November 29, 2021

RTRI Develops Snow Accretion Simulator

RTRI developed the first snow accretion simulator in Japan. This simulator is capable of precisely reproducing the process of snow accretion onto train bogies by computing and the phenomenon can be analyzed under conditions close to actual train running including snowfall and wind intensity. This new device will be used to develop vehicles preventing snow accretion more effectively.

1. Background

While a train is running in snowy areas in winter, the snow on the track is blown off, is accreted onto the vehicle underfloor and bogies, and eventually grows into large chunks (Fig.1). Since it takes a lot of cost and manual work to remove the accreted snow, it has been required to develop vehicle shapes less likely to induce snow accretion. However, as the research on vehicle shapes has been implemented using actual vehicles so far, too much efforts have been required and the testing has been possible only in winter and snowy times. In the meantime, impacts by train running such as wheel rotation and winds cannot be accurately reflected on the testing in the snowfall wind tunnel using a model train. The snow accretion simulator has been developed in order to solve these issues and to reproduce the accretion process more precisely.

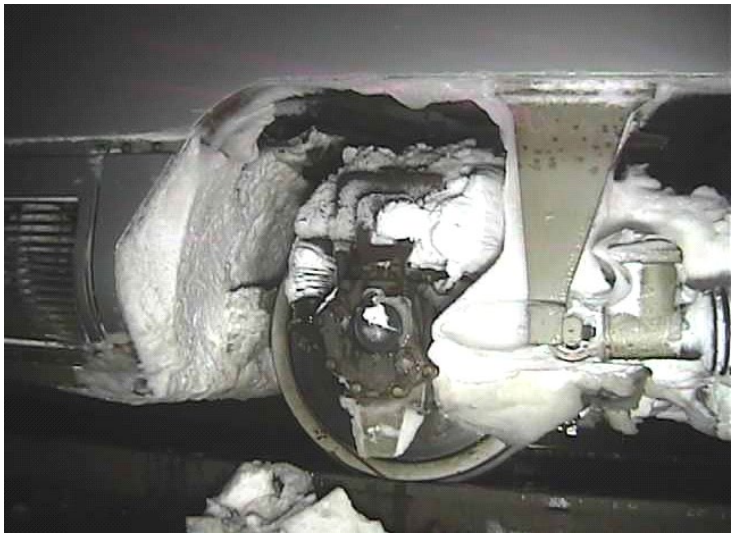


Fig. 1 Snow accretion found on an actual vehicle

2. Overview of the simulator

Using a super computer, this simulator has made possible high-speed calculation under different conditions (Fig. 2).

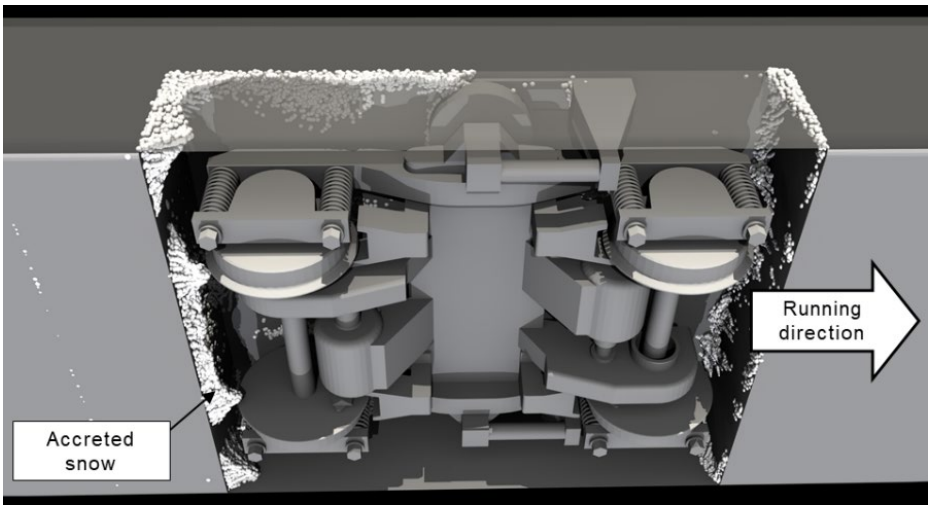


Fig. 2 Simulated snow accretion on a bogie

【Features of the simulator】

- Capable of calculating snow accretion under the impacts of train running such as wheel rotation and winds against a vehicle.
- Capable of simulating snow accretion onto objects with complicated shapes like train bogies.
- Capable of visualizing the accretion process including air flow, flying snow particles and snow accreted state and can be used to analyze the causes of snow accretion and to develop preventive measures.
- The simulator repeats three categories of calculations: calculations to analyze airflow around the object, to trace movements of flying snow particles and to assess the growth of snow accretion. With these calculations, it is capable of reflecting on the simulation the airflow around the object which changes depending upon surface shapes of the growing snow accretion and of reproducing the process more accurately (Fig.3) .

