News Release

Railway Technical Research Institute

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RTRI Develops a Seismic Retrofitting Method for the Suspended Ceilings with Shorter Hanging-Distance

The Railway Technical Research Institute has developed a seismic retrofitting method for suspended ceilings with shorter hanging-disrtance. This method has been adopted by JR West to retrofit its station buildings.

【Main characteristics】

RTRI has developed a seismic retrofitting method that can be applied to the suspended ceilings with a smaller ceiling cavity that allows only a short hanging distance. That type of ceilings are frequently seen in the station facilities constructed beneath viaduct with rather lower heights. The key point of this retrofitting method is to pass the hanging bolt through a steel pipe (square pipe) of standard product and to press the pipe up against the viaduct with a nut at the ceiling side end (Fig. 1). This method has the following advantages.

- Antiseismic performance can be improved while sufficient space for passing plumbing and other pipes etc. is secured.
- As this method makes the construction work easier and uses pipes of standard product, the cost is less than half that of the existing retrofitting method for short-hanging-distance ceilings.

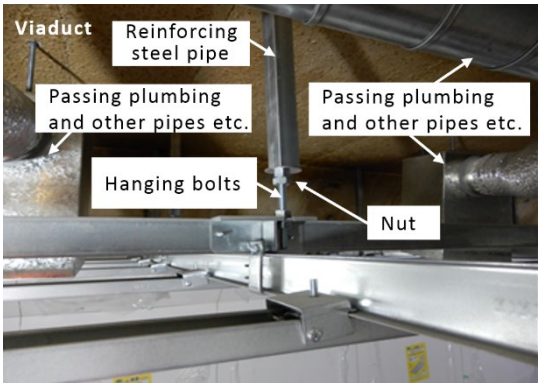

Figure 1: Ceiling retrofitted with steel pipe

【Process of development】

Since train station buildings are accessed by a large number of people, seismic safety must be secured so that the suspended ceilings will not collapse when an earthquake occurs. In the case of seismic retrofitting for ordinary suspended ceilings with 500 to 1500 mm hanging distance, seismic braces can be mounted to bear horizontal load acting on the ceilings at the time of an earthquake (Fig. 2).

However, the brace can only be mounted when its angle θ shown in figures 2 and 3 falls within the range between 30 to 60 degrees. If the hanging distance is not long enough as is the case for station facilities beneath lower viaduct, the angle will be smaller than 30 degrees and the braces cannot be mounted. In such cases, another seismic measures will be required also because braces occupy the ceiling cavity necessary for passing plumbing and other pipes etc.. Meanwhile, another alternative is to fix the ceiling to the viaduct using channel steel (Fig. 3). However, the construction work of this method

is hard and expensive. That is why we have developed this method that enables less expensive retrofitting while leaving sufficient under-roof space (Fig. 4).

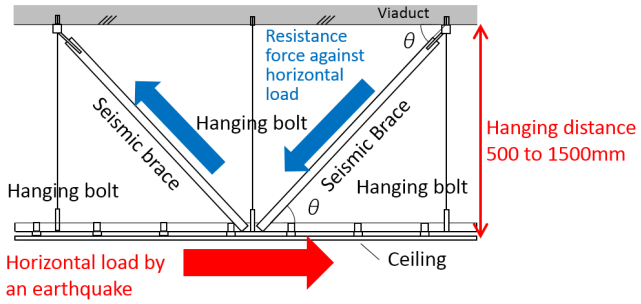

Figure 2: Seismic reinforcement with brace

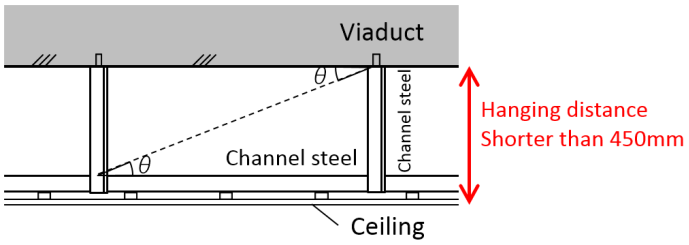

Figure 3: Seismic reinforcement with channel steel
(Existing construction method for short-hanging-distance ceilings)

