International Workshop on Advanced Earthquake Engineering Testing and Simulation for Near-Fault Ground Motions, Nov. 19-20, 2015
近斷層地震工程實驗技術及模擬國際研討會

Collapse Test of Full-Scale Building at Near-Fault Earthquake and Analysis Simulating Two-Directional Column Deteriorations

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Abstract

A full-scale 4-story steel building was tested at the E-Defense shake table using one of the strongest motion recorded near the fault during the 1995 Great Hanshin Earthquake. Test results are discussed with emphasis on deterioration of the columns subjected to simultaneous biaxial moment and axial force that varied in a complex manner. Deterioration was caused by local buckling and consequent decrease in base shear capacity, and was followed by soft-story collapse of the building.

The multi-spring (MS) element that consists of springs discretizing the cross section at each column end is used to simulate the moment deterioration by local buckling. The analysis using the MS element appears to simulate well the two-directional deterioration behavior under some proposed biaxial loading patterns; and analysis results are verified by the finite element (FEM) model.

Test and analysis results are used to interpret different deterioration patterns of the columns and effects of complex loading such as compression and tensile axial load applied alternately, additional high frequency axial load caused by vertical accelerations, and shifting of the principal directions of the bending moments cycle-by-cycle.