Identification Strategies for Maintenance of Bridges

Roman WENDNER
PhD candidate
University of BOKU,
Vienna, Austria
roman.wendner@boku.ac.at

Alfred STRAUSS
PostDoc Researcher
University of BOKU,
Vienna, Austria
alfred.strauss@boku.ac.at

Konrad BERGMEISTER
Professor
University of BOKU,
Vienna, Austria
konrad.bergmeister@boku.ac.at

Drahomír NOVÁK
Professor
BUT University,
Czech Republic
novak.d@fce.vutbr.cz

David LEHKY
PostDoc Researcher
BUT University
Czech Republic
lehky.d@fce.vutbr.cz

Dan M. FRANGOPOL
Professor
Lehigh University,
Bethlehem, PA, USA
dan.frangopol@lehigh.edu

Summary

Non-destructive damage detection and localisation steadily gain importance especially in connection with maintenance planning. New approaches for damage identification based on virtual statistical simulation of dynamic behaviour of structures will be presented and the proposed approaches validated. Using the experimentally obtained frequency response of a structure in the damaged and undamaged state and a numerically-generated sensitivity matrix, the theory is used to predict the location and magnitude of damage inflicted. After having successfully applied the theory to controlled laboratory experiments in the past, the approaches are now used on accurate data from the widely known bridge Z24 on which dynamic measurements have been performed in 1999 to evaluate the effects of artificially inflicted damage on modal characteristics. Since the changes of the frequencies can be relatively small at real structures, the displacements of the modal forms are also considered in the identification algorithms. An ultimate goal of these identification tools is the determination of the time dependent resistance of a structure expressed by a degradation ratio α which will, together with non-linear safety analysis, allow for better maintenance planning.

Keywords: Identification, Inverse analysis, Damage, Dynamics, Sensitivity Factors, Modal data, Assurance criteria, Stochastic analysis, Latin hypercube sampling.

1. Introduction

Continuous health-monitoring of structures (bridges) is an essential part of their maintenance. Such structural monitoring systems provide data (e.g., static and dynamic mechanical quantities) in several points of a structure. Non-destructive testing – vibration measurements to get modal data (frequencies, modal shapes) is a very promising technique as it can be performed using a structure in use. The measured data can serve for the detection of degradation processes as well as potential failure zones. In general identification methods rely on concepts using calibrated values of the measurements of structural behaviour. Well-known techniques are heuristic fitting methods, curve-fitting methods, grey systems methods, and neural network approaches ([2],[3],[4] and [5]).

The first two of these techniques are engineering-based methods. The experience and knowledge of the user decide whether the technique succeeds or not. They do not rely on automatic strategies and local minimum problems can not be detected. Nevertheless they have the advantages that these techniques can be understood easily and that singular illogical results can be excluded from the decision process.

The last two of the methods mentioned above are based on scattering data sets (e.g. random variables). The random variables are used to establish a detection network which together with the random data from real measurements can serve for detecting structural damages [2]. On the other hand it takes an experienced user to set up a suitable network (structure of the network) for each individual task. An identification method characterizing the inputs as random variables and using the stochastic outputs for the identification of elements with high sensitivity to the response changes is an alternative method called STRIDE [6]. Methods that iteratively change individual parameters

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