FIGURE 6-7 Cracking At A Valve Box Wall

break in a 42"$\phi$ pipe. Although the CAVM aqueduct damage was similar in many respects to that which occurred in the D.F. aqueduct, the number of leaks were significantly lower. The damage was due to seismic wave propagation in soft ground conditions. The leaks or breaks typically occurred at joints in the large diameter prestressed concrete pipe. In addition, joints near T or elbows junctions appeared to have a somewhat higher probability of damage compared to joints in long straight runs of segmented pipe.

The difference in the number of breaks between the CAVM aqueduct and the D.F. aqueduct is primarily due to location and orientation. Although both aqueducts are located in the southeastern region of the metropolitan area the CAVM aqueduct generally runs East-West and skirts the south side of the Cerro de St. Catarina, while the most heavily damaged portion of the D.F. aqueduct runs thru the town of Tlahuac.

### 6.1.3. Analysis of Transmission Systems Damage

As mentioned above, the 1985 Michoacan Earthquake damaged aqueducts in the southeastern region of Mexico City but did not significantly damage aqueducts in other parts of the metropolitan area. Ground motions recorded in the valley south of the Cerro de La Estrella indicate large ground displacement amplitudes as well as significant local variation in displacement amplitudes. This is most probably the reason why transmission system damage was concentrated in the southeast part of the metropolitan area. Other contributing factors are ground subsidence and prior repairs. These contributing factors, however, are applicable for all the aqueducts in Mexico City and hence do not by themselves explain the concentration of damage in the southeast.

Figure 6-8 shows the two damaged aqueducts located between the Cerro de la Estrella and the Cerro de Santa Caterina to the north and the Sierra del Ajusco to the south. An approximate elevation view is shown in figure 6-9. Tlahuac, which is considered to be in the Lake Zone, is located in the valley between these two groups of mountains. There were two seismographs located in Tlahuac; one at a pump station (Tlahuac Bombas, TLHB) and another at a sports club (Tlahuac Deportivo, TLHD). Two other Lake Zone seismographs were recorded north of the Cerro de la Estrella and the Cerro de Santa Catarina, at

