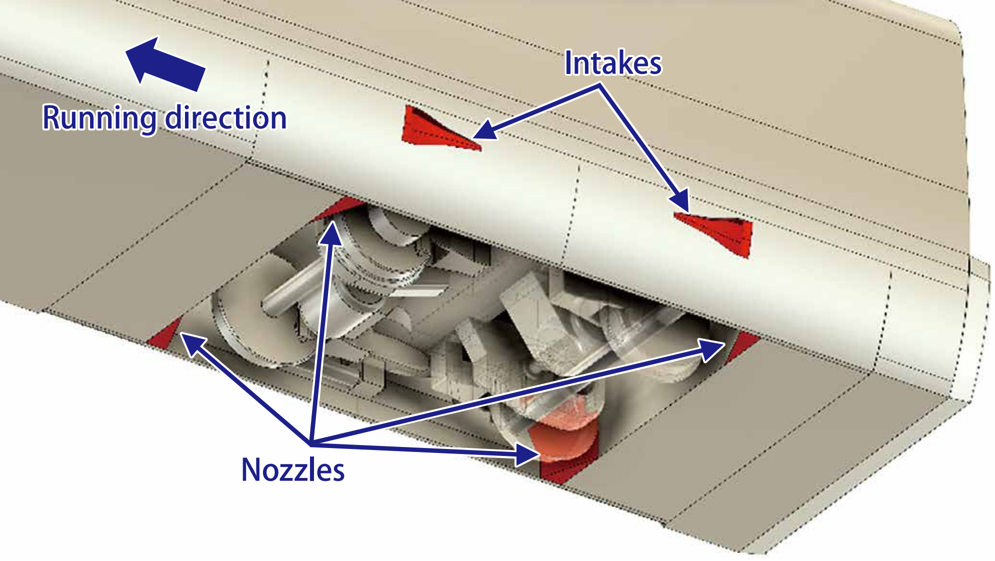
The Vehicle Aerodynamics Laboratory deals with various railway-related aerodynamic phenomena found mainly in open sections. The main research topics we are currently working on include issues targeting the flow field around high-speed vehicles such as the Shinkansen (e.g., aerodynamic brake device for Shinkansen speed improvement, measures to prevent snow accretion on the bogie section using the running wind, high-speed train roof flow analysis for understanding the performance of the current collector) and issues related to safety evaluation against the natural wind (e.g., evaluation of the aerodynamic characteristics of vehicles under cross winds, evaluation of the wind load acting on objects lying on the track surface). This paper introduces three research examples out of these.




**Intake and nozzle layout**

### Aerodynamic brake device for Shinkansen speed improvement

The aerodynamic brake device is a non-adhesive system that temporarily increases the air resistance acting on a running train to directly decelerate the vehicle. It complements the conventional braking force mainly in the high-speed range when sudden deceleration is required in an emergency such as an earthquake.

