

GUATEMALA EARTHQUAKE OF FEBRUARY 4th , 1976. DESCRIPTION AND ANALYSIS  
OF DAMAGES CAUSED ON BUILDINGS

by  
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SUMMARY

Effects on buildings due to the earthquake that on February 4th, 1976 shook the central area of Guatemala, are analyzed. Special consideration is given to materials and types of construction used in those affected areas that were travelled over by author.

INTRODUCTION

On February 4th, 1976 at 9hs 01m 42.4 sec. GMT (03, 02,33 Local time) an earthquake affected the central and north-western areas of Guatemala, leaving as a balance, 25,000 dead and 77,000 wounded and causing damages estimated in 1,000 million dollars, i.e., half the annual gross national product. As for damages, habitational sector was the most affected. About 258,000 units were damaged resulting nearly one million homeless, that is one sixth the population of the country.

Buildings are of different kinds in Guatemala City : single storey buildings made of "adobe", two and three storey buildings of bricks and blocks with little reinforced concrete structure, four to nine storey buildings of the framed sort and modern buildings of up-to-date construction. In country areas, "adobe" buildings without any kind of earthquake resisting links are predominant.

STRONGEST EARTHQUAKES

Guatemalan seismic history is as old as the sixteenth century. The earliest reports are those corresponding to the eruption of "Volcán de Fuego" (Fire Volcano) and it is said that "there were so strong shakes that people could not stand on their feet. (2).

Among the most important and destructive earthquakes, those of July 1773 which destroyed Guatemala City and caused its moving to its present location at Valle de la Ermita and the ones in December 1917 and in January 1918 which affected the City in its new location, can be mentioned.

This last series of earthquakes would be remembered, by the history of destructions suffered by Guatemala City, as the most tremendous one, until on August 6th, 1918 another intense earthquake shook the city and damaged its buildings. Apparently , not any other such intense earthquake had been felt since 1917 and 1918.

ORIGIN AND CHARACTERISTICS OF FEBRUARY 4th, 1976 EARTHQUAKE

The recent seismic motions that affected Guatemala were caused by the displacement of the Caribbean Plate towards the east relatively to the Northamerican and Cocos Plates. Such displacement has taken place along a fault , located at Valle del Río Motagua, which extends through Guatemala with west-northwest direction and into the Caribbean Sea.

The principal epicenter of the earthquake of 4 February has been found , by the United States Geological Survey , to be located near

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Los Amates, in Izabal, in the west of Guatemala at 15,3° north latitude and 89,2° south longitude. Its magnitude has been estimated to be 7,5 Richter. According to given information no accelerograms were obtained.

#### OBSERVED DAMAGES

The towns where damages were of greater importance are located in the Districts of Chimaltenango, El Progreso, Baja Verapaz and Zacapa, amounting between 70 and 100% (intensity IX Modified Mercalli). Damages ranging between 20 and 70% were observed in the Districts of Sacatepéques, Quiché, Izabal, Guatemala and Totonicapán (intensity VIII MM) Figure 1.

Most of the observed damages in the city as well as in country areas correspond to the typical houses made of "adobe" with wooden roofs and clay tile covers. Figure 2.

The behaviour of buildings with brick masonry walls and reinforced concrete structure was fairly acceptable having only been observed the breakage of window glasses, plasterings, coatings and interior walls. However, some of these buildings collapsed partial or totally due to the existence of a non-rational combination of structural and non-structural elements producing varying rigidities. Figure 3. Some capitals of their columns also failed due to the condition of short column. Figure 4.

A steel curve-like bridge over Rio Aguas Calientes some 30 km. away from the capital on the main road to the Atlantic Ocean failed in its three central parts due to a complete lack of linking among its supports. Besides, several earth slidings along this main road interrupted the traffic for nearly two months after the earthquake.

Considerable damages were also caused at Puerto Barrios on the Atlantic coast, where the dock was completely destroyed.

Losses of the cultural patrimony are beyond any possible valuation. Figure 5.

