Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 77 (1998)

Artikel: Modal system identification technique in structural damage assessment
Autor: Barsan, George-Mihail / Dinsoreanu, Mihaela
DOI: https://doi.org/10.5169/seals-58180

Nutzungsbedingungen
Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Mehr erfahren

Conditions d'utilisation
L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. En savoir plus

Terms of use
The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. Find out more

Download PDF: 10.12.2025

ETH-Bibliothek Zürich, E-Periodica, https://www.e-periodica.ch

Modal System Identification Technique in Structural Damage Assessment

George-Mihail BARSAN
Professor
Technical University
Cluj-Napoca, Romania

George-Mihail Barsan, born 1937 received his civil engineering degree from the Technical University of Cluj in 1959 and PhD in 1971. He is currently professor of Structural Mechanics at Civil Engineering Faculty.

Mihaela DINSOREANU
Assistant Professor
Technical University
Cluj-Napoca, Romania

Mihaela Dinsoreanu, born 1970, received her computer engineering degree from the Technical University of Cluj in 1993. She is currently assistant professor at Computer Engineering Faculty.

Summary

A modal damage detection and assessment technique of multi-story, multi-bay framework is presented. The fundamental natural frequency and mode shape of the structure are the only modal information necessary in this approach. The *equivalent relative lateral story stiffness* ($R_{i,i+1}$) is chosen as a physical damage predictor parameter, which seems to be sensitive enough to offer the best information for occurrence, localisation and extent of the structural damage. It is assumed that the baseline parameter values are known. A data perturbation scheme is used both for the baseline and for the damaged structure, to establish the threshold above which damage can be confidently discerned from noise. To examine and illustrate the proposed damaged assessment technique, a numerical simulation study is performed and different damage types were considered.

Keywords: System identification theory, damage assessment, modal damage detection..

1. Introduction

One of the most challenging task for modern day structural engineer is to control the behaviour of the structure during its life time and, from time to time, to evaluate the structural damage, in order to enssure the safety of the construction. The system identification (SI) method seems to be the best tool to accomplish this task [1-3]. A variety of techniques for evaluating damage in structural systems have emerged and evolved in recent years. In this paper, a modal system identification technique is presented. The fundamental natural frequency and mode shape of vibration are the only modal measured information necessary to identify the occurrence, location and extent of the damage. The damage is defined as any change in the performance of the structure. For a structural system, such change means a reduction in its carrying capacity, which can be expressed by the reduction in flexural rigidity EI of the structural members. With this definition of damage, one must look for changes in certain physical parameters of the structure, between two time-separated moments. The choice of physical parameters, which have to be related to the measured modal characteristics of the structure, is of major importance. The *equivalent relative lateral story stiffness* ($R_{i,i+1}$) is chosen as physical damage predictor parameter, which seems to be sensitive enough to offer the best information for occurrence, localisation and extent of the structural damage. It is assumed that the baseline parameter values are known. The accuracy of such a model is generally impaired by the presence of random noises such modelling errors, unmeasurable disturbances, and measurement errors. A data perturbation scheme is used both for the baseline and for the damaged structure, to establish the threshold above which damage can be confidently discerned from noise. To examine and illustrate the proposed damaged assessment technique, a numerical simulation study on a three-story three-bay frame and a five-story two-bay frame is performed and different damage types were considered. We chose a simulation study over a real case study because our aim is to quantify the performance of the proposed technique, not simply to illustrate its use. Simulation is a method of controlled experimentation that allows such a quantification.

2. Conclusion

A new damage detection and assessment technique is presented. This study has shown that the chosen structural parameters, i.e. the equivalent relative lateral story stiffness, are sensitive even to not very large damage, and allows to localise the damaged stories. The damage localisation is based on an output-error parameter estimation procedure. The constitutive parameters of the structural system are estimated using a frame analysis model with known topology and geometry. The measured fundamental modal parameters, frequency and shape mode vector, are the only data necessary for damage detection and assessment, and the number of necessary measurement points is equal to the level number. The procedure was illustrated and tested using Monte Carlo simulation on two examples. The procedure of using noise perturbation on baseline structure proved to be a reliable method for assessing whether damage is detectable above the noise in the measurements. In all of the cases studied, the most severely damaged stories were always identified with great certainty.

Although the feasibility of the proposed procedure for structural damage assessment of multi-story multi-bay structure based on the measured modal data has been demonstrated, many related issues have not yet been addressed and additional research will be required.

3. References

[1] Natke, H.G. and Yao, J.T.P., (editors) *"Structural safety evaluation based on system identification approaches"*. Friedrich, Vieweg & Sohn Verlagsgesellshaft GmbH, Braunschweig, Wiesbaden, Germany, 1988.

[2] Goodwin, G.C. and Payne, R.L., *"Dynamic system identification"*. Academic Press, New York, N.Y., 1977.

[3] Natke, H.G., (editor) *"Application of system identification in engineering"*. Springer-Verlag, New-York, N. Y., 1988.

[4] Barsan, G.M., *"Dynamics and Stability of Structures"*(in Romanian), Ed. Didact. si Pedag., Bucharest, Romania, 1979.