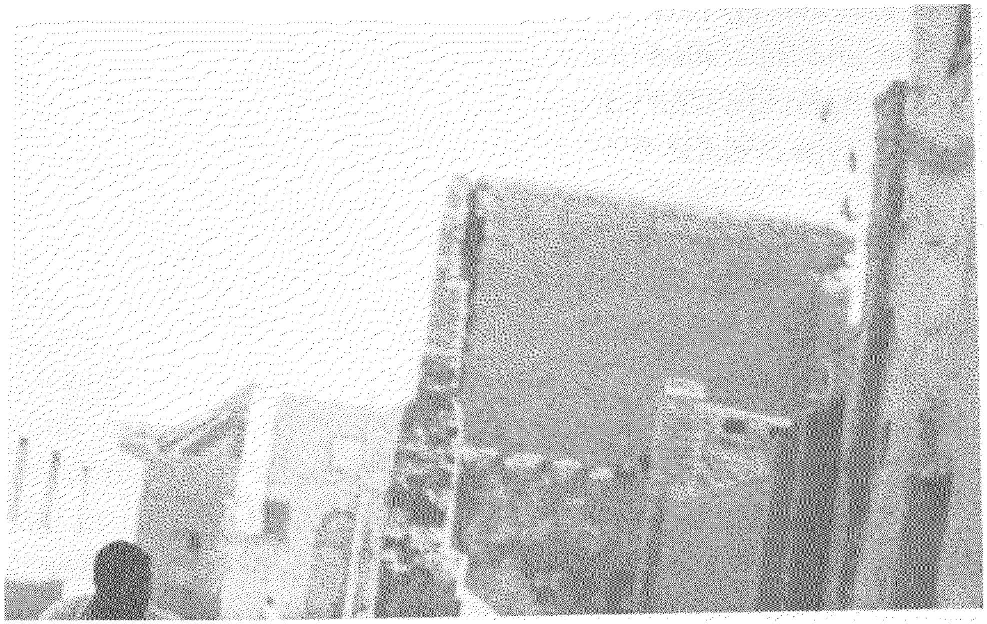

Damage to laterally unsupported walls and vertical cracks at wall connections due to lack of adequate anchorage.

Figure 3-1b: Damage to unreinforced masonry buildings.

the diaphragms, and (4) Lack of adequate anchorage between walls resulted in vertical cracks and separation in the corners at the connection between the walls (Figure 3-1b). Buildings with adequate anchorage in terms of tie-beams did not experience this type of crack.

Monuments. More than 150 monuments throughout Egypt were damaged during the Cairo Earthquake. Ancient Islamic sites in Cairo were seriously damaged. Damage included damage to mosques minarets, cracks at wall connections and wall diaphragm connections, and damage to unsupported parapets. The Valley of the Kings, the burial site of Tutankhamen, and Queen Hatshepsut's temple at Deir el-Bahri in the south, which dates from the 15th century B.C., sustained some cracking. Other well-known tourist attractions that were cracked include the Oracle Temple at Siwa Oasis near Libya, Luxor Temple, and Ramses II's mortuary temple opposite Luxor on the west bank of the Nile River.

3.2 Engineered Buildings

This category of buildings include (1) Reinforced concrete buildings with unreinforced masonry infill walls, (2) Reinforced concrete shear wall buildings, and (3) moment resisting concrete frame or steel frame buildings.

In general, buildings in this category performed well during the October 12, Cairo earthquake. Damage to these type of buildings was due to special conditions, including soft stories, building irregularity, bounding, inadequate detailing, and poor construction materials and workmanship. Examples of these types of damage are discussed below.

Nonductile concrete buildings represent the majority of larger engineered buildings in Cairo. Most of these buildings have not been designed for earthquakes, however. Ductile detailing in the form of beam stirrups, column hoops, joint reinforcement, and development lengths as required by the *Uniform Building Code* is usually not provided in most of these buildings. A high percentage of these buildings have a *soft story*, which represents a serious seismic hazard.

First Stories (or Soft Stories). The ground floor of a building is frequently the weakest part of the structure. Unlike the upper part of the structure, ground floors are seldom enclosed on all four sides by walls capable of resisting shear (or lateral earthquake-induced) forces. Ground floors are also generally taller than upper floors. Ground-floor shops, stores, lobbies, or garages normally allot most of their front wall area to doors or plate glass, leaving one side of the building with no shear resistance. Bending and shear forces induced by strong ground shaking are therefore concentrated in the ground-floor columns. The lack of ductile detailing usually contributes significantly to failure of this soft story.

Among the most catastrophic collapses was the 14-story nonductile concrete building in suburban Heliopolis (about 25 km from the epicenter) where an estimated 61 people were killed (Figure 3-2). It was the only multistory building failure or *pancake* collapse in Cairo. This building was of nonductile concrete construction with a soft story (the building was built about 1986), and had a water tank on the roof (about 30 cubic meters of water). It appears that excessive deflection of the building caused collapse as column-beam connections failed. As collapse began, the impact load of each floor slab striking the ground or the floor below added to the overload and culminated in total collapse. Inspection of the concrete indicated that it was of poor quality. Nondeformed bars were used in this building, which contributed to the low bond between the steel and concrete.

High-rise Buildings. In general, high-rise buildings in Cairo performed well during the earthquake. Most high-rise buildings are located on both sides of the Nile River. Figure 3-3 shows a set of concrete towers (in the City of Maadi about 15 km from the epicenter) that are 42 stories high. Each tower is supported on 36 concrete columns on a pile foundation about 25 meters deep. These towers performed well during the earthquake, only sustaining nonstructural damage as shown in Figure 3-3.

Figure 3-4 shows nonstructural horizontal cracks in a 14-story concrete building, and Figure 3-5 shows a 30-story concrete shear wall building, both in the city of Maadi. The 30-story building has an irregular, staircase shape and sustained a vertical crack (about 2 centimeters wide, between the concrete shear wall and the URM infill wall) at the corner of the third step, as shown in Figure 3-5.