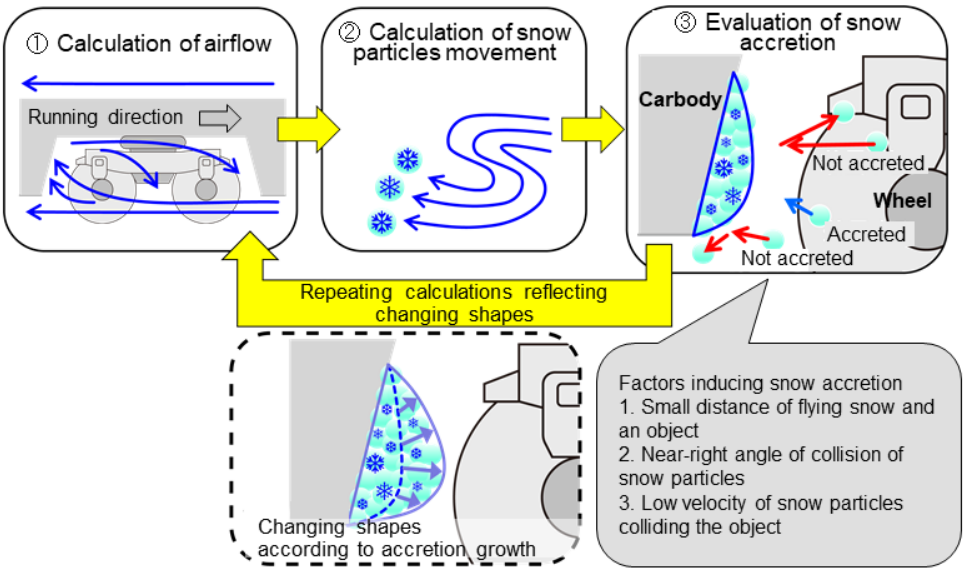
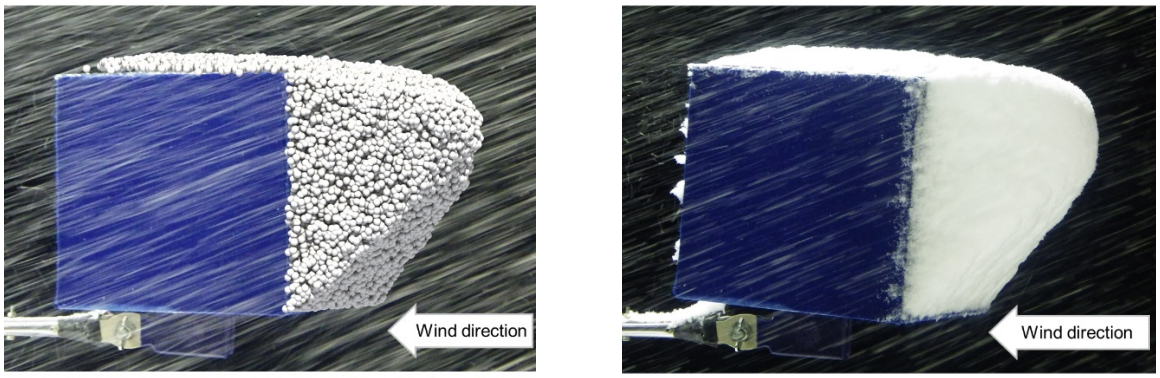


Fig. 3 Calculation system of the simulator

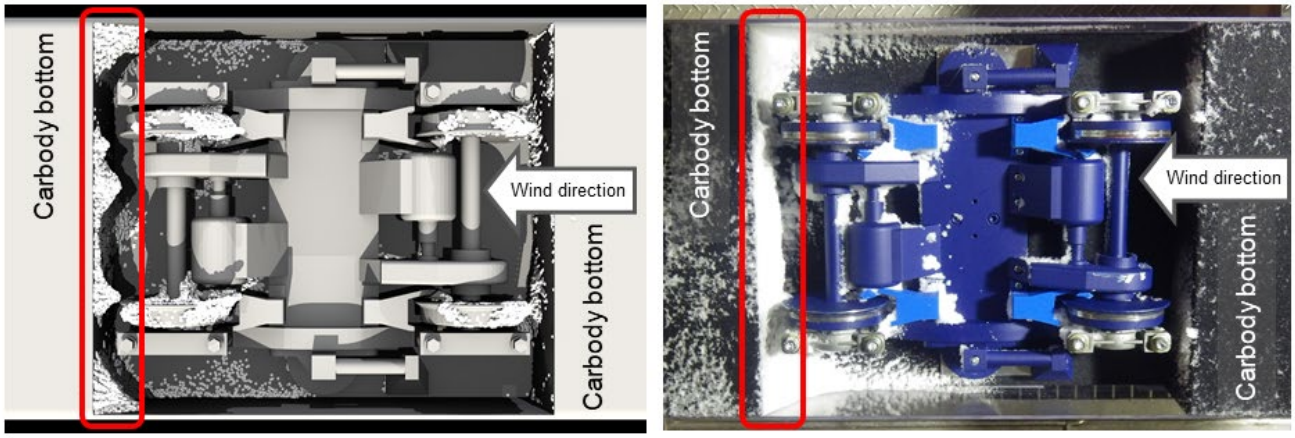


(a) Result of simulation

(b) Result of wind tunnel testing

Fig. 4 Snow accretion on a cubic object

- By comparing the results of this simulation and of the tests in the snowfall wind tunnel using a cubic test object, it has been confirmed that this simulator reproduces snow accretion with 6% error margin in terms of the area ratio from a lateral view (Fig. 4). In addition, the calculation results of the maximum thickness and weight of accreted snow on the complicated-shape bogie are almost consistent with those of wind tunnel tests (Fig. 5).



(a) Result of simulation (b) Result of wind tunnel testing with a model bogie

Fig. 5 Snow accretion on a train bogie

(The simulation is conducted without rotating the wheels in order to compare the results under the same conditions)

3. Research plan using the simulator

RTRI plans to use this simulator to improve vehicle shapes in order to reduce the snow accretion around bogies. Since the simulated snow accretion process can be incorporated in developing shapes of bogie areas, the efficiency of vehicle development can be raised.