Characteristics of Under-Floor Flow of Shinkansen Train

Makoto IWASAKI
Senior Researcher, Vehicle Aerodynamics, Environmental Engineering Division

1. Introduction

To reduce aerodynamic noise and aerodynamic drag of a Shinkansen train, the flow field under the vehicle floor must be understood. The under-floor flow velocity in the longitudinal direction (X direction in Fig.1) induced by the passage of the train has so far been measured at the central position between the rails. However, since the flow velocity is likely to have a distribution laterally across the track (in the sleeper direction), multiple hot wire anemometers were installed across the track as shown in Fig.1 to measure the under-floor flow velocity. These instruments provided measurements of the under-floor flow velocity distributions in the longitudinal direction and the sleeper direction for the passage of the Shinkansen train.

2. Outline of the Measurement

In a slab track of Shinkansen, a total of seven one-dimensional hot wire anemometers were installed, each positioned at one of the seven measurement points across the track, starting from the center of the track to the outside of rails as shown in Fig. 1. This instrumentation arrangement allowed under-floor flow velocities to be measured during the passage of the Shinkansen train.

3. Measured Results

In this study, we took the mean of time series data of velocity and the mean flow velocity was transformed into a non-dimensional form by the train speed. The flow velocity distribution in the longitudinal direction of a 10-car Shinkansen train is shown in

Fig.2. The flow velocity is almost constant throughout the train except for the leading and trailing vehicles. From Fig.2, we can see that the flow velocity was highest at the center of the track (at R1) compared to the other measurement points across the track. And we can see a trend where the flow velocity is highest at the inter-vehicle gaps, and drops off steadily as the front bogie, the between front and rear bogies, and the rear bogie for car No.3 and the other cars behind it. Although there is some variation in the flow velocity under the influence of local locations of vehicles such as bogies and inter-vehicle gaps, the flow velocity at each measurement point was found to be almost constant as car No.2 and the following cars passed the measurement location. There was one exception in that measurements at R7, located outside of the vehicle side surface, tend to show an increase in flow velocity from front to back of the train.

Figure 3 presents the flow velocity distribution across the track for car No.5. We can see that the flow velocity is highest at R1 (center of track) and decreases gradually towards the R7, although variations are observed between measurement points.

The flow velocity distribution obtained by the actual cars as described above was reproduced for a wind tunnel test. This has led us to develop a methodology for estimating the aerodynamic noise and aerodynamic drag generated from bogies with high precision.

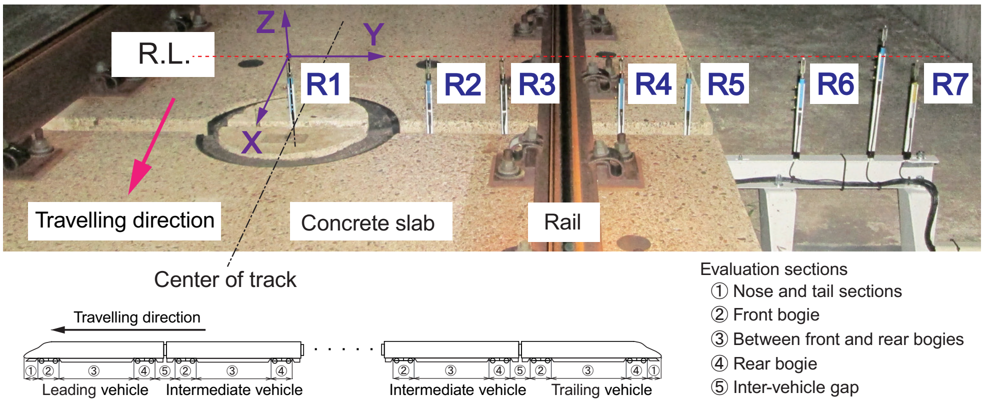

Fig.1 Layout of hot wire anemometers and evaluation sections

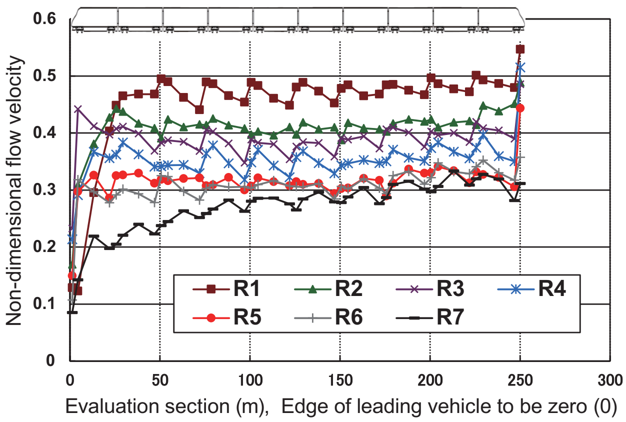

Fig.2 Flow velocity distribution in the longitudinal direction

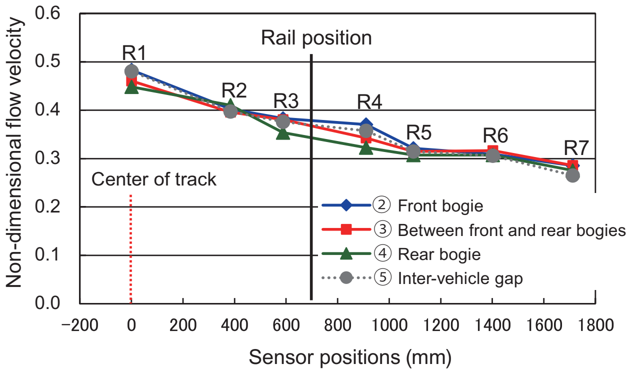

Fig.3 Flow velocity distribution in the sleeper direction of every measurement point for car No.5