Special edition paper

Development of Miscellaneous Rolling Stock Equipment for Speed Increases



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FASTECH360 Shinkansen high-speed test trains are necessary for development of novel mechanisms and devices that Shinkansen rolling stock in operation is not equipped with. Those mechanisms are developed to secure safety and reliability as well as to improve comfort and environmental compatibility. Using FASTECH360, we developed and confirmed performance of current collection systems, drive systems and control systems as well as a train splitting/combining device that is unique to JR East's Shinkansen and a snowplow indispensable for running in regions of heavy snowfall.

●Keywords: Splitting and combing, Noise reduction, Movable cover, Smoothing, Snowplow

1 Introduction

Evaluation by means such as running tests that incorporate many test elements is needed to achieve Shinkansen speed increases and solve existing problems. Using FASTECH360 Shinkansen high-speed test trains, we improved the train splitting/combining device developed in conjunction with the opening of the Yamagata Shinkansen in July 1992 into a new one for coupled operation of high-speed rolling stock. We also developed a movable snowplow cover as a departure from conventional approaches.

2 Train Splitting/Combining Device

The Yamagata Shinkansen and Akita Shinkansen have through service between Shinkansen and conventional line sections. Rolling stock for through service (type 400 and series E3) runs on Shinkansen lines by being coupled to Shinkansen-exclusive rolling stock (series E2 and E4), so much of the Shinkansen rolling stock in operation has train splitting/combining devices.

With FASTECH360, we have developed a new device to improve reliability and fit the nose shape that has been redesigned to reduce micro-pressure waves.

The FASTECH360S test train exclusive for Shinkansen is equipped with an automatic train splitting/combining device at car No. 8, and the FASTECH360Z test train for through service is equipped with it at car No. 11. The automatic train splitting/combining device consists of a coupler cover opening/closing device, an electrical coupler and controllers of those. We also added and tested bus line splitting/combining devices for cabling through the coupled train sets to use the power collected from overhead contact line.

2.1 Coupler Cover Opening/Closing Device

The lead car equipped with the train splitting/combining device has a so-called "arrow-line" shape that is effective in reducing micro-pressure waves. The coupler cover was made to handle that shape and secure an opening for the bus line splitting/combining device (Fig. 1).

As the gap between the car body and the coupler cover was minimized to reduce noise from the nose, we adopted a new device opening procedure. In that, the whole coupler cover moves forward once, opens to the left and right and is then stored in the car body (Fig. 2).

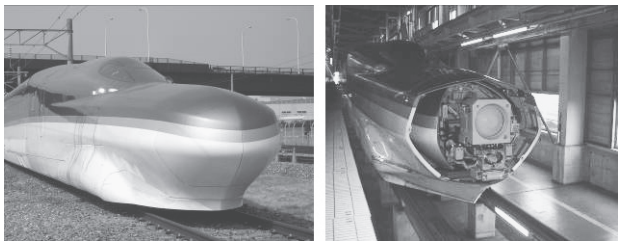

Fig. 1 Lead Car with the Train Splitting/Combining Device

Fig. 2 Coupler Cover Opening Operation

2.2 Electrical Coupler for Train Splitting/Combining

The electrical coupler for train splitting/combining on Shinkansen rolling stock in operation is located on the tight lock coupler. The device on rolling stock for through service is movable.

This structure was developed for type 400 and 200 rolling stock that was the first rolling stock split from/combined to Shinkansen rolling stock, and it takes into account modifications made for 200 series rolling stock. With FASTECH360, we located the electrical coupler under the tight lock coupler and eliminated the movable mechanism for a more simplified structure (Fig. 3 right). Since the new electrical coupler is applied just for coupled operation of high-speed train sets, that device cannot be used in coupled operation with Shinkansen rolling stock in operation.

