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DAMAGE DETECTION AND ERROR PREDICTION OF SKY HIGH BUILDING: A REVIEW

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Abstract: In the last two years, earthquakes broke frequently in the global. Strong earthquakes and their shocks caused adverse effects to people's life as well as social stability. Therefore it is more and more important to defend before earthquakes, to detect damage regions and to estimate damages after earthquakes. It has become a key issue how to identify damage regions automatically based on remote sensing images. Up to now, there are two kinds of building damage detection technologies. However, the damage identification based on single-phase remote sensing images still depends on artificial visual interpretation. This thesis will investigate the damage detection and its impact on the future life of high rise buildings. A new method of system identification and damage detection of high-rise buildings is proposed in which high-rise buildings are represented by a shear-bending model. The method is devised to find the story shear and bending stiffness's of a specific story from the floor accelerations just above and below the specific story. The special characteristic of the proposed method is to derive a set of closed-form expressions for the story shear and bending stiffness's in terms of the limited floor accelerations.
Keyword: Earthquakes, Building Damage Detection, Shear-Bending Model, Prediction Error, ANOVA for damage Analysis and MS Excel.

I. INTRODUCTION

1.1 Sky high building

A skyscraper is a continuously habitable high-rise building that has over 40 or 50 floorsand is taller than approximately 100 m (328 ft). Historically, the term first referred to buildings with 10 to 20 floors in 1880s. The definition shifted with advancing construction technology during the 20th Century.[1] Skyscrapers may contain offices, commercial and residential uses. For buildings above a height of 300 m (984 ft), the term "supertall" can be used, while skyscrapers reaching beyond 600 m (1,969 ft) are classified as "megatall". One common feature of skyscrapers is having a steel framework that supports curtain walls. These curtain walls either bear on the framework below or are suspended from the framework above, rather than resting on load-bearing walls of conventional construction. Some early skyscrapers have a steel frame that enables the construction of load-bearing walls taller than of those made of reinforced concrete. Modern skyscrapers' walls are not load-bearing, and most skyscrapers are characterized by large surface areas of windows made possible by steel frames and curtain walls. However, skyscrapers can have curtain walls that mimic conventional walls with a small surface area of windows. Modern skyscrapers often have a tubular structure, and are designed to act like a hollow cylinder to resist wind, seismic, and other lateral loads. To appear more slender, allow less wind exposure, and transmit more daylight to the ground, many skyscrapers have a design with setbacks, which are sometimes also structurally required.

1.2 Accountability of Damage due to hazard situation

Due to different actions of various earthquakes, overloads, thermal effects or corrosion, the structural systems accumulate damage during their time life. From here the importance of having a reliable procedure that allows their structural evaluation, since if damage is not detected correctly, it can derive in the deterioration of the structural elements and in consequence to risk the stability of the structure. When the damage is visible, its physical detection can be carried out with relative easiness. However, in many cases this is not possible because, generally, the structural elements are not exposed in a direct way. In structures of buildings, for example, it can be necessary to remove panels and their cover. In the last years several methods have been developed that use the changes in the modal shapes and vibration frequencies of a structure as data to evaluate the damage in their structural elements. These methods have the advantage of not requiring the direct exhibition of these elements and of being able to visualize the complete structure if it is properly instrumented. In consequence, it is possible to obtain a reduction in the time and cost of the evaluation, as well as a decrease in the impact of operation of the structure. For the localization and the calculation of the magnitude of the structural damage, these methods require the analytical model of the structure. These methods are denominated methods of detection of damage based on models. The method developed in this work belongs to this group and its application consists of three basic steps: a) construction of the analytic model of the real structure toestablish its initial state without damage; b) estimation of the modal shapes and vibration frequencies for a latter state of the structure; and c) localization and estimation of the magnitude of the damage in the structural elements, using the initially built analytical model and the condensed stiffness matrix of the structure, obtained from the measured modal parameters.

