Evaluation of the effect of the Shinkansen speed increase plan on civil engineering structures showed that three concrete girder spans did not meet the deflection criteria specified in the design standards. We have thus developed a construction method to reduce girder deflection using sound insulating walls. That method focuses on use of cast-in-place reinforced concrete sound insulating walls, and joint deformation is bound to integrate joints with the girders and increase rigidity. As advance test construction for one of those girder spans, we filled joints of the sound insulating walls with non-shrinkage mortar (the first phase) and attached steel covers on the top of the sound insulating walls (the second phase). As a result, girder deflection was reduced to approx. 50% compared to that before the construction, confirming that this method can handle Shinkansen speed increase.

**Keywords:** Shinkansen speed increase, Reduction of deflection, Concrete girder, Sound insulating wall, Steel fitting

1 **Introduction**

Shinkansen structures in the operation area of JR East where Shinkansen speed increase is planned are designed with a maximum design speed of 260 km/h. We thus studied the effect of the operation speed increase on approx. 17,500 concrete girders in the planned speed increase areas by a newly developed analysis simulation method that can reproduce dynamic behavior of structures at train running. As a result, we found that three concrete girders did not meet the deflection criteria specified in the current railway structure design standards (for concrete structure) from a standpoint of ride comfort when the maximum speed was greater than 300 km/h.

In order to solve that problem, we have developed a construction method to reduce deflection of existing concrete girders using sound insulating walls and made advance test construction on one of those three girders using that method. This article will give a summary of the development.

2 **Overview of the New Method to Reduce Girder Deflection**

2.1 Outline of Test Construction Girders

Advance construction with the method to reduce deflection of existing concrete girders using sound insulation walls was done for PC girders of the Tohoku Shinkansen. Since those girders cross a local road diagonally, they consist of separate single-line structures for inbound and outbound lines (four main girders). While the span of the girders is 21.2 m, the height is just 1.0 m, making the ratio of girder height to span smaller than that of usual concrete PC girders. A general diagram of the viaduct that includes these girders is shown in Fig. 1.

2.2 Overview of Construction

Girder bending stiffness has to be increased to reduce deflection by passing trains. Increasing the number of main girders might be one measure to increase bending stiffness, but it is not practical. We thus focused on the fact that the girders have cast-in-place reinforced concrete sound insulating walls and examined a method to use those.

Sound insulating walls have joints at fixed intervals so as not to transmit to sound insulating walls stress by the load of a running train. So, we examined methods to increase rigidity of girders as a whole by binding the deformation of the joints (Fig. 2).

As the result of the examination, we confirmed that the bar arrangement between sound insulating walls and floor slabs and the stress generated on the sound insulating walls were within the permissible range. We thus carried out advance construction by the following method to check the effect (Fig. 3).

**Fig. 1 General Diagram of Viaduct**

**Fig. 2 Deformation of Sound Insulating Wall**

**[First Phase Countermeasure] Fill joints with high-strength non-shrinkage mortar**

We cut the existing joints of the sound insulating walls in advance and filled those with high-strength non-shrinkage mortar using steel molds. That made sound insulating walls contribute to improvement of the girder bending stiffness.
[Second Phase Countermeasure] Add steel covers on top of the sound insulating walls

Taking into account the long-term use of railway structures, we attached steel covers for durability improvement on the top of the sound insulating walls and fixed them with bolts and resin. The purpose of that is to prevent rainwater infiltration and reduce compression stress that is applied to the top of the sound insulating walls.

For construction in this phase, we established a method of fixing those steel covers to sound insulating walls by carrying out tests using samples to confirm the resin filling method. That was done to ensure transmission of stress to the structure to which advance construction was applied. We also developed a new method of resin filling to the area around bolts to ensure stress transmission even with horizontal through bolts and applied that method (Fig. 5).

3.3 Measurement Results

Fig. 6 shows the plotted measurement data of the maximum deflection at the center of the girders when a Shinkansen train passed before and after the test construction. The data proved that the construction reduced girder deflection to approx. 50% of that before the test construction, and it also shows that there would be no aging problems.

Analysis simulation based on the impact vibration test result also confirms that the deflection criteria of the current design standards can be met even in high-speed running at 360 km/h.

4 Conclusion

The first phase of the advance construction to the girders was completed in September 2007 and the second phase in February 2009. More than one year has passed since the completion of second phase construction, but inspection results show no condition changes (Photo 2). We conducted similar construction in 2010 to the other two girders that were found needing deflection reduction.