A PRELIMINARY SURVEY OF DAMAGE TO THE COMMERCIAL DISTRICT*

EERI Reconnaissance Team

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INTRODUCTION

The Coalinga earthquake occurred on May 2, 1983, at 4:42 P.M., Pacific Daylight Time. The epicenter is estimated to be in the vicinity of the Oil Fields Fire Station (near the intersection of Highways 33 and 198), approximately 9 miles north-northeast of Coalinga. Preliminary reports indicate the local magnitude $M_L$ to be 6.5, at a depth of approximately 6 miles. Reported duration of strong shaking was about 30 seconds. We estimate the maximum intensity as VIII to IX.

The damage survey team reached Coalinga on May 3, 1983, at 2:00 P.M. The team was dispatched by Dr. Roger Scholl, Technical Director of EERI; Dr. Roger Borcherdt of the U.S. Geological Survey provided the letter of introduction to the local authorities so that the survey team could enter the cordoned-off downtown commercial area.

DESCRIPTION OF THE SURVEY

The survey was conducted by the team members by walking around each block of the central area of the city. Most of the observations were made from outside the damaged buildings. Since the demolition crews were just getting started in removing the heavily damaged buildings, it was necessary to conduct the survey as quickly as possible.

Figure 1 shows a street map of Coalinga. The main commercial district is bounded by 3rd and 7th Streets and Durian and Forest Streets. The center of town is approximately at 4th and Elm Streets.

To properly and rapidly classify the types of buildings and the damage level to each class, the following scheme was adopted:

*Written May 5, 1983

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Figure 1. Study Area.
A. Building Types

1. Unreinforced old masonry buildings
2. Newer brick masonry buildings
3. Concrete block buildings
4. Wood framed commercial buildings (stucco or metal cladding)
5. Cast-in-place concrete with frames and walls
6. Old wood frame residences on cripple walls

B. Damage Levels (in terms of damage ratios)

1. Damage ratio from 0 to 10% (light damage)
2. Damage ratio from 10% to 30% (moderate damage)
3. Damage ratio from 30% to 60% (heavy damage)
4. Damage ratio from 60% to 100% (collapsed or near collapse)

It should be emphasized that building types and damage ratio classifications had to be made hastily. Types were developed after observing the kinds of buildings at the site. Damage ratio classifications were selected by team decision.

A total of 139 buildings were observed. Table 1 shows a summary of the survey results. When looking at this table, the following points should be kept in mind:

1. The survey was conducted just before the demolition crews began work and is approximate.

2. The survey was made only in the most heavily damaged section of the city. Thus, it is biased towards higher damage. The residential parts of the city had much lower damage, but that survey is not included here.
Both the doors of the Fire Station collapsed

Sloshing of the oil caused this tank to fail. Note the wall buckling near the top where the oil has come out
<table>
<thead>
<tr>
<th>Damage Ratio</th>
<th>Old unreinforced masonry buildings</th>
<th>Newer brick masonry buildings</th>
<th>Concrete block buildings</th>
<th>Wood framed commercial buildings</th>
<th>Cast-in-place concrete (frames &amp; walls)</th>
<th>Old wood frame residences on cripple walls</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10%</td>
<td>0</td>
<td>5*</td>
<td>14*</td>
<td>24*</td>
<td>5</td>
<td>4</td>
<td>52</td>
</tr>
<tr>
<td>10-30%</td>
<td>3</td>
<td>7*</td>
<td>2*</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>30-60%</td>
<td>7</td>
<td>1**</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>60-100%</td>
<td>30</td>
<td>2**</td>
<td>0</td>
<td>1***</td>
<td>0</td>
<td>16(a)</td>
<td>49</td>
</tr>
<tr>
<td>Total Number of Buildings</td>
<td>40</td>
<td>15</td>
<td>16</td>
<td>29</td>
<td>6</td>
<td>33</td>
<td>139</td>
</tr>
</tbody>
</table>

*Reinforced brick or block masonry.

**These were new but unreinforced masonry.

***This building collapsed because an adjacent unreinforced masonry building wall fell on it.

(a) Either the residence fell off the foundation or the cripple wall failed, resulting in buckled walls and roof.

**Table 1. Number of Buildings in Various Categories.**
INTERIOR OF A STORE

A FAMILY WHOSE HOUSE FELL-OFF FROM THE FOUNDATION
USES FRONT PORCH FOR PITCHING A TENT AND WATCHING T.V.
3. It was difficult at times to estimate the damage level. In those cases, if visible damage was excessive, the building was placed in the higher damage ratio category. It is quite possible that some buildings that could be repaired are listed in the 60 to 100 percent damage category.

4. It is possible that in the main commercial section, the authorities may decide to demolish all buildings, independent of the level of damage.

CONCLUSIONS

In the downtown commercial area, where many one- and two-story buildings were built before 1930, the predominant building type was unreinforced masonry walls with timber trusses for roofs. These buildings performed very poorly. Relatively newer buildings (reinforced brick or block masonry or reinforced concrete) performed very well with only minor nonstructural damage. Almost all of the structures in the commercial district had at least some damage. The worst damage was noted in old unreinforced masonry buildings in which the mortar was poor and inadequate connection existed between walls and walls, walls and floors, and walls and roofs. The major problem was not in-plane shear failure in walls, but out-of-plane bending failure and connection failure. Several of the old masonry buildings had imbedded steel columns and also steel beams. These buildings did not collapse, but the masonry was severely damaged. It could not be determined whether and to what extent newer masonry buildings were reinforced. None of the exterior walls of such buildings fell over, indicating that they were adequately anchored.

Apart from the general observation that old unreinforced masonry buildings performed poorly and newer reinforced masonry or concrete structures performed well, the following somber observation should be mentioned.
Front masonry walls of this unreinforced masonry building collapsed.

This timber roof and unreinforced masonry wall structure lost its front. The partition walls were still standing.
Coalinga is typical of many older California communities. One can find similar construction materials and structural types throughout the length of the state. What we saw in Coalinga could happen in any older California community. Thus, it is important that we evaluate the kind of damage to different types of buildings. In such a survey, the emphasis is not on whether the construction is poor or not, but rather on knowing the kind of damage that can occur. Proper damage inventory is invaluable in estimating damages to other communities in future earthquakes.

Follow-up studies of personal behavior during the quake should be made in order to explain the low level of injuries. Observations of damage, which included many collapses into the buildings and onto the sidewalks, suggest that there should have been numerous deaths and serious injuries. Were people saved by running into the streets, contrary to accepted advice? Or did they find protection indoors and then crawl out later? The mystery of why so few people were hurt needs to be cleared up so that people can be given better instructions as to how to react to an earthquake.
Building to the left had fire. Both the buildings were unreinforced masonry.

This building was built before 1930. Note the collapsed wall on the left.