METHODS OF ACHIEVING IMPROVED SEISMIC PERFORMANCE OF COMMUNICATIONS SYSTEMS

Edited by Alex Tang and Anshel J. Schiff

Technical Council on Lifeline Earthquake Engineering
Monograph No. 10
September 1996

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Abstract:

This committee report contains information on seismic exposure, design and installation practices that may be used to improve the seismic performance of communication systems. The suggested practices are born of years of design, analysis, equipment testing and installation, inspection trips, and post-earthquake reconnaissance surveys. While communication systems have been shown to be robust in comparison to other lifeline systems such as electric power and gas, a number of significant earthquakes have affected them since the San Fernando earthquake of 1971. The information in this report can be used to identify these vulnerabilities. It reviews methods for determining seismic hazards in different parts of the country; describes central office facilities and equipment, outside plants, and wireless systems; identifies each of the major elements that make up the facilities; and, finally, reviews the earthquake performance of these elements and recommended practices. With the coverage of these technical areas, this document can serve as a practical introduction to seismic engineering of communication systems or as a checklist by facility managers to assess the earthquake readiness of an installation.

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FOREWORD

This document to improve the earthquake performance of communications systems was started by the Electric Power and Communications Committee of the Technical Council on Lifeline Earthquake Engineering (TCLEE) in 1989. The pace of the development is reflected by the fact that this is a volunteer activity. Indeed it has been difficult to keep pace with the rapid development of new technologies. The suggested practices, building on existing practices, are based on data collected from earthquake reconnaissance reports. The introduction of new telecommunication hardware and network control strategies and the rarity of large damaging earthquakes in a large metropolitan area mean that many of the new systems have not been put to a severe test. The 1994 Northridge, California earthquake, the most damaging to strike an urban area in the US, was a moderate event by seismological standards.

This document covers wire and wireless communications. The methods suggested in the document reflect those gathered by the authors. Equipment installation practices were primarily drawn from those used by the original Bell system. An effort has been made to expand the base of the document developers to a wider range of utility practices, but it has not been successful. Thus, other approaches and design details that are not covered in the document, may provide equivalent seismic performance. This is the first document for telecommunication systems developed by TCLEE. An expanded document to include radio/TV communications, other topics and updates is planned. The committee would welcome any suggestions on the scope or content to be included in the next edition of this document.

This document is directed to a broad audience including intra- and inter-exchange carriers, large organizations such as companies, utilities, municipal and state governments, and universities that may have their own private branch exchanges. In addition to owners and operators of telecommunication facilities, the document may also be of use to emergency response planners in the above organizations to make them

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aware of the vulnerabilities of telecommunications system to earthquakes so that they can anticipate potential communication problems and incorporate mitigation methods into their plans.

Data collection from earthquake damage is key to this document. The committee appreciates the continual support of facility owners to allow reconnaissance visits after an earthquake. Committee members will continue to focus on technical issues without identifying product manufacturers and owners, to provide lessons based on observations of earthquake damage.

Alex Tang
Anshel J. Schiff
September, 1996

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Otto Steinhardt made this document more readable with his insistence on consistency and simplicity.

As this is a volunteer effort, the time provided by the above mentioned individuals is their own time. Most of the committee meetings were held on weekends. Therefore, the last word of acknowledgment goes to the family members and friends who patiently supported the activity and made this document a reality.

Alex Tang
Anshel J. Schiff
September, 1996

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EXECUTIVE SUMMARY

This monograph contains information on seismic exposure, design and installation practices that may be used to improve the seismic performance of communication systems. The suggested practices are born of years of design, analysis, testing and installing equipment, inspection trips and post-earthquake reconnaissance surveys. The report is meant to serve as a practical introduction to seismic engineering of communication systems. It can also be used as a primer by system planners who may not be well-versed in seismic protection, or as a check list by facility managers to assess the earthquake readiness of an installation.

Compared with other lifelines such as electric power, gas, water and transportation systems, today's communications systems have been shown to be robust, based on California's earthquake experience. However, this performance may not be the same for other parts of North America. There have been a number of significant earthquakes affecting communications network since the San Fernando earthquake of 1971, and observations of network performance in these events reveal that significant improvement has occurred in equipment design and installation practices, as well as several problem areas. The 1995 Kobe, Japan, earthquake has also demonstrated the significant damage that can be done to outside plant from soil liquefaction. Observations of earthquake damage to communication facilities are described in this document.

Some problems are systemic. For example, following an earthquake call volume increases substantially, resulting in network congestion. The "network busy" condition causes delayed dial tone, fast busy signal or a recorded circuits busy message, which is perceived by the user as a service disruption. Handsets going off hook are treated by the switching equipment as attempts to place calls. A more recent problem stems from commercially available phones that require household power to function, e.g., some answering machines, cordless phones and

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