Finite Element Model Updating of a High Building based on the experimental modal parameters

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Summary

Ambient vibration testing is the most economical non-destructive testing method to acquire vibration data from large civil engineering structures. Using the modal identification techniques the modal parameters can be determined which are effectively used as validation criteria in the context of finite element model updating to develop reliable finite element models of large engineering structures. These updated models will be useful both for predicting the dynamic behaviour and for assisting in the identification of structural damage.

In this paper, the finite element model updating of a case study (a twelve story reinforced concrete building) is presented. The modal identification results obtained from ambient vibration measurements of the building are the natural frequencies and the mode shapes of the first lateral and torsional modes which are the dynamic characteristics of interest of this study. The finite element model of the building is developed from the information provided in the design documentation. A sensitivity analysis is carried out to determine the most sensitive parameters for FE model. The updating is performed using the genetic algorithm. As results, a good correlation between measured and calculated modal parameters is obtained with parameters updated.

Keywords: finite element updating, optimization, genetic algorithm, modal system identification.

1. Introduction

From the point of view of structural engineering, there are several reasons for conducting the measurement of vibration in the existing building. For instance, the owner of a building located in a seismically active zone may be interested in determining whether the structure complies with the current earthquake engineering design. If the structure is found to be risk during a severe earthquake, then remedial structural modifications may have to be implemented in different parts of the structure. In order to accomplish this, the structural retrofit would aim to provide a design that satisfies the safety and serviceability requirements of the local building code in the most economical way. The structural engineer would not only need information of the actual conditions of the building, including its dynamic behaviours, but would also be required to develop a realistic finite element model of the building, which can be used to evaluate possible retrofit scenarios. In such situations it is not only desirable to have economical and effective ways of determining experimentally the dynamic properties of large civil engineering structures, but also have effective ways to have a high degree of confidence that the numerical model of the structure is a realistic representation of the physical structure.

The aim of this paper is to demonstrate the effective use of the model updating process in the reliable development of the finite element model of a large engineering structure. A twelve story reinforced concrete building is used as a case study for this purpose.

For this objective, an iterative method using the genetic algorithm for updating finite element model based on the experimental modal parameters is described. The detail description of a three-dimensional FE model of the building is presented. The dynamic properties of the building are

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