別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	Artificial Intelligence-Based Optimization of Structural Parameters to Simulate the Seismic Behavior of Buildings

Approx. 800 words

An Artificial Intelligence-based optimization of structural parameters is elaborated in this dissertation to perform a hybrid seismic analysis of building structures. This original problem-solving approach consists of combining advantageous of both Artificial Intelligence and conventional nonlinear time history analysis (NTHA), to increase further the accuracy of seismic response simulation. Two optimization domains are investigated: the first one targets specific physical parameters of the building model; the second one proposes new machine learning models simulating specific structural component or group of components, as surrogates to their analytical counterparts. Both optimization outputs are then deployed in hybrid seismic analyses of several building models to check their respective efficiencies in improving the accuracy of the seismic response simulation. To this end, synthetic, experimental, and field data are used as references.

In evaluation of seismic safety of buildings, system parameter identification is crucial. Although many mathematical models exist to evaluate the physical properties of building structures, the tremendous number of involved parameters maintains a certain degree of uncertainty. In this research, a system parameter optimization procedure is developed using Response Surface Method and Bayesian Optimization Technique. The developed program was successfully tested on real buildings in the Aichi prefecture at eastern Japan, with a view to incorporate it in the existing online seismic diagnosis system. The accuracy and the promptness of the optimization procedure make it efficient for a real-time system identification.

Simulating the structural behaviour of typical seismic isolators under a wide spectrum of realistic loading conditions is still not accurately achieved by a single analytical model. Deep learning networks predicting the non-linear hysteretic behavior of specific triple pendulum bearing (TPB), lead rubber bearing (LRB), and a full seismic isolation layer, are developed, tested, and eventually deployed in the proposed hybrid seismic analysis. Experimental datasets were derived from a shake-table test program of an isolated five-story building specimen, performed at the Hyogo Engineering Research Center (E-Defense) of Miki, Japan. Data measured during 34 different table motions are processed to construct a TPB/LRB dataset of 158/55 samples. Conventional NTHAs were performed to generate synthetic data for the case study of full isolation layer. Comparisons with reference experimental/synthetic data showed that the proposed hybrid analysis could simulate accurately the seismic response of studied buildings. The generalization capability of developed surrogate machine learning models on the substantial datasets used in this study, revealed the benefit of applying machine learning to solve complex structural engineering problems.