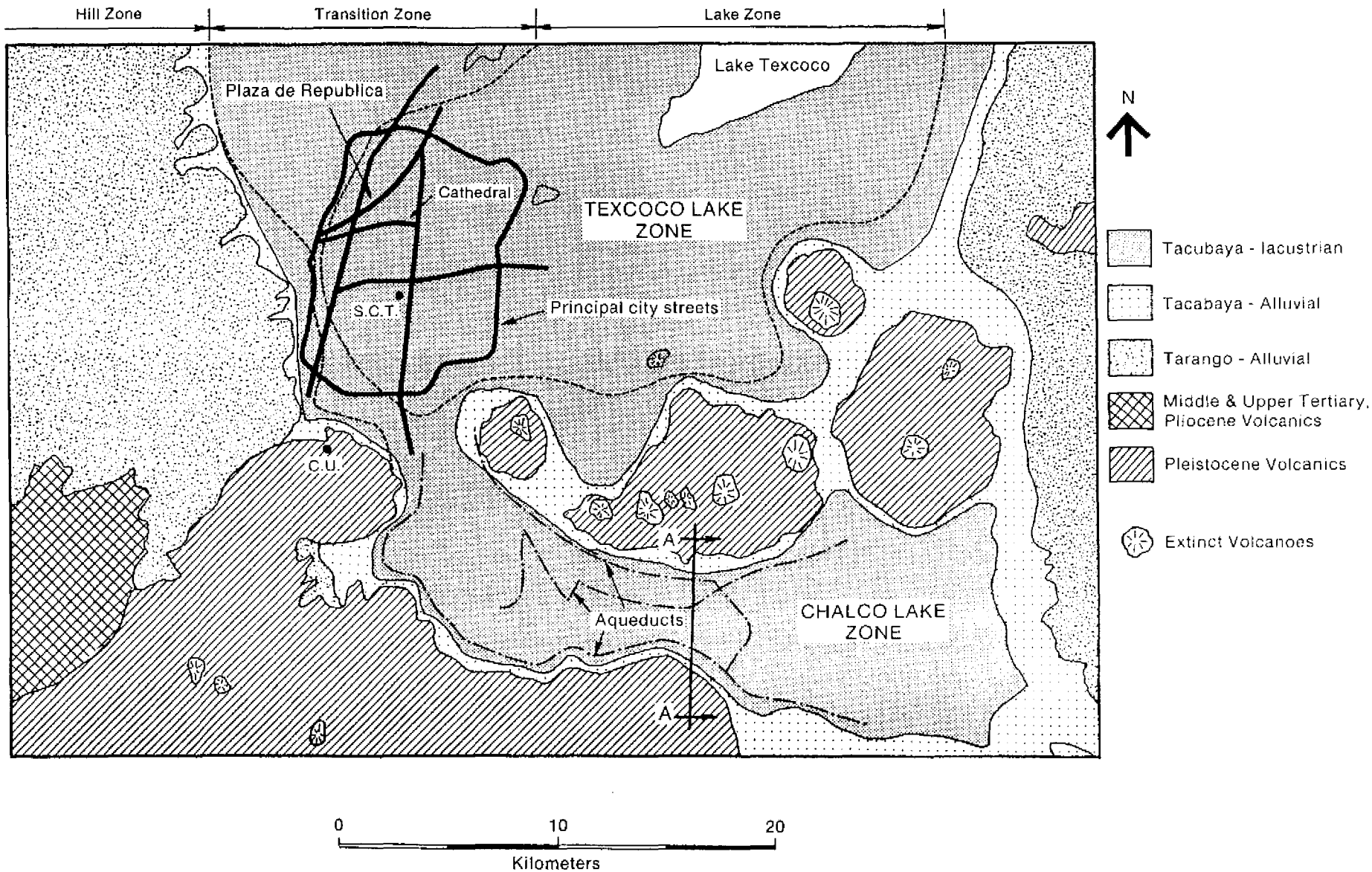


FIGURE 6-8 Location Of Damaged Aqueducts With Respect To Surrounding Mountains

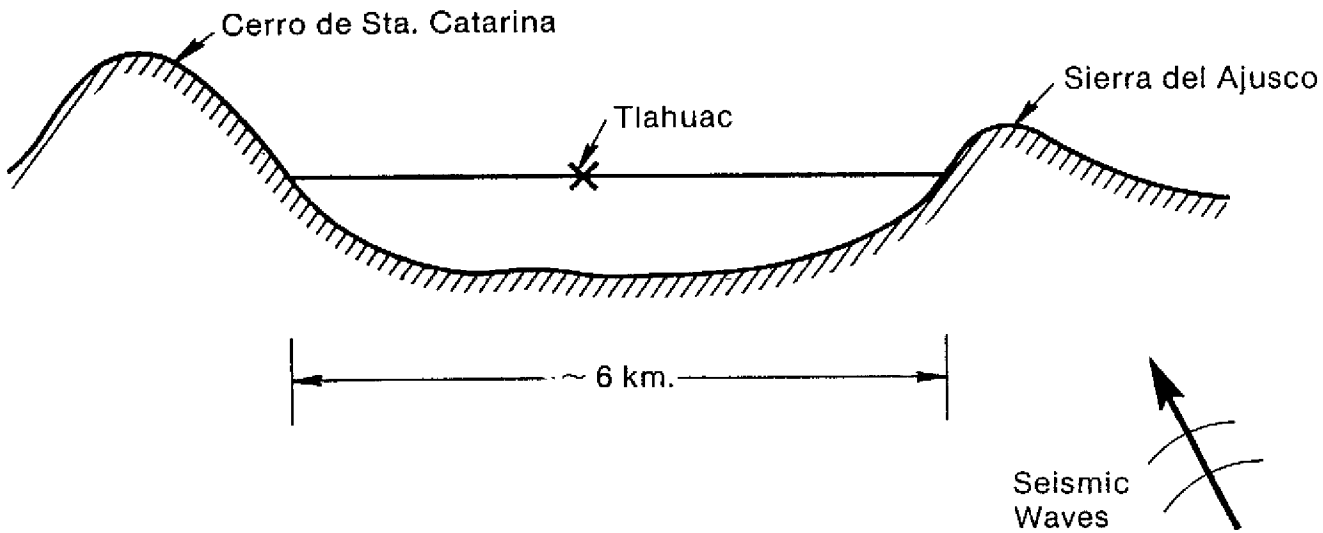


FIGURE 6-9 Idealized Elevation View Showing Tlahuac

Central de Abastos. As shown in table 5-I, the peak horizontal ground displacement at TLHB were the largest recorded in the Valley of Mexico.

The TLHB peak ground displacements were roughly 1.5 times larger than the next largest which were recorded at Central de Abastos. That is, during the 1985 event, the area of aqueduct damage experienced the largest recorded ground displacements.

Another important factor is the large local variation in ground displacement near Tlahuac. Tlahuac Bombas and Tlahuac Deportivo are separated by about 3 km. Yet the horizontal ground displacements at THLB were roughly double those of THLD. This difference is shown graphically in figures 6-10 and 6-11. The North-South ground displacement time histories at THLB and THLD are shown in figure 6-10 while the East-West components at the two stations is shown in Figure 6-11.

It is the authors belief that the local topology of this valley containing Tlahuac resulted in large ground displacement amplitudes as well as fairly severe local variations in ground displacement amplitudes. These factors in turn lead to the transmission system damage.

