別表６
（３）

Keio University

Thesis Abstract

No.

Registration Number	□ “KOU” □ “OTSU” No. *Office use only	Name	Xing, Zhenhua

Thesis Title

Damage Assessment of Shear Structures Based on Autoregressive Models and Substructure Approach

Thesis Summary

This thesis is devoted to improve the damage assessment measures that have been studied by many researchers and to propose an effective damage detection scheme with as fewer sensors as possible, especially for the large scale structures.

Firstly, the improvements on the damage assessment method based on autoregressive models are proposed. To improve the noise immunity of this method, the distance measure of low-order AR models is used as a damage indicator since its advantages in computational efficiency, emphasis of high-energy frequency range, and less sensitivity to spectral peaks caused by noise. In addition, adaptive component weighting is introduced to relieve the noise effect further. Moreover, a method to choose the optimum AR order for distance measures is proposed to solve the problem that the order of the AR models and the order determined by Akaike information criterion or Bayesian Information Criteria is not the optimum AR order for the distance measure. The effect of varying the data length, number of parameters, and other factors are also carefully studied.

Secondly, a substructure approach to local damage detection is proposed. Every substructure is confined to one DOF, which can satisfy the identifiability of substructure easily. By cutting substructure with overlaps, ARMAX models can be directly used to determine the modal information and detect the damage. Substructure approach is to divide a complete structure into several substructures in order to significantly reduce the number of unknown parameters for each substructure so that damage detection processes can be independently conducted on each substructure. This method doesn’t need the vibration measurements at all degrees of freedom.

Moreover, the identifiability of substructures for civil engineering structures is investigated, and a structure division method is proposed to make the substructure identifiable when it is not strongly system identifiable (SSI). To clarify the identifiability of the substructures, the substructures are classified into three types. The structure is divided using the proposed structure division method, and then the support vector machine (SVM) is applied for each substructure to detect the local damages.

Finally, the conclusion is given. The damage assessment based on autoregressive models and substructure approach is proposed, and it can detect and localize the damage accurately. The use of the substructure approach makes this method work efficiently in identification of large scale structures, and moreover the damage detection processes can be independently conducted on each substructure. Thus, it is also suitable for use in a parallel and distributed damage detection system.