SEISMIC RESPONSE AND ANALYTICAL MODELING OF A THIRTEEN STORY GOVERNMENT OFFICE BUILDING

Ruben L. Boroschek

Stephen A. Mahin

Report to the California Department of Conservation

Department of Civil Engineering

Structural Engineering, Mechanics and Materials

University of California, Berkeley

1990

Abstract

The dynamic response of a thirteen story government administration building, located in San Jose, California, is examined and analyzed in this report. The 1984 Morgan Hill and 1986 Mt. Lewis earthquakes are considered. The basic behavioral characteristics together with various engineering design parameters are identified from the response records. The observed behavior is unusual and characterized by a long duration narrow-band motion with strong amplitude modulation, by large amplitude lateral and torsional motions, and by large amplification of the input ground motions. The long duration of the response and the high amplitude of the motion are found to be related to a combination of factors including the long predominant periods of the structure, lateral-torsional coupling, three-dimensional building modes constructively reinforcing one another during portions of the motion, low amounts of viscous damping and the possible resonance of the building with the site.

Several analytical computer models are developed to reproduce and study the causes of the observed response and to evaluate the accuracy of current analysis procedures. The basic parameters affecting the response are investigated. Results obtained from the models show that the elastic dynamic characteristics and response of the building can be accurately predicted by standard modeling techniques. The best correlations are found when models include, in addition to the basic frame geometry, element properties and appropriate damping (for the level of response), beam-column connection flexibility, a realistic floor mass distribution and the partial composite action between beam and floor slab. Studies with the numerical models suggest that the unusual long duration and high amplitude response observed from the earthquake records can be substantially reduced by the inclusion of a moderate amount of viscous damping (e.g., 5% of critical).

Other features of this investigation include the study of the effectiveness of typical design codes in predicting the building demands and responses, and the development of formulae to estimate the ratio of the uncoupled translational and rotational periods of a typical space frame.

Acknowledgments

The authors are grateful for the assistance and recommendations of the Strong Motion Instrumentation Program (SMIP) Building Sub-committee and to the SMIP staff. The assistance of Peter Klaus of Santa Clara County is greatly appreciated. The financial support of the California Department of Conservation is acknowledged (Grant 1088089 / 8-9131). The findings of this study, however, are those of the authors alone.

Contents