There were, however, other factors which may have contributed to the aqueduct damage. These are:

a. The zone where the aqueducts are located is rapidly subsiding due to abatment of the water table. It is common to find ground cracks due to land subsidence in this area. As a result, buried pipeline in this region are subject, over time, to nonearthquake induced deformation. Hence the ability of the joints to accommodate earthquake induced deformation is reduced somewhat. Subsidence is discussed in somewhat more detail in Section 6-4.
b. Leaks frequently occur at joints due to the subsidence induced deformation of the soil around the aqueducts. In most instances repairs are made using steel saddles, as shown in figure 6-12. Such repairs drastically reduce the flexibility of the repaired joint. As a result the adjacent unrepaired joints would be subject to somewhat higher seismically induced joint deformation because

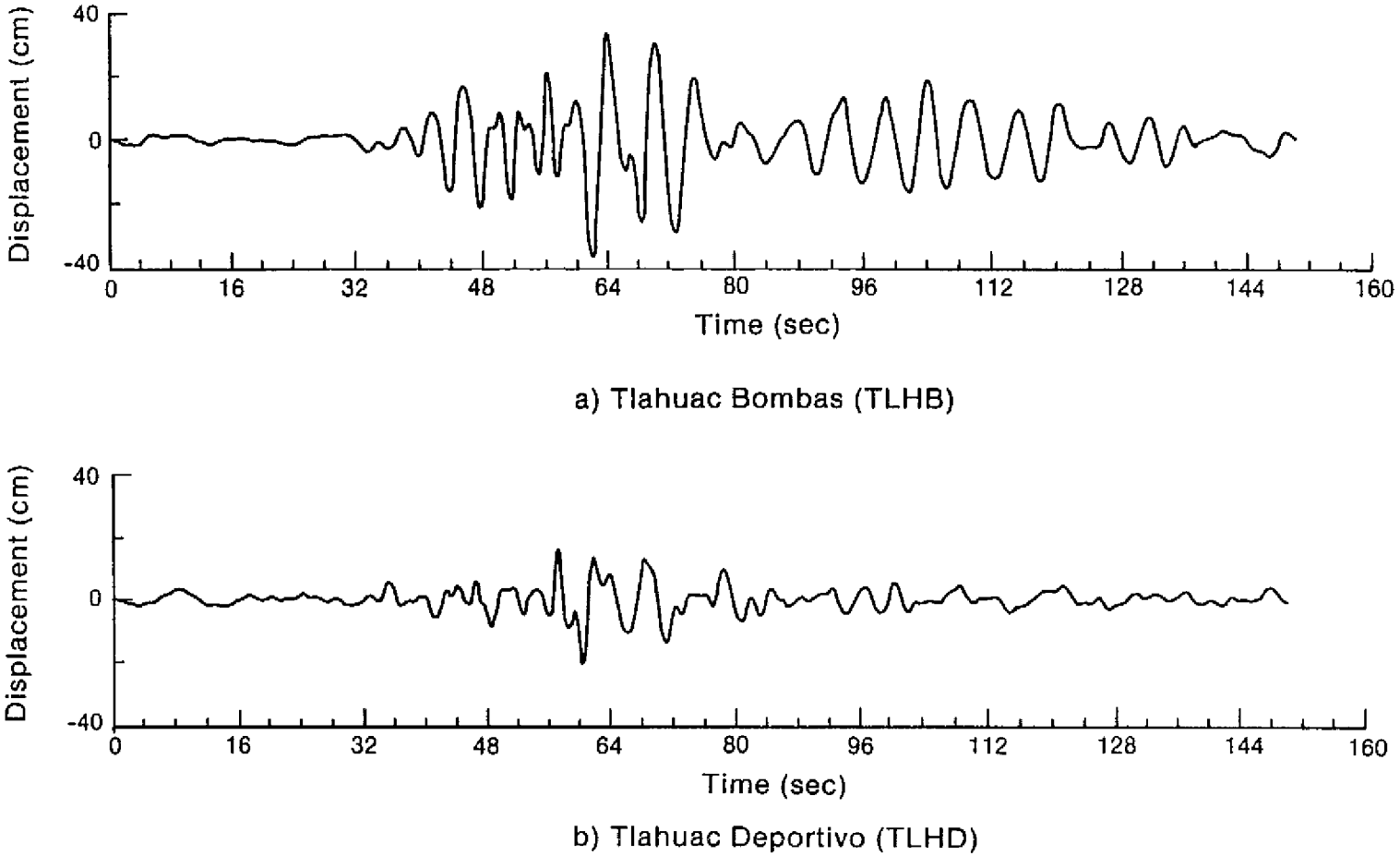


FIGURE 6-10 North-South Ground Displacement Time Histories At Tlahuac - 1985 Michoacan Earthquake