Numerical Investigation on Collapse Mechanisms of Suspended Ceilings in Wide-Area Facilities

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Key Words: *Suspended Ceilings, Collapse analysis, ASI-Gauss Code, FEM.*

In Japan, there have been many reports of damages caused to suspended ceilings of wide-area facilities during high-intensity earthquakes. In response to these events, the collapse behaviors of suspended ceilings were investigated through the experiment conducted at the E-Defense shaking table facility [1]. However, it is costly to investigate collapse behaviors of ceilings, which have various specifications dependent to their aim of use.

In this study, a numerical code that can simulate ceiling collapse phenomena in wide-area facility under seismic excitation was developed based on the Adaptively Shifted Integration (ASI) - Gauss code [2][3][4]. A numerical model of a suspended ceiling was validated by the reproduction analysis of the experiment conducted at the E-Defense. Then, numerical analyses on the behaviors of earthquake-resistant ceilings in the gymnasium were conducted. Furthermore, a collapse behavior of the suspended ceilings that is complex in structure and can be attached to a concert hall were investigated by a simulation.

According to the numerical results, the acceleration and displacement responses of the numerical model agreed well with the experimental results. In addition, a detailed mechanism of the ceiling collapse was obtained. The analyses of earthquake-resistant ceilings showed how each major anti-earthquake measures affect and reduce the damages of suspended ceilings. Finally, it was shown how the shape of ceiling surface affect the collapse behavior of suspended ceilings with complex structure in the simulation of a concert hall.

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