

OPTIMUM SEISMIC PROTECTION FOR NEW BUILDING
CONSTRUCTION IN EASTERN METROPOLITAN AREAS

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Internal Study Report No. 22

1957 SAN FRANCISCO EARTHQUAKE
TALL BUILDING DAMAGE REVIEW

Any opinions, findings, conclusions
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16. Abstract (Limit: 200 words) <p>A study to estimate the damage states of buildings resulting from the March 22, 1957 earthquake in the San Francisco bay area is reported. The earthquake, of Richter magnitude 5.3, caused strong ground motion and lasted about 5 seconds. Most of the data used for this report is derived from a previous report, published in 1957, which gives a descriptive measure of damages to 11 thirteen-story apartment buildings, 4 ten-story apartment buildings, and 6 downtown office buildings. The damage states of the buildings, assumed to be the only ones damaged, are assigned by comparing descriptions given in the report with those defined in the San Fernando Study. Information on 1103 buildings, used to construct the damage matrix, are based on the Sanborn maps of San Francisco up to 1967. A chart of the damage matrix divides the data into two parts, one which includes the Lake Merced area, and the other, which excludes it. Since the number of damaged buildings is so small, it is concluded that the damage potential of the MMI VI seismicity reported for the earthquake is negligible. The report also contains an isoseismal map of the 1957 San Francisco Earthquake and areas covered by the Sanborn maps of San Francisco.</p>		13. Type of Report & Period Covered	
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On March 22, 1957, the San Francisco Bay area was shaken by an earthquake of Richter magnitude 5.3. The strong ground motion lasted for only about 5 seconds. The seismicity in most of the city was reported to be MMI VI, although a limited number of small areas of MMI VII near the epicenter were reported, perhaps due to localized soil conditions. The location of the epicenter and the seismicity in the affected area are shown in Fig. 1 (1).

The earthquake was neither intense nor damaging, and the property loss was estimated to be only about \$1,000,000 (2). The only comprehensive source of information on building damage for this quake is a report by Steinbrugge, Bush and Zacher, entitled, "Damage to Buildings and other structures during the Earthquake of March 22, 1957," California Division of Mines, Special Report 57. For the behavior of the high-rise buildings the report gives a descriptive measure of damages to 11 thirteen-story apartment buildings (the Parkmerced Apartment), to 4 ten-story apartment buildings (The Stonetown Apartments), both located in the Lake Merced area, and to 6 downtown office buildings. Discussion of this earthquake by John Blume (re: letter from R. Scholl to J. Reed, dated 6/15/72) indicates that the Steinbrugge report is reasonably complete. Because of the lack of other information sources, it is assumed that only the buildings mentioned above were damaged. The damage states of the buildings are assigned by comparing the damage descriptions given in the report mentioned above with those defined in the San Fernando Study.