Coming back once more on the problem of "adobe" old buildings, it was detected that the "adobe" had been kneaded in such a way that frequently they contained pine fibres. The soil used to prepare the mud had generally very few clayey components, thus resulting loose "adobes" with brittle failure. Joints among the adobes were wider than they generally are in other Latin American countries, thus producing an inadequate linking among the elements. Besides these there is the rainy season, beginning in May and lasting four to five months, that causes damages in walls and foundations and leaves them in inferiority of conditions.

Nearly all these habitational units with adobe walls and clay tile covers were destroyed and are responsible for the dead and wounded. Some of these houses suffered important damages in their walls but did not collapse because they had an horizontal frame on top of their walls on which the wooden beams of the roof rested. Undoubtly such wooden frame has behaved as an upper enchaining element making the walls to work as a whole and thus preventing them from failing.

There were also some brick and concrete block buildings with minimum reinforced concrete structure that did not collapse in spite of having suffered some damages.

## CONCLUSIONS :

The damages observed are fundamentally due to the lack of seismic resisting provisions. Down to date of the earthquake the country had not a building code of its own being of application some codes of current use in the United States, such as the ACI-318. When applying seismic resisting provisions there must be a clear distinction of steel, reinforced concrete and masonry buildings from smaller habitational units built with materials of little economical value, for instance "adobe". For the latter there are also the social-economical problems of the population which are claiming for special consideration the same as in all Latin America.

The details given by this paper are the result of observations carried on by the author in April 1976 during the mission commended by UNESCO in order to give advice to Guatemalan authorities about seismic resisting provisions for houses located in rural areas.

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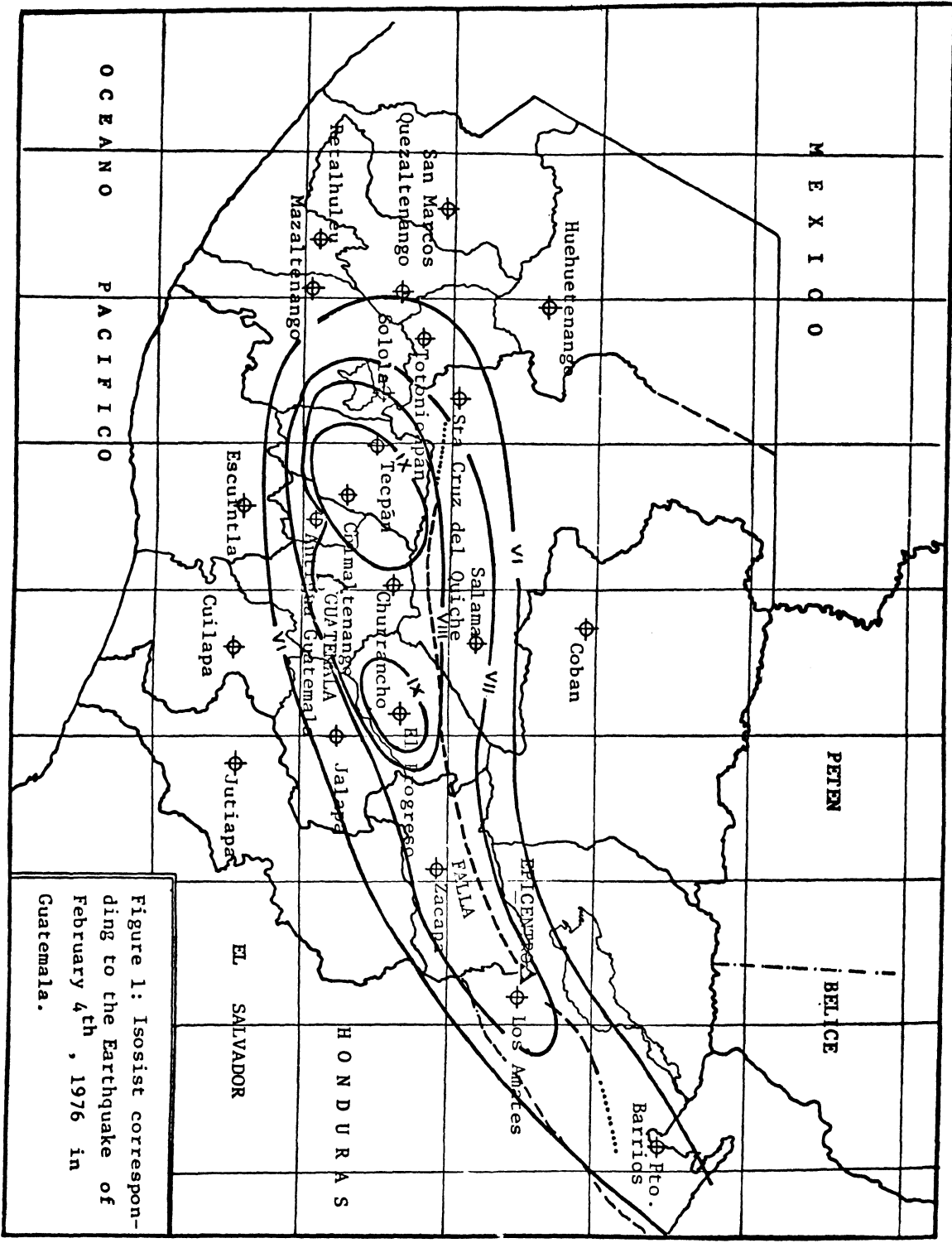


