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Seismic Upgrade by Base Isolation System and Visco-Elastic Damper

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Summary

After the Hyogo-ken Nanbu earthquake on 17 January,1995, many existing buildings have been strengthened in Japan for surviving during severe earthquake in the future. In this paper, we introduce two buildings that employed innovative strengthening techniques.
One is the new reinforced concrete building that replaced the existing building suffered serious damage during the Hyogo-ken Nanbu earthquake. We employed a base isolation system in this building for adding high seismic capacity.The other is the historical wooden building in Kyoto that was constructed in the 18th century. We employed visco-elastic dampers in this building.
We used each technique to control and dissipate input energy from ground motion. Both techniques are useful for new and old buildings. We wish structural engineers and researchers further study and widely utilize new structural systems like energy dissipation system and base isolation system.

1. Seismic Upgrade by Base Isolation System

A condominium located in Takarazuka city was steel structure, which suffered severe damage during 1995 Hyogo-ken Nanbu earthquake. For seismic repair of this building , we have studied several methods, as adding new braces or welding steel plates. But it is evident that we can't obtain good habitability and seismic safety by these methods. So we decided to reconstruct this building of reinforced concrete structure with using base isolation system, so that the building doesn't change the original plan and feature(photo 1).
In this project, we have used the laminated natural rubber as isolator under high compressive axial stress over $10N/mm^2$ for lengthening natural vibration period, and two different types of damper, namely steel bar damper and lead damper(photo 2). The natural vibration period without damper is about 3.0 second. We could reduce the response of first floor shear coefficient from about 0.3 to 0.14 and maximum story drift angle from more than 1/100 to 1/800 in case of 40cm/s maximum ground motion.

2. Seismic Upgrade by Visco-elastic Damper System

The historical wooden building, which was constructed about 250 years ago, is strengthened using visco-elastic dampers(VED). This is one of the buildings in Zen-shu temple "Tenryu-ji" located in Kyoto. Photo 3 shows the appearance of the building. Because this is historical building, we couldn't be allowed to change the appearance. Under this condition, conventional technique couldn't add enough performance to this building, so we put inside the building the steel frame with visco-

elastic dampers in knee-bracing type as shown in photo4. By installing visco-elastic dampers in steel frame(figure 1), we could reduce response story drift angle to smaller than 1/80 and displacement to about 70 percents of displacement without damper in case of 50cm/s maximum ground motion(figure 2).

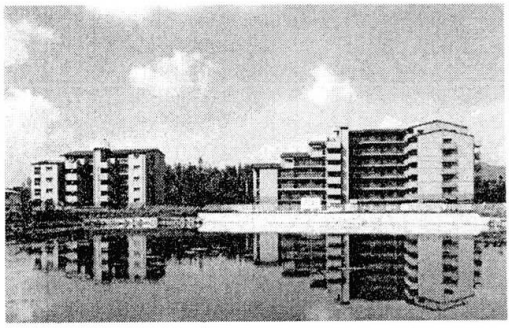

Photo 1. Reconstructed condominium located in Takarazuka city

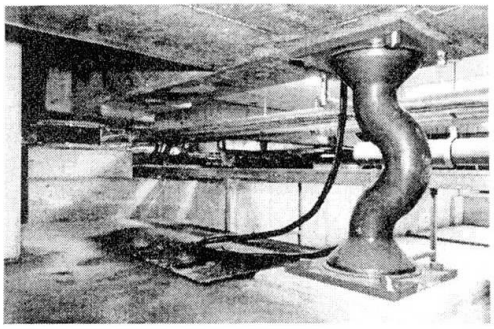

Photo 2. Base Isolation System

Photo 3. Hatto of Tenryuji-temple in Kyoto

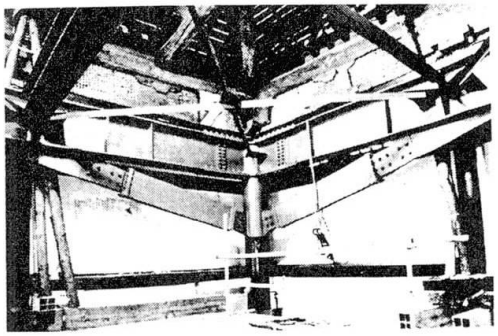

Photo 4. Installed VED in Knee-bracing Type

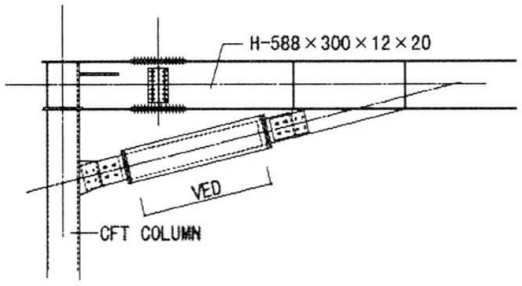

Figure 1. Detail Drawing of VED

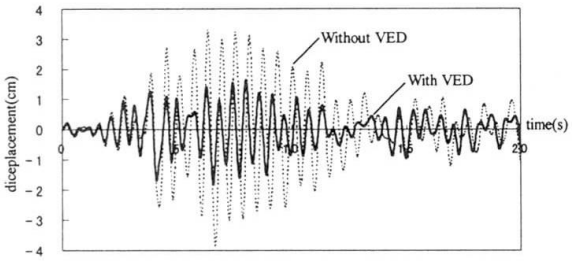

Figure 2. Time-history Diagram of Earthquake Response Analysis

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