論 文 の 内 容 の 要 旨

論文題目　Capacity curve derivation using Wavelet Transform Method for building damage evaluation with limited number of accelerometers
（少数の加速度計を用いた高層建物のWavelet変換による性能曲線算出法に関する研究）

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Structural health monitoring (SHM) has received increasing attention in recent decades and has found global success in applications ranging from long-span bridges to super-tall buildings. An SHM system offers a rapid and quantitative way to evaluate the safety of the structure using the response data from instrumented sensors. This merit could be helpful in quake-hit regions, where post-earthquake damage evaluations for buildings are generally conducted through time-consuming and subjective visual inspections by engineers. Several vibration-based methods have been developed to evaluate the damage condition after an earthquake, such as methods based on the change of modal parameters, e.g., natural frequencies, damping ratios, and mode shape; and methods based on tracking the hysteretic behaviors of the structures. Among other methods, the capacity curve, which is considered to be the fundamental mode relationship between mass-normalized roof displacement and base shear, can provide a straightforward and informative description of the structural behavior immediately after an earthquake. In situ applications have been reported using the capacity curve for damage evaluation. However, several issues, such as the automated derivation of the capacity curve, the sensors placement with limited sensors and the comparison of the damage evaluation results with those using existing codes or guidelines, hinder its practical use in the application of SHM. This dissertation is devoted to address these issues.

First, an automated method for the derivation of the capacity curve from measured structural acceleration response is presented. Based on the decomposition by wavelet transform method, the structural behavior is directly evaluated in the form of a capacity curve of the predominant response, as a relationship between the spectral force and spectral displacement. It enables the user to judge the performance of the building quickly after an earthquake. The feasibility of the proposed method is demonstrated through numerical simulations, full-scale shaking-table tests, and actual response of a steel tower during 2016 Fukushima earthquake.

Then, a strategy based on the piece-wise cubic polynomial interpolation (PWCPI) procedure is proposed to estimate the capacity curve for high-rise buildings from accelerations using limited sensors placed at regular intervals along the height of the building. One salient merit of this method is that detail information of the instrumented building is not needed. Numerical simulations and shaking table tests demonstrated that the proposed method could provide a satisfactory estimate of capacity curve with a few sensors.

Finally, validations for capacity-curve-based (CCB) method for post-earthquake damage evaluation framework are conducted using field survey results, full-scale shaking table tests and numerical simulations. Comparisons between the CCB method and conventional visual inspection-based method are made. It is shown that the damage evaluation results using the CCB method agree fairly well with those of visual inspection, indicating that the CCB method could serve as a useful tool for post-earthquake damage evaluation.