別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	Seismic Performance Assessment and Improvement of Reinforced Concrete Buildings with Vertical Irregularity

Approx. 800 words

A vertical irregularity setback in a reinforced concrete (RC) structure has an impact on its performance and reaction, particularly against earthquake ground movements. It is important to understand how earthquake damage is caused by setbacks in order to prevent damage concentration on the irregularity location. This work aims to propose a formula for estimating the damage distribution along the height of a setback structure based on a geometric size of the degree of irregularity. First, past experimental tests for two setback types in structure, a towered and stepped setback frame, were investigated to evaluate the accuracy of the frame analysis. The frame analysis results closely matched the experimental test results. Further, in order to examine the correlation between the degree of setback and the distribution of damage, a parametric analysis was done to 35 reinforced concrete setback frames with varying degrees of setback, including models with stepped setback type and towered setback type. All frames were subjected to inelastic dynamic analyses under selected seismic ground motions. The irregularity indices established by Karavasilis et al. were chosen to quantify the degree of setback, while the Park–Ang damage index quantified the structural damage. Using nonlinear regression analysis, formulae were developed to predict the damage index ratio between two major structural sections (tower and base) using setback indices. The proposed formula was confirmed by applying it to the experimental test findings.

Besides setback buildings, vertical irregularity can also exist in the building with dual system, such as reinforced concrete frame with shear walls. The shear walls are one crucial seismic element that strengthen the bearing capacity of a structure against earthquakes. Under lateral load and earthquakes, shear walls in mid- and high-rise structures are exposed to predominant bending deformation, and the reactions in upper levels increase. Previous research recommended installing shear walls up to a specific building height, referred to as the curtailed wall, to make optimal use of shear walls. However, the upper frame structure without shear walls has larger deformation response compared to the lower stories under the lateral load. Therefore, the purpose of this research is to offer a structural design for buildings with curtailed shear walls by adding buckling-restrained braces (BRBs) at the top frame to limit its deformation during earthquakes. First, the accuracy of the analysis was validated by reproducing the experimental findings of shaking-table tests on four sets of scaled frames with curtailed shear walls. The nonlinear responses of ten- and twenty-story plane frames with different wall heights to earthquake ground movements were then studied. Utilizing the genetic algorithm, the optimal BRB locations that satisfy the design requirements were determined. Implementing BRBs at certain location in upper frames have been proven to greatly enhance the seismic response of structures with curtailed shear walls.

Keywords: setbacks; damage index; seismic evaluation performance; damage distribution; optimization; curtailed shear wall; buckling-restrained brace; genetic algorithm.