

## 7. EARTHQUAKE EFFECTS ON BUILDINGS

### 7.1 General Features and Summary

There were no deaths or serious injuries as a result of structural failures in the earthquake. The structural integrity of the majority of the buildings in the area of strong shaking was not seriously impaired, although significant damage was sustained by a variety of structures. Had the duration of strong shaking lasted a few seconds longer it is likely that a number of structures would have sustained serious damage. As in other recent earthquakes, wood or steel structures generally sustained less severe damage than concrete or masonry structures, although some well designed reinforced concrete structures survived with no apparent damage.

As noted in previous sections of this report, the most intense ground motion apparently occurred west of Santa Barbara near Goleta. Consequently, structures in the Goleta area generally suffered more damage than those in Santa Barbara. Many of the major structures in Goleta are located on or near the UCSB campus. These structures include a number of reinforced concrete shear wall buildings up to 8 stories in height located on the UCSB campus itself (see Fig. 3.2), several large steel frame hangars and a control tower at the adjacent municipal airport (Fig. 1.2), a pair of high rise (10 and 11 story) reinforced concrete shear wall dormitories west of the UCSB campus, and a number of long low rise (1-3 story) commercial buildings north of the campus. The majority of the remaining buildings in the Goleta area consist of conventional 1 and 2 story wood frame and commercial buildings. A considerable number of 1-3 story wood frame apartment buildings and duplexes are located in the area, notably in the community of Isla Vista which borders the UCSB campus on the west side (see Fig. 1.2). Finally, there are several mobile home parks in the area located east, north and west of the campus.

Except for a few old wood frame and adobe structures (mostly farm houses), the buildings in Goleta are relatively modern. The majority of these buildings have been constructed within the last 20 to 30 years. Since 1955, building code requirements for earthquake resistance in the Goleta area have been provided by the contemporary edition of the Uniform Building Code.

The total earthquake damage to structures and buildings on the UCSB campus is currently estimated at \$3.44 million. Of this total approximately \$300,000 in structural damage was sustained. An additional \$2.36 million in mostly minor damage is estimated to have been incurred by other structures in the Goleta area, including some 25,000 housing units. Most of the damage to privately owned structures was sustained by mobile homes (\$1.62 million) and businesses (\$740,000). Of the 148 businesses which were damaged, 68 are apartment buildings with approximately 6 units each. Very little structural damage was sustained by single family dwellings.

The most common structural damage suffered by large buildings consisted of diagonal cracking of concrete shear walls, particularly those aligned along the north-south direction. The most common damage

to residential and small commercial buildings consisted of cracking of plaster walls (particularly in multistory buildings), differential settlement of foundations, the failure of a few unreinforced chimneys, fallen hot water heaters, and broken glass. Approximately 25% of the mobile homes in the area were damaged by the earthquake. Many were knocked from their foundation piers and fell mostly toward the south, rupturing utility connections in the process. Over one-third of the mobile homes in a few parks were damaged in this way. Most mobile homes in the area are mounted on piers without adequate lateral reinforcement. Selected examples of the type of damage sustained by the various structures in the Goleta area will be discussed in more detail later in this chapter.

Structures in the Santa Barbara area display a wider variation of age, architecture, and construction than those in Goleta. However, damage to structures of all types was comparatively minor in Santa Barbara.

There are only 4 buildings in Santa Barbara which are 5 or more stories high, and each is more than 25 years old. (Local city zoning ordinances have prevented the construction of additional buildings over 4 stories or 60 feet in height since 1972.) These buildings vary in height up to 8 stories, and the majority are of reinforced concrete shear wall construction. Several of these major buildings were damaged in previous earthquakes (Steinbrugge and Moran, 1954) and were subsequently repaired. In the present earthquake a number of these buildings received minor diagonal cracks in the reinforced concrete shear walls, particularly in the lower stories. In most cases repairs, when needed, will consist of epoxy injection to rebond the cracked surfaces. An example of a building which suffered slight damage of this type is the Freitas Building at 200 E. Carrillo Street (see Fig. 3.6). This building is well instrumented, as noted in Chapter 3, and 9 strong motion records were obtained from different locations within the building. Another large building which suffered minor damage is the Santa Barbara County Administration Building (see Fig. 7.1) located at the corner of Anacapa and Anapamu Streets, in Santa Barbara. This structure is a nonductile reinforced concrete rigid frame with no shear walls. Minor diagonal tension cracks forming an X pattern were developed in some of the columns on the north side of the building, as shown in Fig. 7.2. The Santa Barbara County Court House (Fig. 3.12), across the street from the Santa Barbara County Administration Building, suffered only minor cracking. Total structural and nonstructural earthquake damage to all public buildings in Santa Barbara was estimated at \$500,000 to \$600,000.

The many smaller old buildings in Santa Barbara, mostly residences, survived the earthquake essentially undamaged. For example, the old Santa Barbara Mission sustained no apparent damage. It is noteworthy that building codes enforced by the City of Santa Barbara have included provisions for earthquake resistance since 1926 as a consequence of the major damage suffered in the earthquake of 1925 (an account of the 1925 Santa Barbara Earthquake is given in Volume XV, No. 4, December 1925, Bulletin of Seismological Society of America). In the present earthquake it has been reported that architectural damage (cracked plaster, broken glass, etc.) to the smaller old buildings in Santa Barbara may have been less severe than that incurred by similar new buildings in this area, which are often more flexible.



Fig. 7.1 Santa Barbara County Administration Building, a reinforced concrete rigid frame structure.

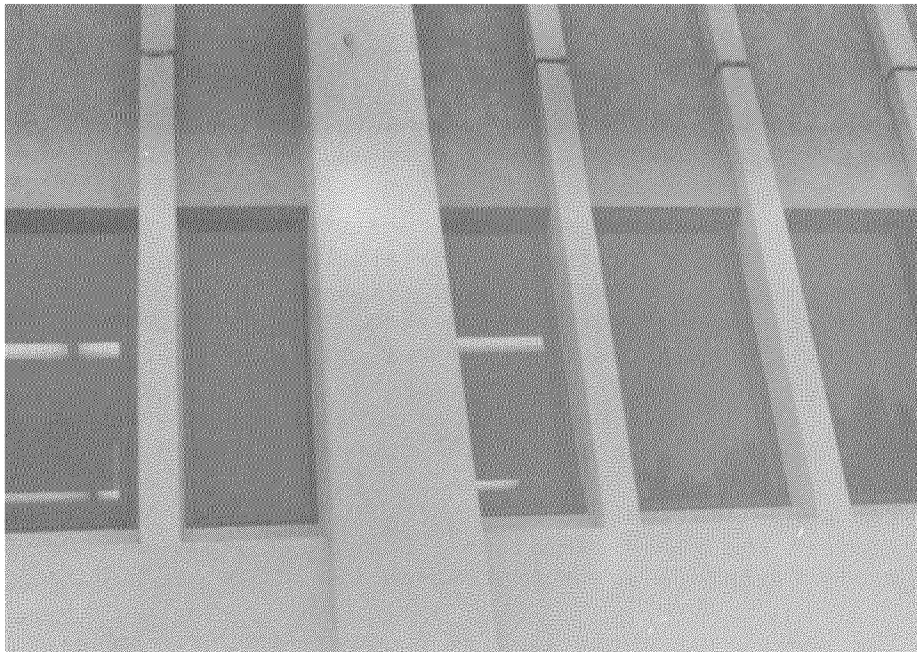


Fig. 7.2 Shear crack forming an X pattern in column in second story of Santa Barbara County Administration Building.