1.3 Error prediction model

When building prediction models, the primary goal should be to make a model that most accuratelypredicts the desired target value for new data. The measure of model error that is used should be one that achieves this goal. In practice, however, many modelers instead report a measure of model error that is based not on the error for new data but instead on the error the very same data that was used to train the model. The use of this incorrect error measure can lead to the selection of an inferior and inaccurate model. Naturally, any model is highly optimized for the data it was trained on. The expected error the model exhibits on new data will always be higher than that it exhibits on the training data. As example, we could go out and sample 100 people and create a regression model to predict an individual's happiness based on their wealth. We can record the squared error for how well our model does on this training set of a hundred people. If we then sampled a different 100 people from the population and applied our model to this new group of people, the squared error will almost always be higher in this second case.

1.4 Building maintenance

Problems that building owners usually encounter in the maintenance or management of their properties, and their possible causes are described in this Chapter. Having acquired the relevant background knowledge, building owners can be in a better position to assess the conditions of their properties.

II. LITERATURE SURVEY

Alan Russell , Sheryl Staub-French , Ngoc Tran, William Wong suggested that in paper Visualizing high-rise building construction strategiesusing linear scheduling and 4D CAD that Project teams face ever increasing pressure to deliver projects as quickly as possible. To meet these demands,contractors are faced with the need to explore various construction strategies in order to meet delivery dates,and to assure themselves as to the achievability and quality of a schedule. Various visual representations of aproject's schedule and associated information combined with visual representations of the project in progress, i.e. 4D CAD, can assist with these tasks of identifying effective construction strategies for shortening projectduration, assessing their workability, and judging schedule quality. Such visual representations aidcommunication amongst project staff and facilitate brain-storming, and, implemented well they can provideclear, fast, and multi-dimensional feedback to the project team. In this paper, we describe aspects of our workwhich is directed at formulating a dynamic visualization environment that links 3D CAD, a generalization oftraditional CPM which embraces linear scheduling, dual product representations (scheduling and CAD system)and their mapping onto each other, and schedule and CAD graphics in a manner which facilitates the relativelyrapid exploration of alternative construction method and scheduling strategies for large scale linear projects(e.g. high-rise buildings, bridges, etc.). Requirements of such an environment include quickness, treating scale,working at multiple levels of detail, dealing with design variability, and realistic representation of the work. Useis made of a realistic example to highlight aspects of our approach and identify important issues that must be addressed if a visualization environment useful for construction professionals is to be developed. L. Jaillon , C.S. Poon , Y.H. Chiang suggested in paper Quantifying the waste reduction potential of using prefabrication in buildingconstruction in Hong Kong thatAs Hong Kong is a compact city with limited available land and high land prices, the construction of highrisebuildings is prevalent. The construction industry produces a significant amount of building waste. In2005, about 21.5 million tons of construction waste were generated, of which 11% was disposed of in Landfills and 89% in public filling areas. At the present rate, Hong Kong will run out of both public filling areas and landfill space within the next decade. The government is taking action to tackle the problem,such as by introducing a construction waste landfill charge, and promoting prefabrication to reduce onsitewaste generation. This paper reports an ongoing study on the use of prefabrication in buildings andits impact on waste reduction in Hong Kong. A questionnaire survey was administered to experiencedprofessionals, and case studies of recently completed building projects were conducted. The results revealed that construction waste reduction is one of the major benefits when using prefabrication comparedwith conventional construction. The average wastage reduction level was about 52%. This impliesthat a wider use of prefabrication could considerably reduce construction waste generation in Hong Kongand alleviate the burdens associated with its management. Sergio Valle, Weihua Li, and S. Joe Qin suggested in paper Selection of the Number of Principal Components: The Variance ofthe Reconstruction Error Criterion with a Comparison to OtherMethods that one of the main difficulties in using principal component analysis (PCA) is the selection of thenumber of principal components (PCs). There exist a plethora of methods to calculate the numberof PCs, but most of them use monotonically increasing or decreasing indices. Therefore, thedecision to choose the number of principal components is very subjective. In this paper, we presenta method based on the variance of the reconstruction error to select the number of PCs. Thismethod demonstrates a minimum over the number of PCs. Conditions are given under whichthis minimum corresponds to the true number of PCs. Ten other methods available in the signalprocessing and chemo metrics literature are overviewed and compared with the proposed method. Three data sets are used to test the different methods for selecting the number of PCs: two ofthem are real process data and the other one is a batch reactor simulation. Ting-Yu Hsu and Chin-Hsiung Loh suggested that in paper Damage detection accommodating nonlinear environmentaleffects by nonlinear principal component analysisDamage detection in structural health monitoring should accommodate the variation caused by varyingenvironmental conditions such as temperature, humidity, loading, and boundary conditions. A structuraldamage detection technique is proposed to deal with the continuous monitoring data of a structural systemsubjected to the complex nonlinear behavior caused by varying environmental conditions. Based on theidentified or measured target features of the structural system under varying environmental conditions, e.g.stiffness of the structural components, the nonlinear principal component analysis (NLPCA) using auto associative neural network is performed to extract the underlying environmental factors. Then a predictionmodel for NLPCA is proposed to estimate the damage extent. This proposed technique is capable ofdealing with not only the non-increasing features, e.g. stiffness, but also the non-decreasing features, e.g.damage index, after damage is introduced without measuring the environmental factors directly. Anumerical study is performed to demonstrate the advantages of the proposed technique over the techniqueusing principal component analysis. A synthetic bridge model is simulated with the consideration of aspecific element stiffness reduction together with the change due to environmental conditions includingtemperature, gradient of temperature, humidity, and frozen supports. Results show that the extent ofstiffness loss can be quantified accurately and promptly after the damage is introduced. Hoon Sohn, Keith Worden and Charles R. Farrar suggested in the paper Statistical DamageClassification under ChangingEnvironmental and Operational Conditions Stated in its most basic form, the objective of damage diagnosis is to ascertainsimply ifdamage is present or not based on measured dynamic characteristics of system to bemonitored. In reality, structures are subject to changing environmental and operationalconditions that affect measured signals, and environmental and operational variations of thesystem can often mask subtle changes in the system's vibration signal caused by damage. Inthis paper, a unique combination oftime series analysis, neural networks, and statistical inference techniques are developed for damage classification explicitly taking into account theseambient variations of the system. First, a time prediction model called an autoregressiveand autoregressive with exogenous inputs (AR-ARX) model is developed to extract damage sensitive features. Then, an autoassociative neural network is employed for data normalization, which separates the effect of damage on the extracted features from those caused bythe environmental and vibration variations ofthe system. Finally, a hypothesis testingtechnique called a sequential probability ratio test is performed on the normalized features toautomatically infer the damage state of the system. The usefulness of the proposed approach isdemonstrated using a numerical example ofa computer hard disk and an experimental studyof an eight degree-of-freedom spring-mass system.

III. METHODOLOGY

This proposal develop a relationship between how well a model predicts on new data (its true prediction error and the thing we really care about) and how well it predicts on the training data (which is what many modelers in fact measure). True Prediction Error=Training Error+Training OptimismTru e Prediction Error=Training Error+Training Optimism

Here, *Training Optimism* is basically a measure of how much worse our model does on new data compared to the training data. The more optimistic we are, the better our training error will be compared to what the true error is and the worse our training error will be as an approximation of the true error.

3.1 Least-mean-square estimate of parameter vector

The method of least squares is about estimating parameters by minimizing the squared discrepancies between observed data, on the one hand, and their expected values on the other (see Optimization Methods).

IV. OBJECTIVE

Analyze the damage of High rise building after the hazardous situation and minimizes the loss of contraction as well strengthen the old structure.

V. TOOLS

ANOVA for damage Analysis and MS Excel.

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