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1964 ALASKAN EARTHQUAKE
TALL BUILDING DAMAGE
REVIEW

Robert V. Whitman

Erik H. Vanmarcke

John W. Reed

Eduardo B. Kausel

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Department of Civil Engineering

Massachusetts Institute of Technology

Cambridge, Massachusetts

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R. V. Whitman, E. H. Vanmarcke, J. W. Reed, E. B. Kausel

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Department of Civil Engineering
Cambridge, Massachusetts 01239

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16. Abstract (Limit: 200 words)
This review organizes and presents information on building performance in terms of damage probabilities. These probabilities are the elements of matrices which quantify the uncertain relationship between the amount of building damage and the intensity of ground shaking. They are a basic component of the input to an analysis aimed at predicting losses of life and property during future earthquakes. The peak acceleration of the 1964 Alaskan earthquake is estimated at about 0.16g and the damaging shaking lasted for about three minutes. The Modified Mercalli Intensity was about 1X to X. Wood frame dwellings and other low rise buildings not located in landslide areas performed very well. All buildings of five or more stories in the Anchorage area suffered some structural damage. The predominant period of the horizontal ground motion in Anchorage was estimated at 0.5 seconds or longer. Most of the buildings had reinforced concrete shear walls as their principal lateral force resisting system. Almost all of the structures built since 1955 were constructed according to the UBC seismic zone three, and those built before 1955 had roughly a zone two strength. A summary of the number of buildings by height and zone used in developing the damage probability matrices is presented.

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List of Internal Study Reports

1. R.V. Whitman, "Preliminary Work Plans and Schedules," August, 1971.

2. E.H. Vanmarcke and R.V. Whitman, "Background for Preliminary Expected Future Loss Computations", October, 1971.

3. P.J. Trudeau, "Identification of Typical Soil Profiles in the Boston Basin Area", November, 1971.

4. J.M. Biggs, "Comparison of Wind and Seismic Forces on Tall Buildings," December, 1971.

5. R.V. Whitman, "Contribution to State-of-the-Art Report of the Earthquake Committee of the IABSE-ASCE Tall Buildings Committee--Economic and Social Aspects," March, 1972.

6. J.E. Brennan and R.J. McNamara, "Optimum Seismic Protection for New Building Construction in Eastern Metropolitan Areas," April, 1972.

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9. R.V. Whitman, E.H. Vanmarcke, "Damage Statistics from Japanese Earthquakes," May, 1972.

10. E. H. Vanmarcke, J.W. Reed, D. Roth, "Evaluation of Expected Losses and Total Present Cost: Preliminary Sensitivity Analysis", July, 1972.

Introduction

This report is the third of the Boston Quake Study internal reports directed to tall building damage during historic earthquakes other than the 1971 San Fernando earthquake. Internal Study Report No.8 reviews the 1967 Caracas, Venezuela earthquake experience, and Internal Study Report No. 9 summarizes some findings from two recent Japanese earthquakes. This report deals with the damage to buildings with five or more stories during the 1964 Alaska earthquake.

The purpose of these reviews is to organize and present the information on building performance in terms of damage probabilities (1). These probabilities are the elements of matrices which quantify the uncertain relationship between the amount of building damage and the intensity of ground shaking. They constitute a basic component of the input to an analysis aimed at predicting losses of life and property during future earthquakes (1).

The senior writers had the opportunity of visiting Anchorage, Alaska on April 19-20, and holding discussions with Messrs. Frank E. Nyman, John E. Cerutti and Robert Lyle to firm up building damage statistics obtained from the many published reports on the Alaska earthquake (2-9).

The 1964 Alaska Earthquake

On March 27, 1964, at about 5:36 p.m. local time, an earthquake of magnitude between 8.4 and 8.6 on the Richter Scale and an epicenter located north of the Prince William Sound shook the cities and towns of south central Alaska. In Anchorage, where most of the damage occurred,

the peak acceleration, while not actually measured, was probably about 0.16g (2,3) and the damaging shaking lasted for about 3 minutes. The Modified Mercalli Intensity was about IX to X.

Total loss of life, 115 people, was very small for an earthquake of this magnitude. Public and private property loss was estimated at $300 million. Wood frame dwellings and other low rise buildings not located in landslide areas performed very well. On the other hand, all buildings of five or more stories in the Anchorage area suffered some structural damage. The predominant period of the horizontal ground motion in Anchorage was estimated at 0.5 seconds or longer (4).

The Data Base.

