Applying Seismic Isolation Technologies to Buildings Above tracks

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Summary

Applying seismic isolation technologies to over-track buildings enables a reduction of lower structures accompanying reduced seismic response. That reduction of structures will likely allow cuts in construction time and costs of those buildings that face severe constraints in terms of design and construction. Using seismic isolation to control the area where damage occurs can also enable earlier recovery after a disaster. There were, however, technical issues faced in achieving seismic isolation of over-track buildings. To overcome those, we came up with a new seismic isolation frame form. Using a model that simulates a over-track building, we verified safety of the building at earthquakes through test design and analysis of seismic isolation by the conceived frame form.

Keywords: Over-track building; Seismic isolation; Laminate rubber; Seismic response analysis.

1. Introduction

In recent years, buildings such as stations and commercial facilities have been constructed in space above railway tracks in order to enhance the convenience of passengers and revitalize surrounding community. There are some constraints in structural design of such ‘over-track building’ so as not to disrupt train operations. For example, the building has the peculiar structural forms without underground beams under railway tracks and walls and braces at the ground floor. Furthermore, its construction work must be carried out in short time at night, because it is located near tracks. Those constraints often lead to increase time and costs in its construction.

To overcome those issues, we propose ‘smart building’ by applying seismic isolation technologies to over-track building. Because of efficient use of over-track space, the building has a new frame form that minimizes the height of the seismic isolation layer. In this study, the test design and the seismic response analysis of the building were executed using models that simulate a over-track building.

2. Overview of study

There were technical issues faced in applying seismic isolation technologies to over-track buildings as follows:

(1) When locating the seismic isolation layer at the lowest layer, the dimensions of seismic isolation clearance are restricted to secure that space for trains and passengers.

(2) Many over-track buildings were designed to have a pile-per-column foundation without underground beams. Therefore, the rigidity of the lower structure could cause large rotational deformation of the seismic isolation layer.

(3) For effective use of the over-track space, the height of seismic isolation layer should be minimized while securing damper space.

To overcome those issues, we developed a new seismic isolation frame form which was composed

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of second floor column base seismic isolation and double girder structure (Fig. 1).

We also made a test design and analysis study of a over-track building model with the new frame form (Fig. 2). We set and used a total of four engineering foundation waves for the design input seismic motion. Those were three waves of the Building L2 on the Building Design Code and one wave of the Railway L2 stipulated in the Railway Structure Code. The analysis results of the seismic response of the studied model confirmed that, for the most part, targets of performance to secure safety of a building in case of earthquake could be met. In order to demonstrate the effect of seismic isolation of over-track buildings, we compared seismic isolation model with earthquake resistance model. As shown in Fig. 3, when Building L2 was input to each model, the story sheer force values in the seismic isolation model were mach smaller than that in the earthquake resistance model at every floor. Because of reduction of seismic response, the pile diameter in seismic isolation model was 1900mm while the pile diameter in earthquake resistance model was 2600mm. That reduction of structures will likely allow cuts in construction time and costs of those buildings that face severe constraints in terms of design and construction. We were therefore able to confirm the effect of seismic isolation.

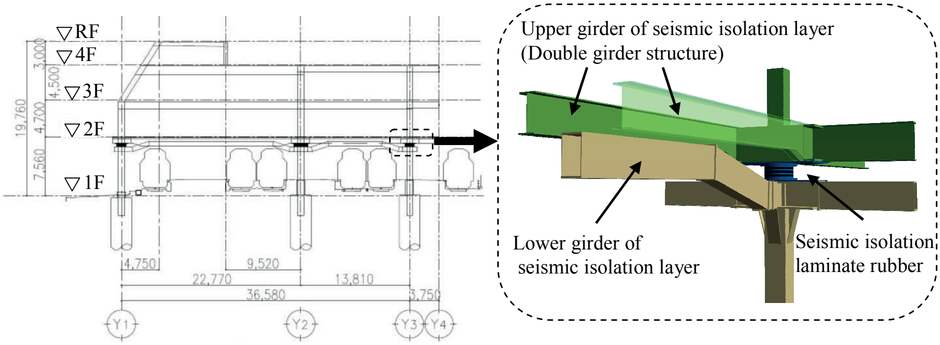

Fig. 1: New Frame Form Around

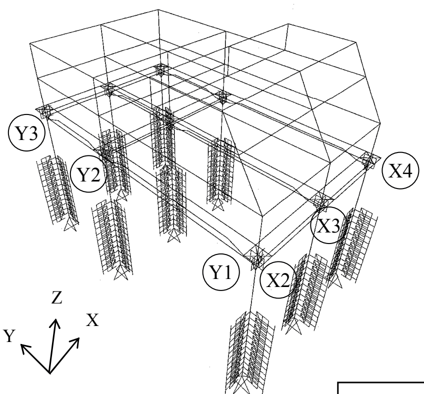

Fig. 2: Analysis Model

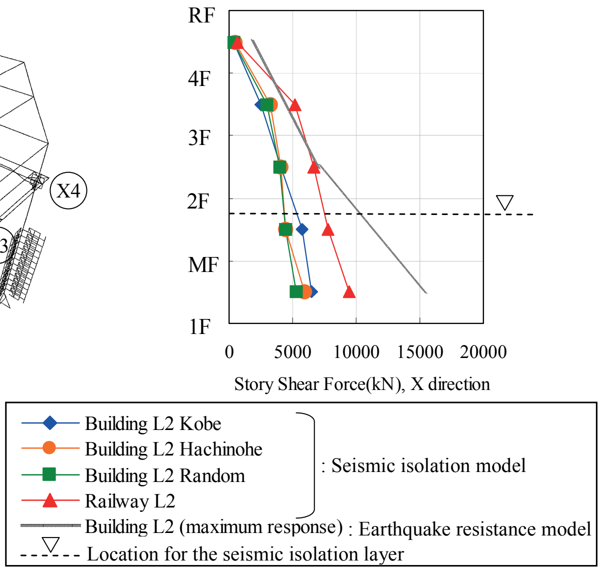

Fig. 3: Analysis Result