

## RTRI Develops and Puts into Practical Use Seismic Reinforcement Method for Bridge Abutments Using Ground Reinforcing Nails and Available Even in Narrow Places

The Railway Technical Research Institute (RTRI) developed a “seismic reinforcement method for bridge abutments using ground reinforcing nails” (Fig. 1) as an effective seismic reinforcement method which can be performed while minimizing the workspace in front side of bridge abutments. This method eliminates the need for extensive work starting from the front side of the abutment as in the past and enables economical design according to the required seismic performance levels.

We hereby report that this method has been used for the first time in the seismic reinforcement of a bridge across railways.

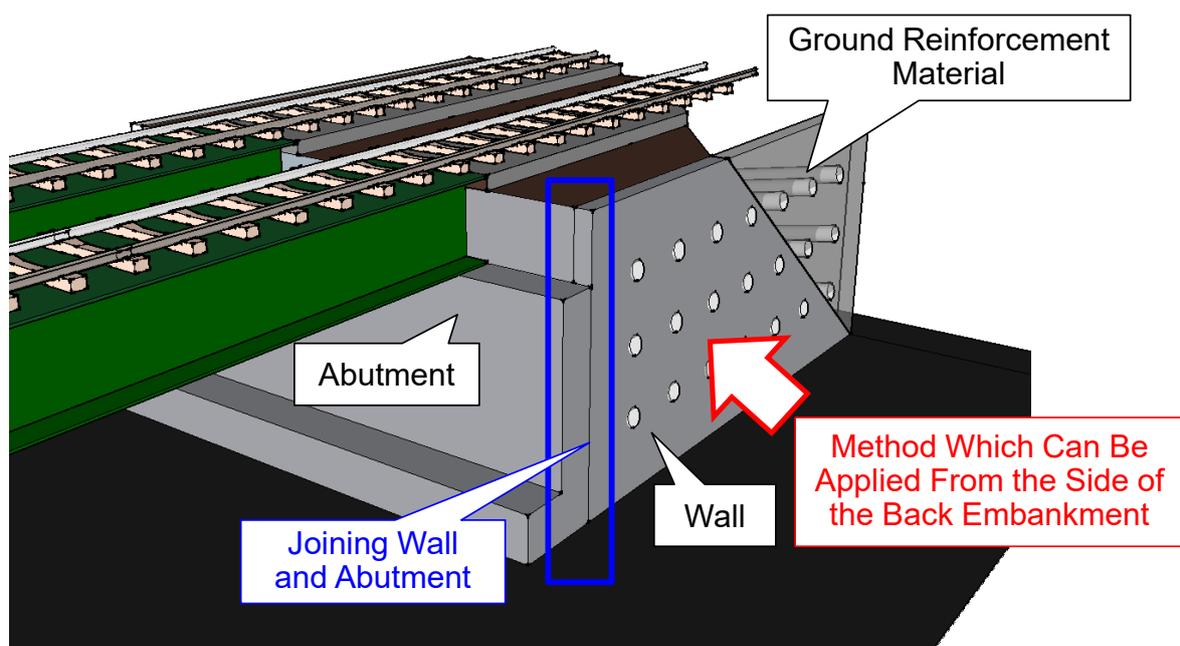


Fig. 1 Overview of Seismic Reinforcement Method for Bridge Abutments  
Using Ground Reinforcing nails

### 1. Background of Development

In past earthquakes, many cases of damage (Fig. 2) have been reported in which horizontal displacements and tilting of abutments caused settlement of the abutment backfill. Since such damage can cause track deformation and significantly reduce safety during train running, seismic reinforcement of existing abutments has been conducted so far by using supporting strut (reinforcing members installed between abutments) and ground anchors (tensile materials such as high-strength steel, Fig. 3).

However, these methods require a wide workspace in front of an abutment, making it difficult to perform seismic reinforcement in narrow places such as bridges across railways and those across roads in urban areas.

Therefore, the RTRI has developed an effective seismic reinforcement method for abutments of bridges built in such locations, a "seismic reinforcement method for bridge abutments using ground reinforcing nails", which can be applied from the side of the abutment backfill without obstructing the front side of the abutment.

