Control Performance of Clear Damping Wall with Glass and Viscoelastic Material applied to Steel Frame Structure

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Summary

Clear Damping Wall is a novel vibration control system comprising a transparent glass wall and a viscoelastic material. It is effective in both architectural and structural designs because glass walls make the structure visually attractive and the viscoelastic material dissipates vibration energy produced by various external loads such as strong winds and large earthquakes. Clear Damping Wall was employed in the new guard station at the Obayashi Corporation Technical Research Institute as the tenth application of the system. Shaking tests of the building were conducted to confirm the vibration control performance. As results, installation of the Clear Damping Wall increased the modal stiffness of the fundamental mode by approximately 35%, with the acceleration response decreased by approximately 50%. Furthermore, it was confirmed that the dynamic characteristics such as the natural frequency and the damping ratio of the structure obtained by the shaking tests agreed well with that of the prospected values calculated by the design method of the Clear Damping Wall.

Keywords: Viscoelastic Material; Glass Panel; Shaking Test; Control Performance; Safety of Glass; Steel Frame Structure.

1. Introduction

Clear Damping Wall was employed in the new guard station at the Obayashi Corporation Technical Research Institute which is located in Kiyose City, Tokyo. The basic concepts of this new guard station are; (i) Physically and psychologically spacious as a gate to open research campus both for visitors and for employees, (ii) With accessibility and visibility needed as a guard station. Not only to meet these concepts but also to meet its seismic performance, Clear Damping Wall has been adopted.

2. Outline of Clear Damping Wall

Clear Damping Wall (Fig. 1 & Fig. 2) consists of transparent glass panel and viscoelastic materials attached around the glass panel with fixing plates and mounting angles which dissipates vibration

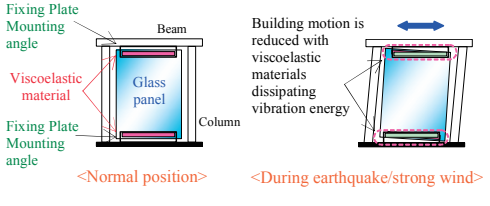

Fig. 1: Outline of Clear Damping Wall with Glass and Viscoelastic Material

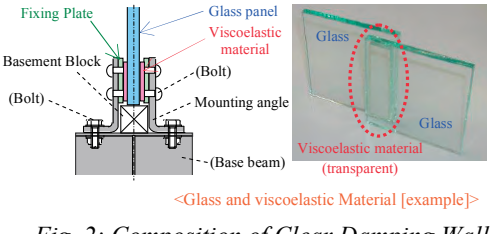

Fig. 2: Composition of Clear Damping Wall with Glass and Viscoelastic Material

energy induced by seismic motion and strong wind. Clear Damping Wall is invented as a new idea, since glass materials have rarely used as structural elements. Using this system, both architectural exterior and seismic performance can be satisfied. Also this system is free of maintenance and no need for exchanging devices even after large earthquakes.

3. Application of Clear Damping Wall

3.1 Outline of applied building and shaking tests

Appearance of the new guard station (1 story steel frame building) is shown in Fig. 3. The aimed control performance was set to reduce acceleration response in frequency domain by 1/2.

Fig. 3: Appearance of the Building

Forced excitation tests were conducted for each horizontal direction with a shaker set on roof beams. Since the main objective of these tests is to confirm the vibration control performance comparing the cases with and without Clear Damping Walls, these tests were conducted just before (uncontrolled; without Clear Damping Walls) and just after (controlled; with Clear Damping Walls) installation of Clear Damping Walls.

3.1.1 Outline of free vibration tests

After exciting the building with resonance frequency by a shaker, the shaker was stopped to measure free vibration time histories. The excitation force generated by the shaker was set for the maximum acceleration response on the roof beam of each of the uncontrolled and controlled building to be 2-3 cm/s^2.

3.2 Test results

3.2.1 Results of free vibration tests

Fig. 4 shows the time histories of free vibration tests comparing the uncontrolled and controlled building.

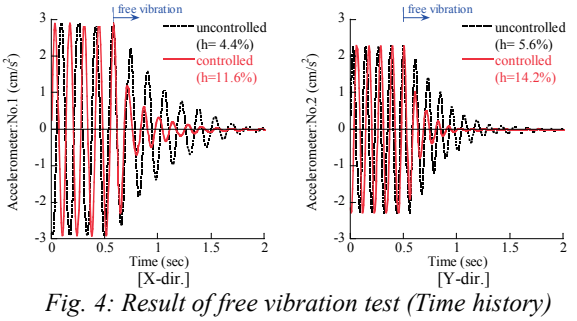

Fig. 4: Result of free vibration test (Time history)

According to these results, it was confirmed that the damping factors (h) derived from logarithmic decrement calculated using five waves just after excitation stop were 4.4% for uncontrolled building and 11.6% for controlled one in X-direction, and 5.6% for uncontrolled building and 14.2% for controlled one in Y-direction. So, installation of Clear Damping Walls increased the damping factor by 7.2% in X-direction and 8.6% in Y-direction.

4. Conclusions

Clear Damping Wall was employed in the new guard station at the Obayashi Corporation Technical Research Institute and vibration control performance was examined by shaking tests.

5. Acknowledgements

Clear Damping Wall was developed in a joint research project among OBAYASHI Corporation, SUMITOMO 3M Limited, and ASAHI GLASS CO., LTD.