Dynamic experiment of integrated ceiling system used in large span office buildings

Shoki ISHIGURO[1*], Tetsuo YAMASHITA[a]

[1*]Graduate Student, Kogakuin University
Tokyo, Japan
dm18003@ns.kogakuin.ac.jp

[a] Professor, School of Architecture, Kogakuin University

Abstract

In 2011, the Pacific coast of Tohoku earthquake caused severe ceiling collapse [1]. The integrated ceiling system (fig.1) is widely used in large span office buildings. However, the falling mechanism of the ceiling boards has not been revealed. We carried out a full scale shaking table experiments of an integrated ceiling system.

Fig.1 shows the integrated ceiling system components. The ceiling boards are connected with the H-bars on the T-bar flange (fig.2-a). The T-bar and H-bar are jointed by the vulnerable clip. Therefore, the ceiling boards easily fall by the rotation of the T-bar (fig.2-b). However, the T-bar is easily deformed by the inertial force of the ceiling board.

We carried out the dynamic experiments using the test ceiling placed the lighting boxes at both ends of ceiling(fig.1). The test ceiling had braces subjected to the inertial force. As expected, the ceiling deformed into arch-like-shape. Therefore, we increased the number of clip to prevent fall of the H-bar due to the in-plane deformations of the ceiling. Moreover, we reinforced the the lighting boxes to prevent the in-plane deformations of the ceiling.

In this experiment, we constructed the five test ceilings to study the effect of the number of clip and the rigidity of the lighting boxes on the ceiling collapse. In the test ceiling desinged by the general standard, the ceiling boards fell at only about 50gal. However, in the test ceiling with the increased clips and reinforced the lighting boxes, the ceiling boards fell at about 500gal(fig.3). From these experiments, we revealed the response characteristics of the integrated ceiling system with braces to the ground motions. Moreover, we devised an method to construct an seismic resisting the integrated ceiling system.

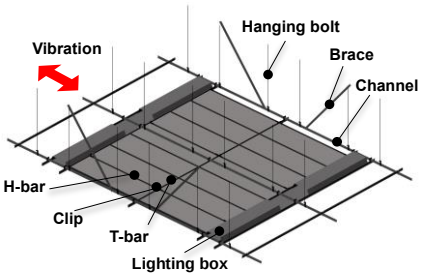

Fig.1 Overview of integrated ceiling system

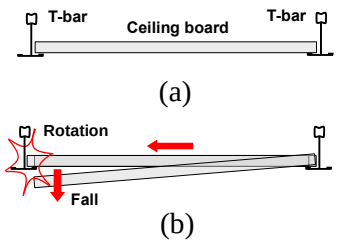

Fig.2 Fall of ceiling board due to rotation of T-bar

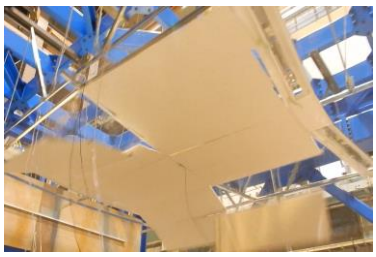

Fig.3 Ceiling collapse

References

[1] Ken'ichi KAWAGUCHI, Yasushi OBA, Yosuke NAKASO. FAILURE OF CEILINGS AND ESTIMATION OF ITS IMPACT OCCURRED IN AN AIRPORT BUILDING DURING THE 2011 OFF THE PACIFIC COAST OF TOHOKU EARTHQUAKE. AIJ J. Technol. Des. Vol. 18, No.39, 789-793, Jun., 2012 (in Japanese)