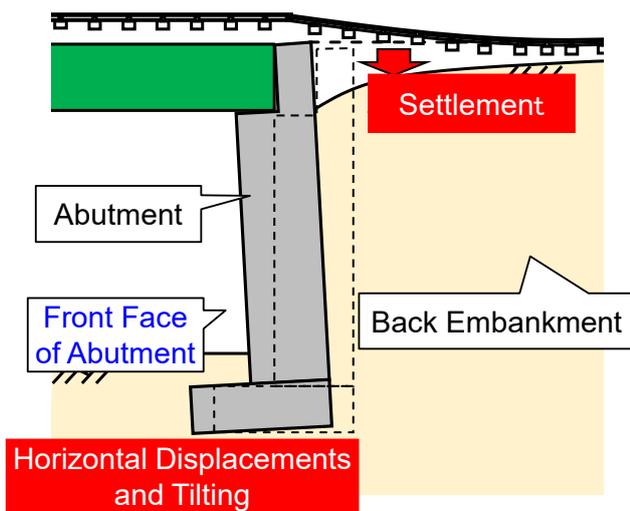


Fig. 2 Example of Damage to Bridge Abutment in Past Earthquakes

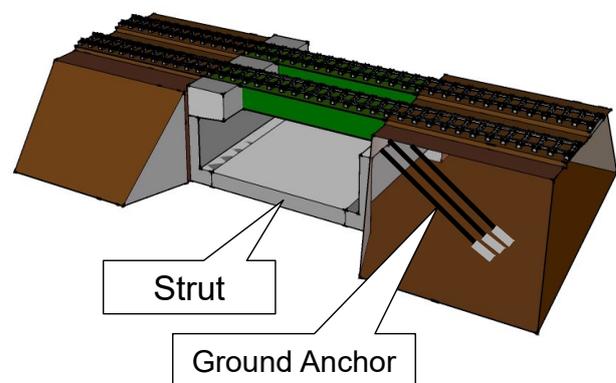


Fig. 3 Example of Conventional Seismic Reinforcement of Abutment

## 2. Overview and Major Characteristics of the Method

This method can be applied from the side of the abutment backfill using ground reinforcing nails and reinforced concrete walls without obstructing the front side of the abutment.

- This method integrates abutments, walls, and ground reinforcing nails to improve seismic resistance and reduce horizontal displacements and tilting of abutments as well as settlement of the abutment backfill.
- This method reinforces the abutment by placing ground reinforcing nails from the side of the abutment backfill, eliminating the need for extensive work starting from the front side of the abutment and simultaneously reinforcing the abutment backfill.
- With this method, the effectiveness of seismic reinforcement can be adjusted by varying the quantity of ground reinforcing nails. This allows economical design according to the required seismic performance levels (Fig. 4).

