Development of Device to Prevent Deviation of the Tokaido Shinkansen during an Earthquake


Sakanoue, K.[*1]
(born in1965)


Adachi, M.[*2]
(born in 1968)


Minami, Y.[*1]
(born in1967)


Sunami, H.[*2]
(born in1971)


Takada, N.[*3]
(born in 1981)

1. Abstract

A post derailment stopper (hereinafter referred to as, “stopper”) is a device for preventing derailed vehicles from deviating from the track in the event of a derailment caused by an earthquake. In order to enhance the safety of the Tokaido Shinkansen in regard to earthquakes, two countermeasures for vehicle derailment and post-derailment vehicle deviation have been newly developed. An anti-derailment guard rail (hereinafter referred as, “guard”) prevents vehicles from derailing and the stopper, which has been developed to add redundancy, prevents a derailed vehicle from deviating off the tracks. The stopper is attached to the bogie frame and restricts the lateral motion of the derailed vehicle through contact with the guard (Figure 1).

2. Technical Features

Figure 2 shows examples of the stoppers for the Series N700 and Series 700, both of which are operated on the Tokaido Shinkansen. Figure 3 shows the positional relationship of the bogie, stopper, track, and the guard when a vehicle is on the rails. The stopper is attached near the center of the bogie frame using two bolts, which makes it possible to attach the stopper to bogie frames that have already been put into service. In order to improve the wear resistance of the stopper when it comes in contact with the guard, the stopper was elongated in the direction of travel to enlarge the surface area. In addition, the stopper has been made from chromium molybdenum steel. The stopper mass is approximately 20kg, which improves the ease of maintenance. The distance between the bottom of the stopper and the top of the rail is 172mm when a vehicle loaded to passenger capacity is on the rails, which means that when the vehicle has been derailed the bottom of the stopper will be level with the top of the rails.

Figure 4 shows the positional relationship between the stopper and the guard when in contact. In order for the stopper to function effectively, the bottom of the stopper must not be higher than the guard and at the same time it must not strike the guard supports. Therefore, the vertical tolerance level of the bottom of the stopper must be 45mm. When a vehicle derails from ballast track the wheels are forced up and down which causes vertical movement generated by vertical translation and the pitching of the bogie. The stopper is attached near the center of the bogie in order to decrease the vertical motion of the stopper by reducing the influence of the pitching motion of the bogie. However it was difficult to predict the motion of the derailed vehicle. Therefore, we optimized the configuration of the stopper and evaluated its performance by conducting running tests under derailment conditions using Tokaido Shinkansen vehicle bogies on a test track equivalent to Tokaido Shinkansen. We also conducted running tests over a turnout and verified that the stopper has little influence on vehicle motion even over turnouts. These running tests under derailment conditions were conducted more than 20 times between 2007 and 2009 in order to determine fundamental specifications for the stopper.

3. Summary

We have developed a stopper effective from both standpoints of function and maintenance by conducting running tests under derailment conditions, as well as long-term running tests on commercial tracks and numerical analysis. Based on these results, we optimized stopper design according to vehicle and bogie type and started installing the stoppers on all Series 700 and Series N700 bogies in 2009.

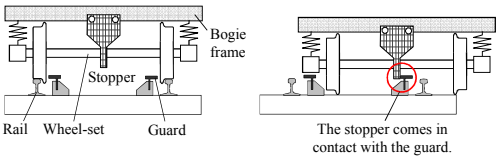

Figure 1 Function of the Stopper

For series N700 driving bogie　For series 700 trailing bogie

Figure 2 Post derailment stopper

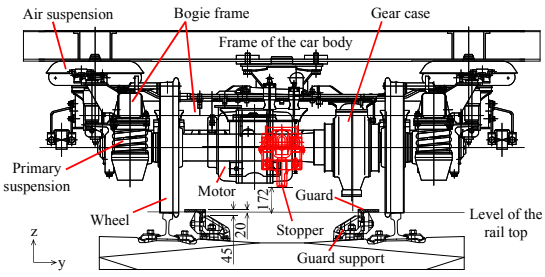

Figure 3 Positional relationship of bogie, stopper and guard

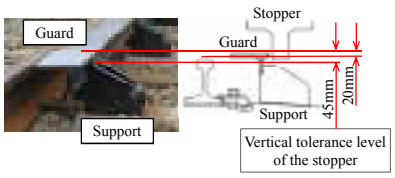

Figure 4 Vertical tolerance level of the stopper

[*1]Member, Central Japan Railway Company(CJR)
(1-9-1, Marunouchi, Chiyoda-ku,Tokyo, 100-0005, Japan)
[*2]Member, CJR (1545-33, Ohiyama, Komaki-shi, Aichi, 485-0801, Japan)
[*3]Member, Nippon Sharyo, LTD. (2-20, Honohara, Toyokawa-shi, Aichi, 442-8502,Japan)