8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

Structural Damage Analysis of a Frame Structure Model by Variable Parametric Projection Filter

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Key Words: *Damage Identification, Inverse Analysis, Frame Model, Variable Parametric Projection Filter.*

ABSTRACT

Most architectural structures such as multistorey buildings accumulate damage gradually during their service lives or suddenly during seismic activity. In order to assure the structural safety and human comfort of architectures, it is necessary to monitor the state of structural systems at regular intervals. It is well-known that modal parameters are one of the effective monitoring data, because the changes in modal property such as natural frequencies based on each vibration mode especially characterize the assessment of damage state of structures [1] .

Against the forward problems on the dynamic analysis relating to earthquake resistant structural design, structural damage identification analysis has been categorized as the inverse problems in computational mechanics. In general such inverse problems must be solved under the consideration of stochastic properties of mathematical model because the observation data measured from the structural system are usually including observation noise [2] , [3] .

Filtering algorithm based on filter theory is well known as one of procedures to estimate the optimal state vector in the stochastic dynamic system. We have presented the results of structural damage analysis for various structural system [4] , [5] using three kinds of filtering algorithms based on the Winner, the projection filter and the parametric projection filter as follows:.

$$\boldsymbol{B}_k = \boldsymbol{R}_{k/k-1}\boldsymbol{M}_k^T\left(\boldsymbol{M}_k\boldsymbol{R}_{k/k-1}\boldsymbol{M}_k^T + \boldsymbol{Q}_k\right)^{-1} \text{ (Wiener filter)}$$

$$\boldsymbol{B}_k = \left(\boldsymbol{M}_k^T\boldsymbol{Q}_k^{-1}\boldsymbol{M}_k\right)^{-1}\boldsymbol{M}_k^T\boldsymbol{Q}_k^{-1} \text{ (Projectin filter)}$$

$$\boldsymbol{B}_k = \boldsymbol{M}_k^T\left(\boldsymbol{M}_k\boldsymbol{M}_k^T + \gamma\boldsymbol{Q}_k\right) \text{ (Parametric projection filter)}$$

From these results of the inverse analysis, it was made clear that the parametric

projection filter is able to make compose the effective filtering algorithm.

The parametric projection filter includes the parameter γ to be regularized the filtering process. In this study, a new treatment of the above parametric projection filter is developed. We construct filtering algorithm with use of the variable parameter γ determined automatically based on the linear assumption between state vector and observation vector at first step.

Thus the damage identification analyses which identify lateral stiffness of 5 story-frame structure model shown in figure 1 are performed as an example of inverse analysis using the proposed variable parametric projection filter.

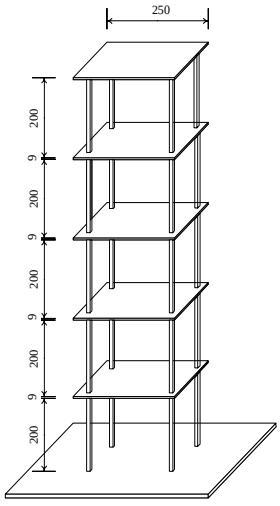

Figure 1 5 story-frame structure model.

The effectiveness of variable parametric projection filter is shown through numerical calculations.

REFERENCES

[1] R.Endo, S.Shiota, N.Tosaka, “Structural Damage Identification of Frame Model based on Filtering algorithm” Inverse Problems in Engineering Mechanics Ⅲ, Elsevier, pp.153-160, (2002).

[2] E.D.Catlin, “Estimation, Control, and the Discrete Kalman Filter”, Springer-Verlag, 1989.

[3] Tosaka,N., Utani, A., and Takahashi, H., “Unknown Defect Identification in Elastic Field by Boundary Element Method with Filtering procedure”,Eng Analysis with boundary Elements, Vol.15, Elsevier, pp.207-215, (1995).

[4] R.Endo, Y.Kawakami, T.Imai, N.Tosaka, “Identification Analysis of Structural Damage on Unit-Linked Offshore Filtering Models”, International Journal of Offshore and Polar Engineering, Vol.9, No.3, pp.201-207, (1999)

[5] Y.Kawakami, R.Endo, S.Shiota, N.Tosaka, “Damage Identification on Unit-Linked Floating Structure by Parametric Projection Filtering Algorithm”, Proceedings of the 12th International Offshore and Polar Engineering, pp.385-390, (2002)