Wind Tunnel Test on Windbreak Fence Installed on Railway Lines

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To improve the safety and stability of railway transport under windy conditions, windbreak fences have been installed on more and more parts of railway lines in wind-exposed areas in Japan. To effectively and economically install windbreak fences, we need to know the relation between the perpendicular distance from a windbreak fence to the track and reduction in aerodynamic forces on railway vehicles. For that purpose, we conducted a wind tunnel test to measure the aerodynamic forces that act on a vehicle located at different perpendicular distances from the windbreak fence.

We conducted the test for the 1/40 scale vehicle model of narrow gauge train series 103 under atmospheric boundary layer condition where representative wind speed is 30 m/s, using a large-scale low-noise wind tunnel (measurement section 5 x 3 x 20 m) at the Maibara Wind Tunnel Technical Center, RTRI. We installed a windbreak fence having a porosity of 40% at a height of 2 m (in full-scale dimensions) from the rail level on the windward side of a bridge/viaduct. A three-component aerodynamic force balance inside the vehicle model measured the side force and lift working on the model and the roll moment around the car-body center. The bridge model was actually composed of two sets of single-track bridges placed in parallel, the distance between the two of which could be varied. For the test on viaduct, we made several models with different widths. See Fig.1 for a photograph of the wind tunnel test on a viaduct.

Figure 2 shows the relation between the side force coefficient (non-dimensional side force coefficient based on vehicle side area and dynamic pressure of wind) on an intermediate vehicle and the perpendicular distance from the windbreak fence. Where there are no fences, the coefficient of side force is approximately 1.4 both with bridges and viaducts. Where a fence exists, the value of the coefficient at a distance of 7 m from the fence is less than half that measured when there are no fences. At a distance of 13 m or over, the coefficient is larger with bridges than with viaducts, presumably because the two sets of single-track bridges are placed apart to allow air to flow in between.

In the present wind tunnel test, we used the models of vehicle and bridges/viaducts all set in a static state. Accordingly, the relative motion of the vehicle and the bridges/viaducts, which occurs in full-scale situations, was not simulated in the test. We will further study this effect of the relative motion on the estimation of the effectiveness of windbreak fences.

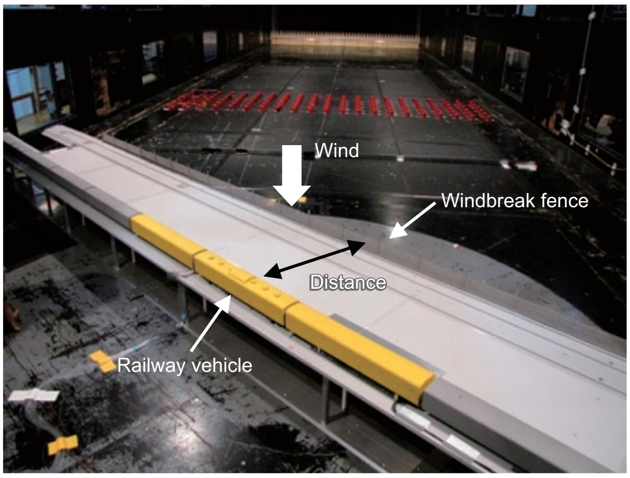

Fig. 1 A photograph of the wind tunnel test on a viaduct

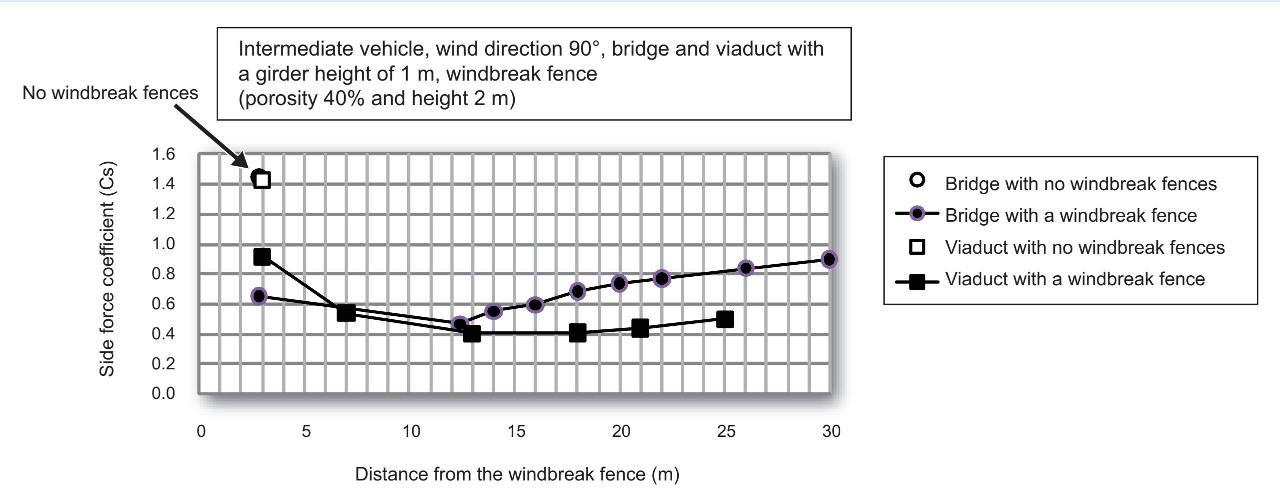

Fig. 2 Relation between the distance from the windbreak fence and the of side force coefficient (for bridge and viaduct)