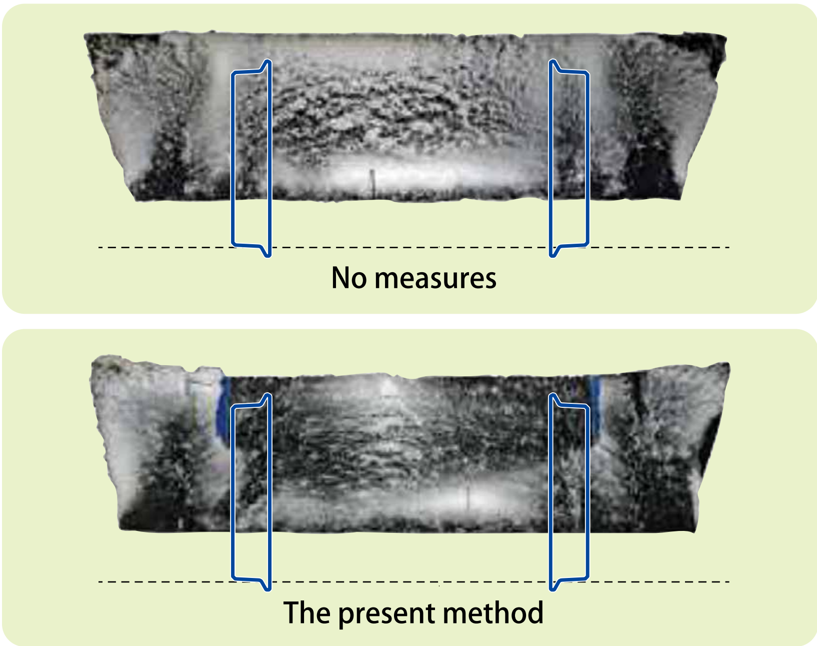
Its feature is that it can decelerate directly by using the air resistance of the vehicle without relying on the wheels or rails. Higher vehicle speeds provide higher deceleration because air resistance generally increases in proportion to the square of the train speed. A mechanism is incorporated that uses headwind to cause the resistance panel to stand on its own, thereby realizing a compact and lightweight configuration with a device thickness of 65 mm and a mass of 36 kg. This allows it to be stored compactly during normal operation without affecting passenger space. It has been verified to have no safety issues by conducting a vibration test, low temperature freezing test, bird striking test, computational fluid dynamics (CFD) analysis, etc., in addition to a 400 km/h wind tunnel test.

It is expected to be used to shorten the emergency stop distance when the Shinkansen vehicle speed is increased in the future.

### Measures to prevent snow accretion on the bogie section using passing air

Countermeasures against snow have been an issue in the recently promoted extension of Shinkansen to snowy areas such as Hokkaido and Hokuriku. Thus, we have developed a method to control the flow of snow particles around bogies and prevent snow accretion mainly on body panels behind the bogie. This will improve safety against snow falling from vehicles and reduce accreted snow removal work in snowy areas. The method consists of an intake that takes in the air passing the side of each bogie and a nozzle that blows out this air to the bogie (Intake and nozzle layout).

We conducted an experimental model running test and a snow wind tunnel test to reproduce the snow particle advection and snow accretion into the bogie. The results showed a potential reduction in snow accretion mass at the body panel of approximately 50% (Verification of the effect of reducing the snow accretion mass). In addition, as a result of simulating a shape that was expected to have a snow accretion suppression effect through a model experiment, we have verified that the number of accreted snow particles on the body panel was reduced by approximately 30%. We also investigated the effect of the intake shape on aerodynamic noise in a large-scale low-noise wind tunnel and verified that the increase in noise level due to the addition




**Verification of the effect of reducing the snow accretion mass**

of snow accretion measures can be suppressed to less than 1 dB.

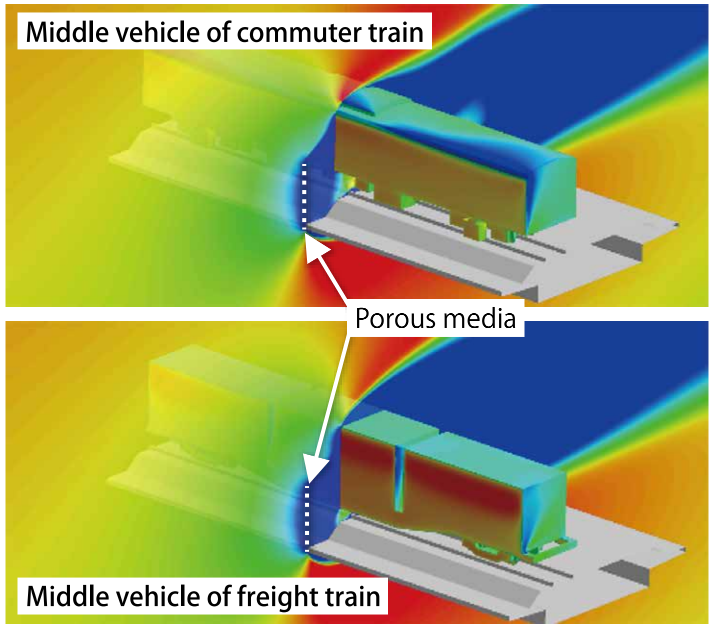
In the future, we will apply this method to actual Shinkansen vehicles to verify the effects of snow accretion prevention and noise increase.

