Numerical Investigation on Differences in Behaviors of Suspended Ceilings during Earthquakes

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In Japan, there have been many reports of damages observed in the suspended ceilings of wide-area facilities during high-intensity earthquakes. In order to prevent the ceiling collapse phenomena, it is necessary to evaluate the behaviors of suspended ceilings during earthquakes. However, suspended ceilings have various specifications depending on the size and dimensions of buildings, and its behaviors during earthquakes may change accordingly. In the former study, a numerical analysis was performed to see the seismic behaviors of suspended ceilings with inclination [1]. In another experimental study [2], it was mentioned that the eccentricity of hangers, a joint metal that connects a hanging bolt to a ceiling joist receiver, tends to produce variations of axial forces acting on the hanging bolts. However, these effects of inclination and eccentricity on the behaviors of suspended ceilings have not been quantitatively evaluated.

In this study, some numerical analyses were conducted to see the behaviors of suspended ceilings during earthquakes caused by the inclination and eccentricity. The adaptively shifted integration (ASI)-Gauss technique [3], which could effectively simulate the behaviors of suspended ceilings during earthquakes [1], was applied to the analyses.

The numerical results showed that the eccentricity of hangers has little effect on the axial forces acting on the clips and hanging bolts in the case of non-inclined suspended ceilings. The results also showed that the inclination of ceilings increased the vertical responses of ceiling surface and the amplitude of axial forces acting on the clips and hanging bolts. Furthermore, it was confirmed that the eccentricity of hangers induced the buckling of the hanging bolts and vertical responses of the ceiling surface, which affected and increased the amplitude of axial force acting on the clips.

References

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