Numerical Investigation on the Effects of Local Damage to the Dynamic Properties of Buildings Using Limited Vibration Data

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Summary

The challenge in structural health monitoring and damage detection is how to use the limited number of sensors on a building to assess the condition of the structure at any point in time. A case study simulating application of different levels of isolated local damage to the different floors were done to determine the corresponding dynamic properties and to observe the sensitivity of the dynamic properties to local changes using a several shear building models. Dynamic condensation was also applied to the model to portray limited vibration data.The results from the condensed 2 DOF model resulting into the two lowest natural frequencies in the structure can only be used in detecting the damage from the first unto the fifth floor in the building. With that, a change of 5% in the frequency can mean up to a 50% local damage to the stiffness in a single floor. These findings can be used to estimate the damage present in a building and provide warning signals for the building owner.

Keywords: Structural Health Monitoring, Modal Analysis, Damage Detection, High-rise building.

1. Introduction

Structural health monitoring can be started as soon as structure construction is completed and can be ended at its failure. Due to costly and time consuming inspections when a structure is damaged, many researchers are engaged in studying and developing different techniques on how to use and maximize data from recorded accelerographs and apply it to different types of structures as part of advance data processing and interpretation in structural health monitoring. Sensors or instrumentation of buildings is very helpful in rapid condition assessment as it provides a real time monitoring of the structure [1]. In addition, the study of response records from instrumented structures can be helpful in identifying performance problems of a structure and eventually will help engineers in formulating a solution to the problem [2]. According to [3], specific regulations and guidelines on installing accelerograph have been published in some codes in different countries. Although instrumentation of these accelerographs on every floor of a structure is impossible because of its high cost. So the usual optimum or reasonable installation guideline taken is to place it in three locations.

Numerous researchers have tried do develop and improve the way of detecting damage in a structure. A common way for most of researchers in starting their process is by having a finite element model of the undamaged state then comparing it to the damaged state. In the study of [4], he was able to estimate the severity of the damage by matrix disassembly technique. The approach was a typical damage detection method - localizing the damage then quantifying it. A similar

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