Figure 1: Isosist corresponding to the Earthquake of February 4<sup>th</sup>, 1976 in Guatemala.



Fig. 2 - Failure of adobe made houses.

Fig. 3 -Xavier College  
Failure of its central  
part.

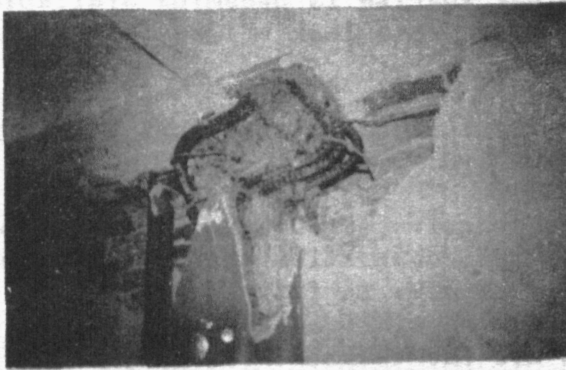
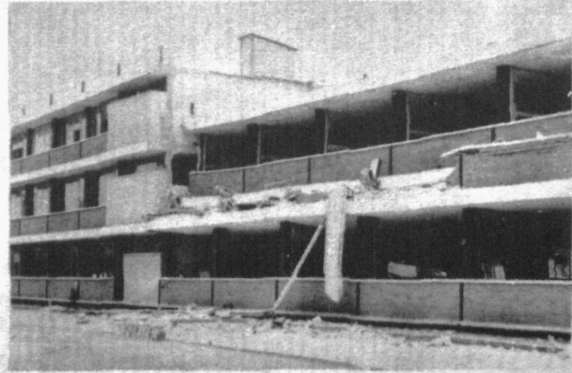


Fig. 4 -Short column- Failure of  
its capital.

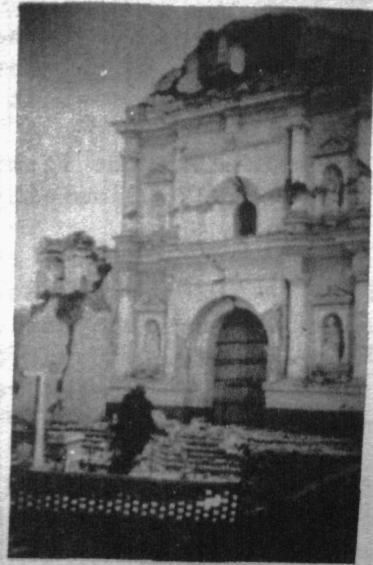


Fig. 5 - Damages in a church