In order to construct the damage matrix, information on all

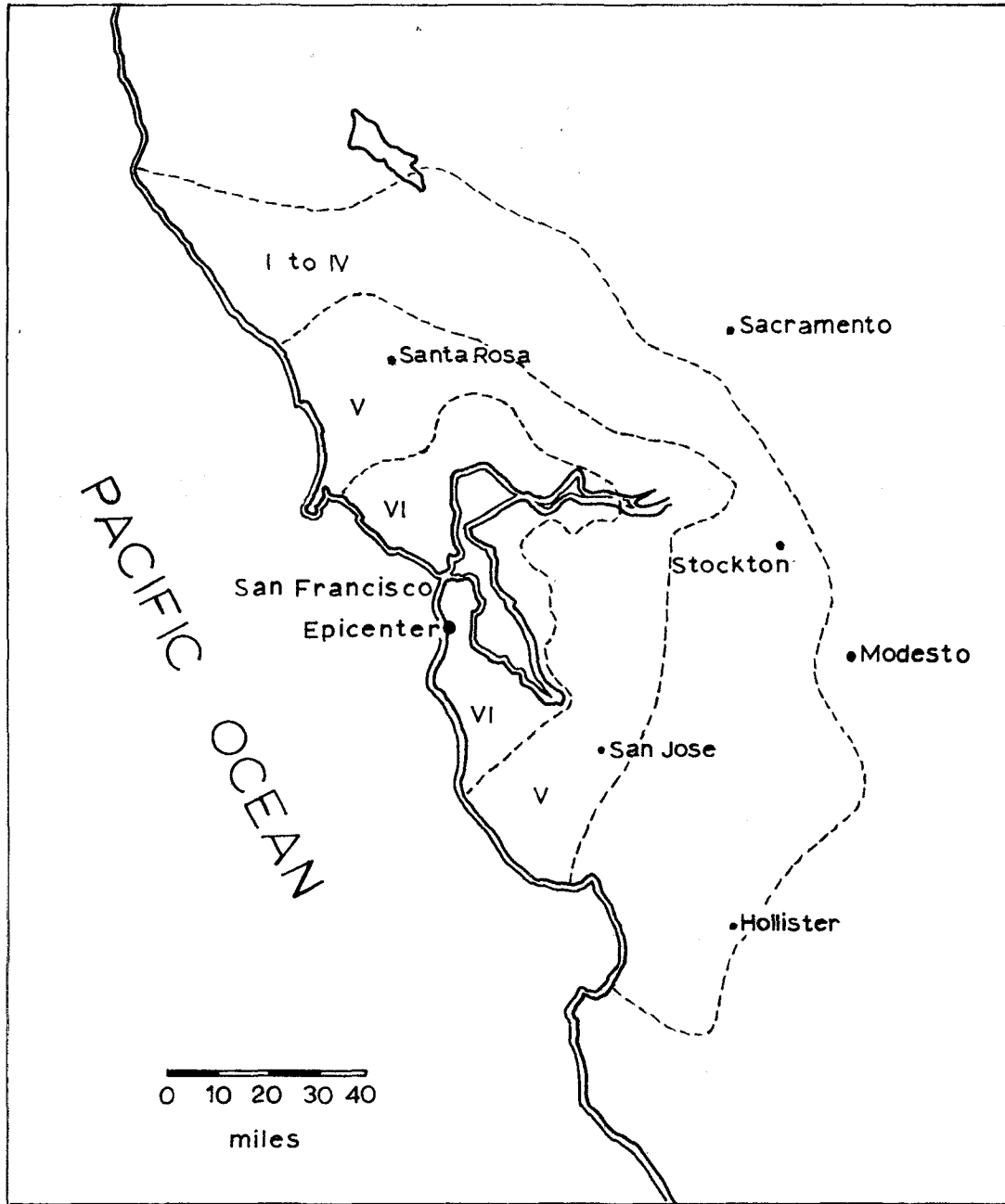


Fig. 1. Iseismal Map of 22 March 1957 San Francisco Earthquake

high-rise buildings, 5 stories and higher, in the area covered by the Sanborn maps of the City of San Francisco, up to the year 1968, were extracted from the maps. In all, 1356 buildings were documented. The Sanborn maps provide the building address, date of construction, structural type, building function, building height, building dimensions, and some fire-proof related information. The areas covered by the Sanborn maps of the City of San Francisco are shown in Fig. 2 along with the location of the damaged buildings reported by Steinbrugge, et al. Unfortunately, the Lake Merced area is not covered by the Sanborn maps. The numbers shown in Fig. 2 correspond to the volume numbers of the Sanborn maps.

There were a total of 1109 high-rise buildings in the area covered by the Sanborn maps at the time of the 1957 earthquake. Only 6 downtown office buildings suffered light damages. Four of them are estimated to fall into the damage state 1 category, and the other two are considered to be in damage state 2. The 15 apartment buildings in the Lake Merced area are all estimated to fall into damage state 1.

The damage matrices were derived by assuming that the damaged apartment buildings were the only high-rise buildings in the Lake Merced area at the time of the 1957 San Francisco earthquake. The damage matrix is shown in Fig. 3.

Because the number of the damaged buildings is so small, the only significant conclusion that can be drawn is that the damage potential of the MMI VI seismicity with a short duration, say 10