Given in Table 1 is a list of all buildings of five stories or more that were located in the heavily shaken area. All except the Hodge building were in the Anchorage District. The 14-story Hodge building is located in Whittier, some 30 miles from Anchorage, and is founded on bedrock. It suffered no significant structural damage (10). The Knik Arm apartment building (built in 1950) moved about 10 ft. due to a landslide and suffered only negligible damage. This building has not been included in the statistical sample as our primary concern is with building damage caused by ground shaking at the foundation level. Most of the buildings had R/C shear walls as their principal lateral force resisting system (2). Almost all of the structures in Table 1 built since 1955 were constructed according to the UBC seismic zone 3, and those built before 1955 had roughly a zone 2 strength. Shown in Table 2 is a summary of the number of buildings by height and zone used in developing the damage probability matrices.

TABLE 1

List of Buildings of 5 Stories or More in the Vicinity of Anchorage, Alaska

	Building Name	Number of Stories	Year Built	UBC Zone	Damage Category+
1.	Airport Building	6	1952	2(?)	8
2.	Knik Arm Apartments	6	1950	2	-
3.	Four Seasons Apt. House	6	1964	3	8
4.	1200 L Street Apartment	14	1951	2	6
5.	Westward Hotel	14	1960-64	3	5
6.	Penney Building	5	1962	3	8
7.	Hill Building	8	1962	3	5-6
8.	Hillside Manor Apts.	5	1950	2	8
9.	Cordova Building	6	1960	3(?)	5-6
10.	Mt. McKinley Apartments	14	1951	2	6
11.	Alaska Native Hospital	5	1951	3	2
12.	Providence Hospital	5	1961	3	3
13.	Community Hospital	5	1959	3	1-2
14.	Elmendorf AFB Hospital	7	1955	3	4
15.	Elmendorf AFB Control Tower	7	1955	3	7
16.	Hodge Building, Whittier	14	Post-1955	3	1-2

+For damage state category definitions see Reference 1 or Tables 4 and 5.

TABLE 2

Number of Buildings in Survey

UBC Seismic Zone	Building Height (Stories) 5-8	14
Zone 2	2	2
Zone 3	9	2(a)

(a) Includes the Hodge Building located in Whittier.

Damage Probability Matrices

It is assumed that the entire Anchorage area experienced a (common) Modified Mercalli Intensity 9+. The MMI 9+ columns for each of four damage probability matrices (for each height category and zone) are given in Table 3. Shown in Tables 4 and 5 are the matrix values obtained by accounting only for differences in the UBC seismic zone.

TABLE 3

Probability Matrix Values for MMI 9^+

Damage Category	Replacement Cost Ratio (Central Range)	Zone 2		Zone 3	
		5-8	14	5-8	14
No Damage	0.00	0	0	0	0
Light Damage	.001-.005	0	0	2/9	1/2
Moderate Damage	.02-.05	0	0	2/9	0
Heavy Damage	.10-.30	0	2/2	2/9	1/2
Requires Replacement	1.0	2/2	0	3/9	0

TABLE 4

Probability Matrix Values

Name of Earthquake	ALASKA
Date of Earthquake	March 27, 1964
Building Code or Age	Zone 2 (Pre-1955)
Height Zone	Various (5^+)

Number of Buildings

			Mercalli Intensity					
General	Detailed	Replacement Cost Ratio	4^-	5	6	7	8	9^+
No Damage	0	0						0
Light	1	.001						0 (0)
	2	.005						(0)
Moderate	3	.02						0 (0)
	4	.05						(0)
Heavy	5	.10						.50 (0)
	6	.30						(2)
Requires Replacement	7	1.0						.50 (0)
	8	1.0						(2)
TOTAL								1.00(4)

TABLE 5

Probability Matrix Values

Earthquake Damage Summary

Name of Earthquake ALASKA

Date of Earthquake March 27, 1964

Building Code or Age Zone 3 (Post-1955)

Height Zone Various (5^+)

Number of Buildings

			Mercalli Intensity					
General	Detailed	Replacement Cost Ratio	4^-	5	6	7	8	9^+
No Damage	0	0						0
Light	1 2	.001 .005						.20 (0) (2)
Moderate	3 4	.02 .05						.20 (1) (1)
Heavy	5 6	.10 .30						.30 (1) (2)
Requires Replacement	7 8	1.0 1.0						.30 (1) (2)
TOTAL								1.00(10)

The sample does not include the Hodge building which is untypical in two ways: (i) it is located in Whittier which is some 30 miles from Anchorage, and (ii) it is founded on bedrock.

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