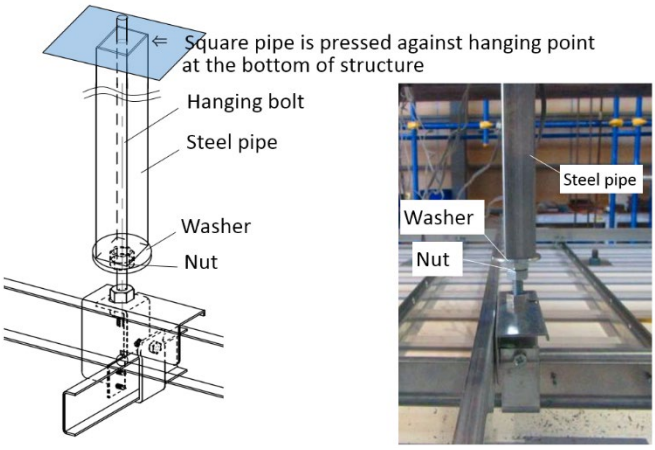

Figure 4: Retrofitting with steel pipe

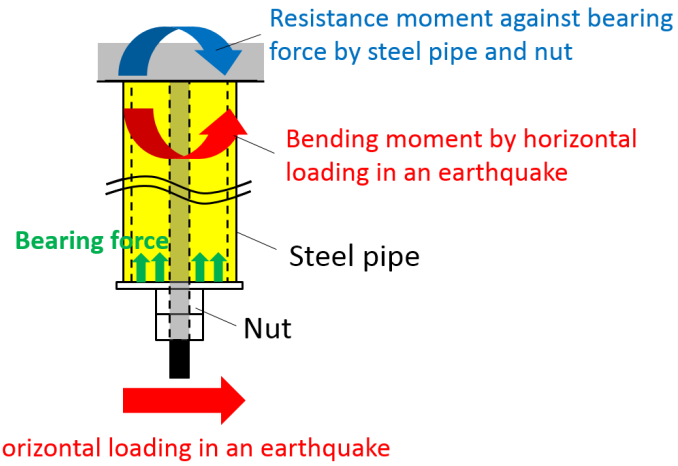

Figure 5: Resisting force against seismic force

【Outline of the method】

In this retrofitting work (Fig. 1 and 4), the horizontal load acting on the ceiling in an earthquake is borne by the force pressing the steel pipe up against the structure (Fig. 5).

We implemented structural testing according to “the Technical Standards Concerning Measures to Prevent the Collapse of Ceilings in Buildings” using a real-size test specimen. The steel square pipes of test specimen are 25 mm-wide and 1.6 mm-thick in consideration of the natural period of the suspended ceiling. In this testing, it was confirmed that the retrofitted ceiling attained necessary seismic performance and its horizontal load did not diminish under the repeated loading that exceeds the maximum design load (Fig. 6). From this result, we have concluded that this method can be applied to retrofitting work for suspended ceilings with short hanging distance (distance: shorter than 450 mm, angle: smaller than 30 degrees).

【The station retrofitted with this method】

The suspended ceiling of bathrooms in Osaka station building was retrofitted with this method and it contributed to cost reduction (Fig. 1)

【Patent filing】

RTRI has applied for a patent regarding part of this method jointly with Kirii Construction Materials Co., Ltd.

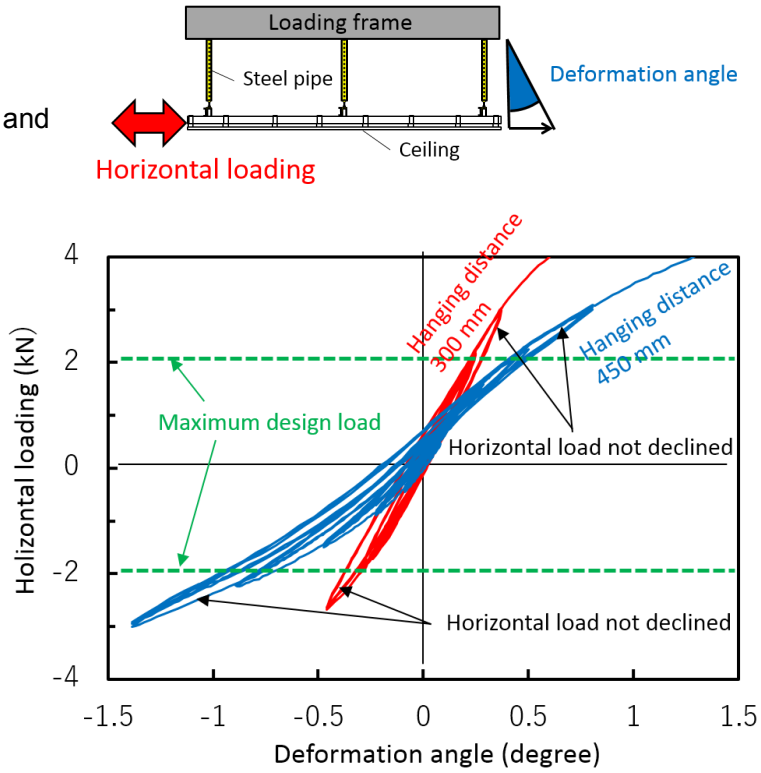

Figure 6: Result of structural testing