The Great Tangshan Earthquake of 1976

Volume 1

Earthquake Engineering Research Laboratory
California Institute of Technology
Pasadena, California 91125
2002

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Published by

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Earthquake Engineering Research Laboratory
California Institute of Technology
Pasadena, California
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唐山大地震震害

（第一册）

刘恢先 主编

地震出版社

1985

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FOREWORD

On July 28, 1976, a magnitude 7.8 earthquake devastated the city of Tangshan, China. Of the 1.5 million people living in the affected area, about 242,000 died and 164,000 were severely injured and most of the surviving inhabitants lost their homes because of collapse. This earthquake caused one of the greatest natural disasters in human history.

The great structural, economic, and social impacts of this earthquake made it obligatory to record the seismic effects and also the geological and seismological setting of the earthquake. An effort of six years was initiated under the leadership of Professor Huixian Liu, the former director of the Institute of Engineering Mechanics (IEM), State Seismological Bureau of China (former Institute of Engineering Mechanics, Academia Sinica). This report, "Damage in the Great Tangshan Earthquake," was published in four volumes. Volume I presents basic information on seismological and geological features relevant to the earthquake; Volume II records real and vivid damage to civil structures and facilities; Volume III describes damage, relief and rebuilding of the lifeline system and Volume IV contains about seven hundred photographs of various typical damages. A unique feature of this report is that all damages collected in the book are described in detail with little subjective explanation so as to insure that the information provided is as objective as possible. This report reflects on the one hand the whole picture of damages to the various buildings, structures, lifeline systems, etc. distributed in a vast region, ranging from completely destroyed in the near-field to more distant regions where structures were only slightly damage. The report provides also basic information on seismic damage for further earthquake engineering research.

The years 1990–2000 have been designated by the United Nations as the International Decade for Natural Disaster Reduction (IDNDR). The Decade would be a potent first step in reducing the impacts of natural hazards through coordinated research, data gathering and information sharing. In 1986, four years earlier than the beginning of the Decade, Professor George W. Housner initiated a program to translate the report "Damage in the Great Tangshan Earthquake" into English language after he received and examined a copy. In his letter to Professor Liu Huixian he said "This appears to be an excellent report that contains much information that would be valuable to all earthquake-prone countries in the world. Earthquake engineers and seismologists everywhere could learn from this report how to improve the safety of their cities." This initiation received an active response from Liu Huixian who mentioned in his reply letter that he decided to arrange an English language edition of the Tangshan Earthquake Report. Since then under the sponsorship of the Ministry of Construction and the State Seismological Bureau of China and U.S. National Science Foundation a joint project was finally established and executed in 1991 between the Institute of Engineering Mechanics in Harbin, China and the California Institute of Technology in USA with Professors Liu and Housner as Principal Investigators for the project

The translation from Chinese to English was done at the Institute of engineering Mechanics. Many of the sections were translated by those who had originally written them. The editing and the publication was done in the United States under the direction of Professor Housner.

Unfortunately, Professor Liu Huixian became ill in 1991 and died on June 24, 1992. Thus, he did not live to see the completion of the report. As his successor, Professor Xie, Li-Li, the current director of IEM, has the responsibility of carrying on the unfulfilled work left by Professor Liu. Through the joint effort since then, the English language version of the report is expected to be completed in 1996 and published in 1997. Undoubtedly, it will be a significant contribution to IDNDR.

On the occasion of the Twentieth Anniversary of the Tangshan Earthquake, we would like to issue the First and Fourth Volumes of this report as a preliminary publication in memory of the Tangshan Earthquake and as an expression of sympathy we dedicate it to the victims of the earthquake.