## Evaluating aerodynamic characteristics of vehicles under cross wind

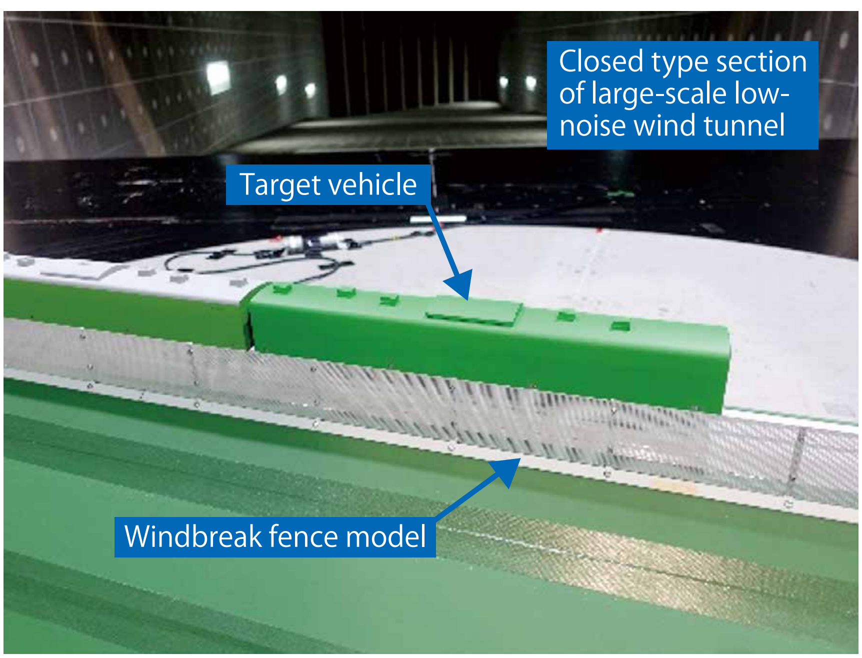
RTRI conducted wind tunnel tests with five types of typical vehicles and seven types of track structures in the previous studies, and summarizes the aerodynamic coefficients of the five vehicles under cross winds. These coefficients have been used to evaluate vehicle running safety in strong winds and review train operation control methods. However, the coefficients of aerodynamic force for the condition with a windbreak fence have not been comprehensively obtained, and it was sometimes difficult to evaluate the critical wind speed of overturning if countermeasures against strong winds were taken.

Thus, we conducted a wind tunnel test to measure the aerodynamic forces with a windbreak fence (Wind tunnel test for the windbreak fence) to expand the data of aerodynamic force coefficients and clarify the improvement in the critical wind speed of overturning by installing the windbreak fence. We also developed a method of CFD analysis that can consider the effect of the windbreak fence, and conducted CFD analysis to reproduce the wind tunnel tests using the windbreak fence model (CFD analysis that reproduced the wind tunnel test for the windbreak fence). By comparing with the results of the wind tunnel test, we have verified that the effects of vehicle shapes and track structures on the amount of aerodynamic force reduction caused by the windbreak fence are properly reproduced in CFD analysis.

For vehicles with the same roof curvature radius, we have clarified the differences in aerodynamic force coefficients obtained from the wind tunnel test and CFD analysis, and also revealed the differences in critical wind speed of overturning calculated from the aerodynamic force coefficients.




**CFD analysis that reproduced the wind tunnel test for the windbreak fence**




**Wind tunnel test for the windbreak fence**