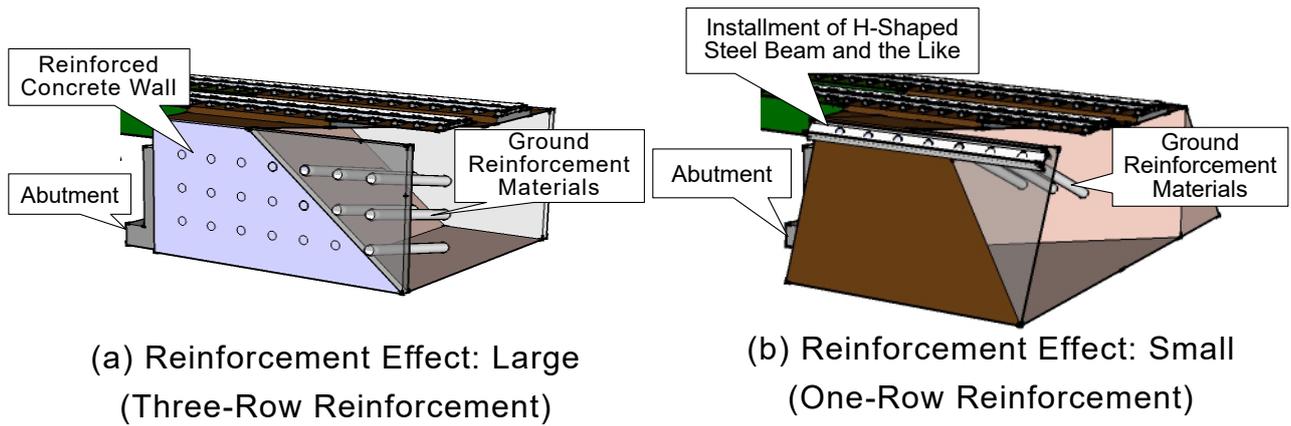
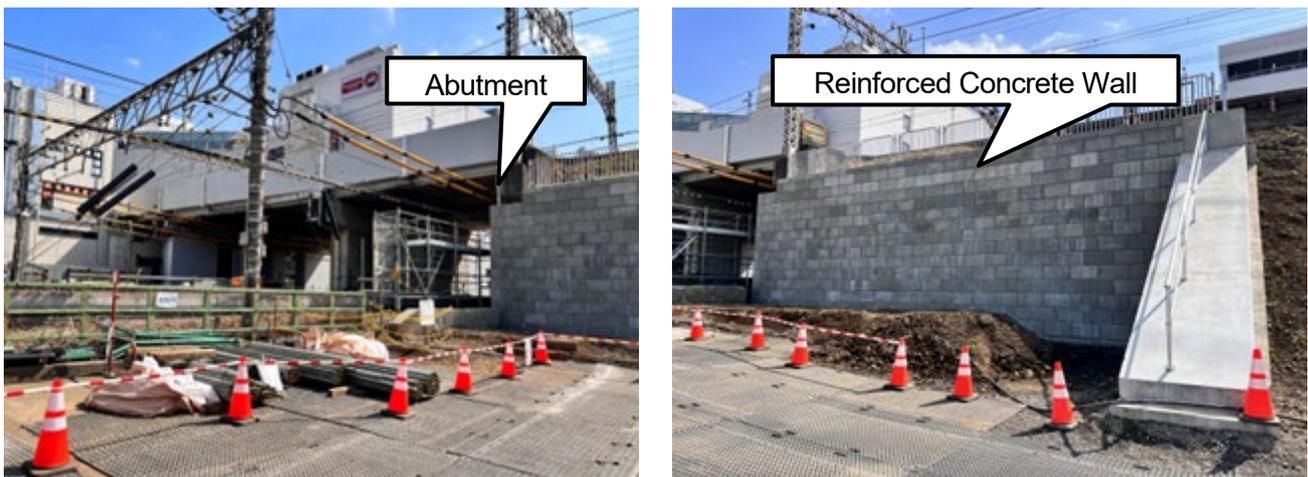


Fig. 4 Example of Economical Design According to the Required Seismic Performance Levels

### 3. Example of Practical Use

This method was first used in the seismic reinforcement of the bridge over the Odawara Line of Odakyu Electric Railway Co., Ltd. (Construction completed in March 2023, Fig. 5).



(a) Construction Status of the Site

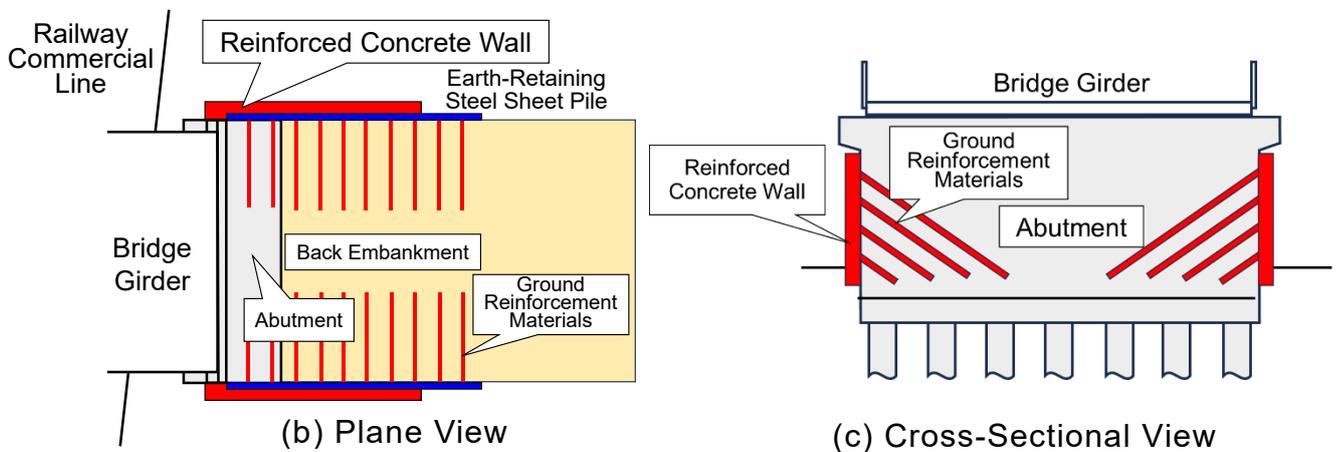


Fig. 5 Overview of Practical Use Example