Xie Li-Li

April 5, 1996

PREFACE

The great disaster caused by the Tangshan earthquake has special significance for all those cities in seismic regions throughout the world which were designed and built with inadequate attention to the effects of ground shaking. All seismic countries have cities with buildings that would not survive strong ground shaking and, therefore, these countries are potential candidates for an earthquake disaster. It appears that in these cities an approximate cost-benefit analysis shows that the probability of a strong earthquake is small and the cost of retrofitting is large and, therefore, the decision is made to ignore the problem. However, such analysis is not complete without giving consideration to the overall cost to society of an earthquake disaster. For example, the 1995 Kobe, Japan earthquake is reported to have cost the country at least $200 billion.

It does not necessarily require a large earthquake to cause a great disaster. In 1960 the city of Agadir, Morocco experienced an earthquake of magnitude 5.7 located directly under the city whose population was 33,000 individuals. The city was completely unprepared for ground shaking and most of the building collapsed and more than one-third of the inhabitants were killed. To have a great earthquake disaster depends not only upon the magnitude of the shock but also on its distance from the city; for even a large magnitude earthquake will not produce a disaster if it is sufficiently far from the city. The other feature that controls the size of the disaster is the degree of earthquake resistance that has been built into the structures. Buildings that have been designed and constructed according to modern earthquake engineering principles can survive strong ground shaking without collapse and loss of life. However, the city of Tangshan was poorly prepared to withstand earthquake shaking and, in addition the earthquake was centered on the city so that it experienced very strong ground shaking with extensive collapse and large loss of life. Many cities in seismic countries have weak buildings that will collapse if subjected to strong ground shaking.

Before the earthquake there were no obvious evidences of potentially active earthquake faults in the region of Tangshan and, therefore, the seismic map in the building code located Tangshan in a zone that did not require earthquake resistant design of structures. However, after the earthquake, geological and seismological studies of the Tangshan region showed that there were significant faults in the general area and therefore it was not a mystery as to how a destructive earthquake could occur there. The lesson to be learned from this is that just because there is no historical record of a destructive earthquake in the region does not mean that a destructive earthquake can not occur in the future.

This is an important lesson for cities in the mid-western United States and in the eastern United States. These regions experienced destructive earthquakes in 1812 and in 1886. In these regions it is known that large earthquakes can occur but it is not known when and where. There are many other cities in seismic regions throughout the world that may experience large earthquakes but do not know what the likelihood of occurrence is.

The great Tangshan earthquake disaster shows what can happen to cities that experience strong ground shaking and are not prepared. It is therefore important that the report on the Tangshan earthquake be translated into the English language so that it can be read in other

seismic countries. The lessons to be learned from this earthquake are important to the earthquake engineering communities in seismic countries and also to city building officials and building code writers, as well as governmental officials who are ultimately responsible for the safety of the citizens. It is hoped that this translation of the Tangshan earthquake report will aid in reducing the casualties in future earthquakes.

George W. Housner
California Institute of Technology

ACKNOWLEDGMENTS

The project to translate the report on the Tangshan earthquake was a part of the United States-China Program on Cooperative Research in Earthquake Engineering. Financial support was provided by the National Science Foundation and Dr. S. C. Liu, Program Director at the NSF, provided encouragement and moral support for the project.

To insure that the technical meaning in the Tangshan earthquake report was translated correctly it was necessary that the first draft of the translation should be reviewed by persons knowledgeable in the particular technical subject: geology, seismology, geotechnical engineering, structural engineering, performance of structures during earthquakes, and also knowledgeable in both the English language and the Chinese language. The following persons volunteered to do this technical review:

Dr. Frank K. Chang	U.S. Army Engineer-Waterways Experiment Station, retired
Professor Nien-Yin Chang	Department of Civil Engineering, University of Colorado
Professor Zhikun Hou	Department of Mechanical Engineering, Worcester Polytechnic Institute
Dr. Moh-Jiann Huang	Office of Strong Motion Studies, California Division of Mines and Geology

The final editing and the preparation for publication was carried out at the California Institute of Technology by Sharon Beckenbach and Denise Okamoto.

The valuable work by all of the foregoing persons contributed greatly to a successful translation and publication of the report "The Great Tangshan Earthquake".

George W. Housner

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