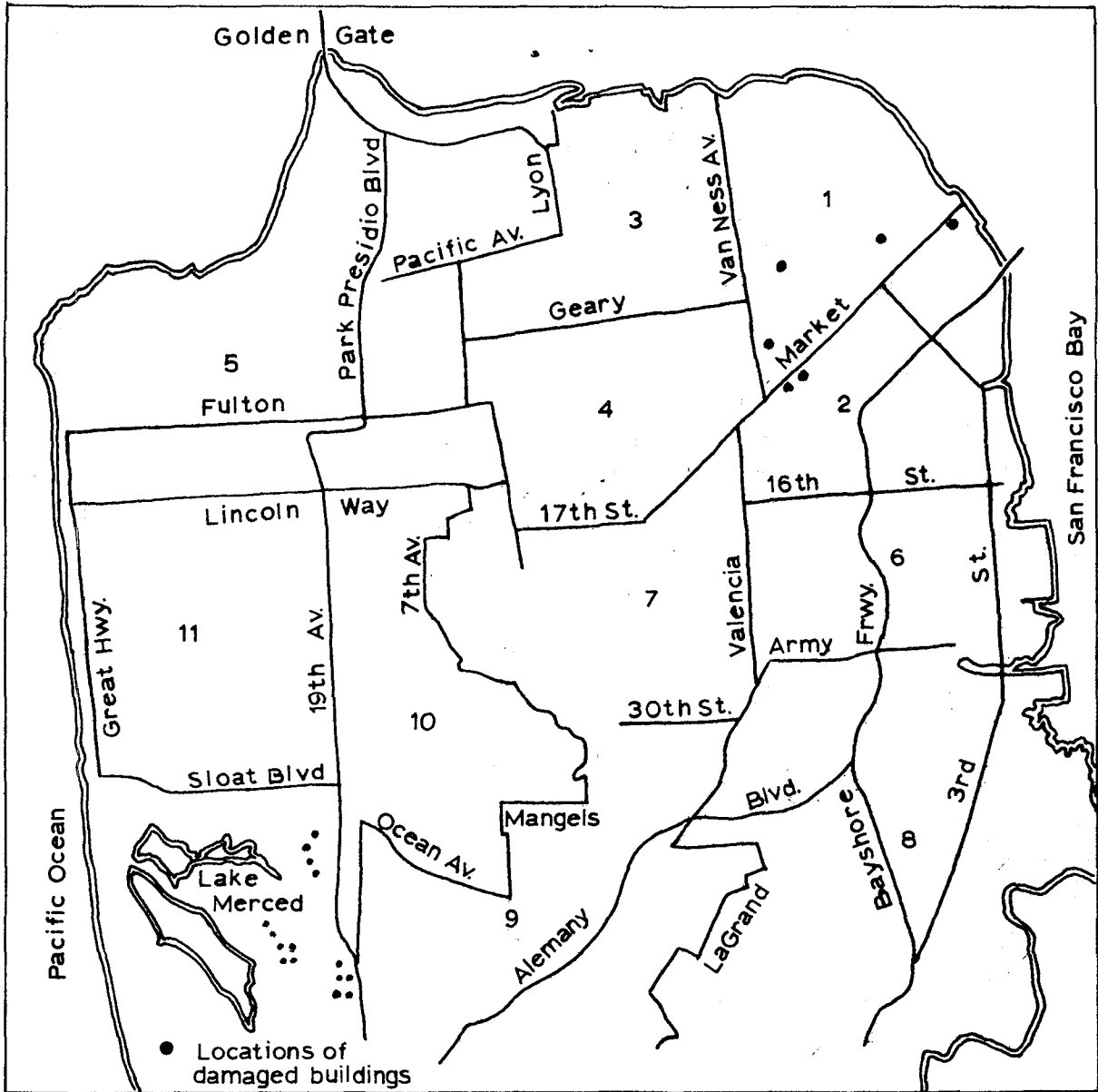


Fig. 2. Areas Covered by the Sanborn Maps of the City of San Francisco

seconds or less, is negligible.

It is interesting to note that the damaged apartment buildings in the Lake Merced area are all of medium height, i.e., 8 to 13 stories. The damage behavior may have been affected by the local soil conditions.

Damage State	Damage Matrix Excluding the Lake Merced Area		Damage Matrix Including the Lake Merced Area [*]	
	Number of Buildings	Percent	Number of Buildings	Percent
0	1103	99.4	1103	98.1
1	3	0.3	18	1.6
2	3	0.3	3	0.3
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
Total	1109	100	1124	100

* Based on the assumption that the damaged apartment buildings are the only high-rise buildings in the Lake Merced area. This assumption does not affect the matrix to a significant extent.

Figure 3. Damage Matrix from the 1957 San Francisco Earthquake

References

1. "Intensity and Ground Motion of the San Francisco Earthquake of March 22, 1957," by William K. Cloud, U.S. Coast and Geodetic Survey.
2. "Damage to Buildings and Other Structures during the Earthquake of March 22, 1957," by K.V. Steinbrugge, V.R. Bush and E.G. Zacher, California Division of Mines, Special Report 57.