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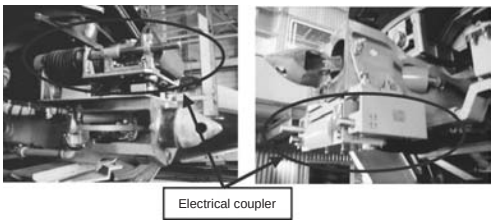

Fig. 3 Electrical Coupler (Left: Current type, Right: Newly developed type)

2.3 Bus Line Splitting/Combining Device

Pantograph contact loss will increase with Shinkansen speed increase. In current collection with two pantographs per train set, the rear pantograph cannot track the contact wire as the front pantograph in the running direction lifts up the contact wire, causing overhead contact line vibration. The same phenomenon will occur in coupled operation with one pantograph per train set, so the contact loss ratio of the pantograph at the rear train set will increase too.

With FASTECH360, we anticipated cases where current cannot be stably collected in coupled operation. We thus developed a bus line splitting/combining device that allows bus line cabling through the coupled train sets (Fig. 4).

The body of the bus line splitting/combining device consists of bus line connectors and a dustproof and waterproof cover with movable shutters to store those connectors.

The device also consists of a controller and of a high voltage equipment box that contains a vacuum circuit breaker to allow flow of current only when connected. Issues such as reliability improvement, however, must be overcome before the device can be equipped to cars in commercial operation.

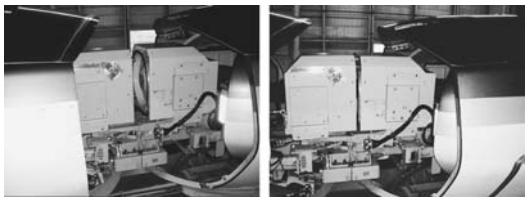

Fig. 4 Bus Line Splitting/Combining Device (combining from left to right)

3 Snowplow

3.1 Movable Snowplow Cover

We installed movable snowplow covers (Fig. 5) to achieve both plowing performance in snow and low noise at high speed running, but the structure ended up being complex as it had to be smooth with the car body. The movable structure was particularly complex with the FASTECH360S and adjustment was very difficult.

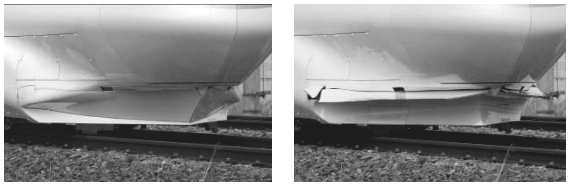

Fig. 5 Movable Snowplow Cover for FASTECH360Z (Left: Closed, Right: Open)

3.2 Change to a Fixed Cover

We studied performance in wind tunnel tests using models of a low-noise snowplow shape to replace the complex retractable cover. The running test results of the snowplow shape obtained from the wind tunnel tests results showed only a slight increase of noise with the snowplow without a cover (Fig. 6).

Fig. 6 Shape of Low-Noise Snowplow

4 Smoother Handle for Cab Hinged Door

A smoother door handle is a mechanism that makes the handles and the area around them smooth when running to reduce noise at the handles at the both ends of the cab hinged door. When the train reaches a specified speed, a cover next to the handle rotates by a rotary actuator to fill the gap of the handle (Fig. 7).

In running tests, a noise source was clearly detected when handles remained uncovered. That proved the noise reduction effect of the smoother door handle.

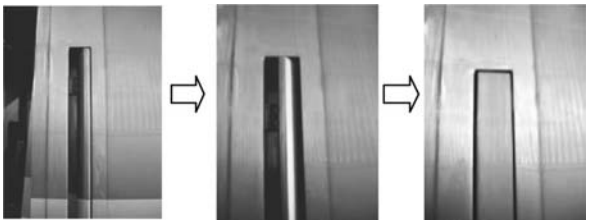

Fig. 7 Operation of Smoother Handle (from left to right)

5 Conclusion

Through train splitting/combining tests and high-speed running test of coupled trains on operating lines, we confirmed normal operation of the coupler cover opening/closing device and electrical couplers as well as the noise reduction effect of smoother handles for cab sliding doors. We also confirmed normal operation of the movable mechanism of the bus line splitting/combining device, but reliability improvement and other issues still remain unsolved for that. The movable snowplow cover showed little noise reduction effect, but we have confirmed that improvement of the snowplow shape would reduce noise.