AUTOMATED POST-EARTHQUAKE DAMAGE ASSESSMENT OF INSTRUMENTED BUILDINGS

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Abstract. A set of methodologies for automated post earthquake damage assessment of instrumented buildings are presented. These methods can be used immediately after an earthquake to assess the probability of various damage states in the N-S and E-W directions and throughout the height of each building. The methods have been applied to more than 40 CSMIP instrumented buildings which have recordings from more than one earthquake. The results indicate that the proposed methods, when used in combination, can provide very useful information regarding the status of a building immediately after an earthquake by simple and rapid analysis of sensor data and prior to any building inspections.

Keywords: earthquakes; damage assessment; fragility functions; wavelet analysis; instrumentation; automated; remote

1. Introduction

This paper provides an overview of an exhaustive investigation to determine the feasibility of an automated approach to post-earthquake damage assessment of
instrumented buildings and establishment of a coherent set of techniques and methodologies to achieve the objective of automated post-earthquake damage assessment.

The objective of this project was to use and study strong-motion data from instrumented buildings with several earthquake records to determine the threshold of measures of motion that would provide guidance to the building officials, in a manner consistent with ATC-20, for determining whether to inspect the building or evacuate it based on the records taken from the building. The proposed measures are such that they can be computed directly from recorded data of instrumented buildings.

Due to publication space constraints this paper provides only a preview of the methodologies developed and a small number of representative examples. A full report which is currently in preparation (Naeim et al., 2005) will contain detailed information regarding various methodologies implemented and the results of application to numerous instrumented buildings. In addition, papers are being prepared for submission to scientific journals that document certain major developments achieved during this project (Alimoradi et al. 2005a; Alimoradi et al., 2005b).

Automated damage assessment (ADA) provides an incentive for building owners to instrument their buildings and has the potential of significantly adding to the inventory of instrumented buildings so critically needed for development and evaluation of existing and future design provisions. Elimination or reduction of possible false alarms produced by ADA procedures is a major concern. Therefore, we assess damage using several independent techniques and provide the degree of confidence in terms of probability of occurrence with each of our damage assessments.

Robust ADA methodologies should be able to provide increasingly more accurate estimates of post-earthquake damage when more information is available regarding the building and its contents. With our approach, preliminary damage estimates are provided based on the sensor data and a general understanding of the building and its contents. More accurate damage estimates may be obtained if more detailed information regarding the structural system and contents are available such as detailed fragility curves for various components.

The more specific the information that ADA provides, the more useful it is. We provide damage estimates per floor in each direction of the building. Damage estimates may be based on the maximum response values per floor or response values at the geometric center of each floor’s diaphragm.

In more ways than one this project is a natural continuation of last year’s effort which resulted in development and dissemination of the CSMIP-3DV software system (Naeim et al., 1994). We utilized and expanded on the