Large-Scale Collapse Analyses of Buildings and Motion Analyses of Non-Structural Components within Them

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In this talk, a finite element approach to analyze large-scale collapse behaviors of buildings and motion behaviors of non-structural components within them is presented. The numerical code applied was developed with a use of an ASI (Adaptively Shifted Integration)-Gauss technique [1][2]. It dramatically reduces computational cost when solving large-scale problems.

The code was applied to a fire-induced collapse analysis of a high-rise tower, which was carried out for an investigation seeking for the true cause of the total collapse of New York World Trade Center (WTC) towers, which collapsed in 2001. A seismic pounding analysis of the Nuevo Leon buildings, in which two out of the three collapsed completely in the 1985 Mexican earthquake, showed that the difference of natural periods between the north and the center buildings may have triggered the collision, followed by the collapse. The code was also applied to investigate the collapse behaviors of ceiling, which is one of the main, indoor non-structural components. It is very important, nowadays, to know the collapse mechanism of the ceilings since it causes not only the possibility of human injuries, but may disturb the use of the facilities after earthquakes. The other numerical cases include motion analyses of furniture under seismic excitation. A sophisticated penalty method was applied, in this case, to realize the slip and contact motions of furniture with and without casters. Many movies regarding the results will be provided in the talk.

References

[1] D. Isobe, L. T. T. Thanh and Z. Sasaki: Numerical Simulations on the Collapse Behaviors of High-Rise Towers, International Journal of Protective Structures, Vol. 3, No. 1, (2012), pp.1-19.
[2] D. Isobe, W.S. Han and T. Miyamura: Verification and Validation of a Seismic Response Analysis Code for Framed Structures using the ASI-Gauss Technique, Earthquake Engineering and Structural Dynamics, Vol.42, No.12, (2013), pp.1767-1784.