

THE EARTHQUAKE OF 23 NOVEMBER 1977
IN CAUCETE, SAN JUAN, ARGENTINA

(Preliminary Report of the Working Group of the
Institute of Antiseismic Investigations:
Ing. Aldo Bruschi)

In the morning of the 23rd of November 1977 at 6:28:30, half an hour before schools and offices opened, a violent earthquake struck the central and southern regions of the Province of San Juan and northern part of the Province of Mendoza, in the western part of Argentina.

The vibrations were felt inside buildings in four South American capitals: Santiago, Chile (300 km), Buenos Aires, Argentina (960 km), Montevideo, Uruguay (1200 km) and Asuncion, Paraguay (1250 km) and were also felt in tall buildings in Puerto Alegre and San Pablo, Brazil at a distance of more than 2000 km. The most important town that experienced fatalities and serious damage was Caucete, located 30 km east of the city of San Juan, and minor damage extended to some buildings in the city of Cordoba approximately 400 km east of Caucete.

The number of casualties in the Province of San Juan reached 75 and the number of injured was somewhat greater than 200. The ratio of casualties to population was greatest in the locality of Bermejo, 60 km to the east of Caucete.

In the area surrounding Caucete a considerable number of constructions either collapsed or suffered severe damage. Among these were dwellings of adobe and masonry without reinforcement, recently constructed school buildings with earthquake resistant provisions (these were not occupied at the time of the earthquake), and some old and new

wine storage buildings of masonry, reinforced concrete, and steel plate, causing the loss of about 10,000,000 liters of wine. Also damaged were small railway stations of unreinforced masonry and the control tower of San Juan Airport which was approximately half way between San Juan and Caucete.

Liquefaction of the soil occurred in an area of approximately 1,000 square kilometers affecting vineyards, irrigation canals, roads and railways. There were also large earth lurchings on roads located alongside large drainage ditches which produced deep longitudinal cracks in the roadway. An idea of the intensity of shaking that occurred in the epicentral area is given by the overturning of most of the freight cars of a train which was running at the time of the earthquake through the epicentral area, 10 km west of Bermejo. However, almost all dwellings of one or two stories with seismic resistant provisions had practically no damage, thus demonstrating once again the great advantage of adequate connecting and bracing with columns and beams of reinforced concrete to tie wall panels of masonry made of brick, hollow brick, or concrete block, making them suitable elements for resisting and transmitting earthquake forces.

The Modified Mercalli Intensity was estimated to be slightly greater than IX in Bermejo, almost IX in Caucete, between VII and VIII in the city of San Juan and between VI and VII in the city of Mendoza.

The city of San Juan and the surrounding area was destroyed by a magnitude 7.8 earthquake on 15 January 1944, with almost 10,000 casualties. However, the damage occurring now in the affected area was greater but of almost the same nature as the damage incurred during the earthquake of 3 July 1941.

amplitude of 2.4×10^4 mm which, with a correction factor of 3 for distance, gives a magnitude of 7.5 on the Richter scale.

The November 1977 earthquake operated a group of seismoscopes and accelerographs that were installed in the Provinces of San Juan and Mendoza. The seismoscopes located in the city of Caucete (Figure 1) went slightly off scale, thus reaching a displacement slightly greater than 0.5 radians. This instrument was installed near the Vieytes School by the Institute of Antiseismic Investigations. One room of this school collapsed even though it had been designed to be earthquake resistant. These seismoscope records have the largest amplitudes recorded in South America up to now. Other seismoscopes installed by the Institute of Antiseismic Investigations recorded amplitudes of 0.26 in San Juan and 0.30 in La Rinconada, approximately 20 km away to the south. The seismoscope located at the Center for Engineers, Architects and Surveyors in Mendoza, located 150 km south of Caucete, reached an amplitude of 0.10.

The accelerometers installed by the Institute of Antiseismic Investigations in San Juan recorded a peak acceleration of 0.17g in the east-west component and almost the same in the other horizontal component. The vertical component had a peak acceleration of 0.08g. The accelerograph located in the Center for Engineers, Architects and Surveyors in Mendoza, 150 km away, recorded a peak acceleration of 0.07g approximately.

The record of the accelerograph located in San Juan began with small vibrations which lasted approximately 9 seconds before the strong waves arrived. Using this as the difference between the times of arrival of the P and S waves indicates that the focus of the earthquake was not less than 70 km from the city of San Juan.

The east-west component of the San Juan accelerogram was digitized and the response of a Wood-Anderson seismograph (2400 amplification, 0.8 damping and 0.8 natural period) was computed to have a maximum trace

ness and strength provided by masonry walls constructed in accordance with the building practice and materials of the region. This conclusion

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amplitude of 2.4×10^4 mm which, with a correction factor of 3 for distance, gives a magnitude of 7.5 on the Richter scale.

In Figure 2 there is shown the response spectrum calculated from the east-west component for 5% damping. The corresponding maximum response of the seismoscope located adjacent to the accelerograph is also shown.

Damage in the city of San Juan was in general minor. In multi-story buildings the damage was mainly to interior partition walls. There were a few cases of important damage, the most significant of these being the School ENET No. 2 in which there was a permanent displacement in the east-west direction of 4 cm in the first story, with some evidence of damage to the tops of the columns.

125 Among the modern public buildings in Caucete the most significant damage was that sustained by the Banco de San Juan building. Among the school buildings constructed to resist earthquakes, the most severe damage observed was that in the Normal School of Caucete which partly collapsed, and in the Vieytes School in which one room collapsed. Among the industrial buildings in the area of strong shaking the most severe damage was sustained by wine storage buildings, an example of which was the complete collapse of the reinforced concrete containers resting on reinforced concrete columns of the Bodega Segura shown in Figure 3. There were also a number of collapses of cylindrical steel tanks for storing wine. Throughout the area, strong shaking collapsed water supply tanks attached to dwellings.

From the observations of damage in the city of San Juan and in Caucete the primary conclusions that can be drawn are the benefits of stiff-

ness and strength provided by masonry walls constructed in accordance with the building practice and materials of the region. This conclusion cannot be applied to other areas of the country. Another important conclusion is that for reinforced concrete structures it is necessary to review in some cases the assumed value for ductility, because it appeared that some structures reached failure with only a low value of ductility, which was especially observed in cases where the walls and upper windows have formed so-called short columns.

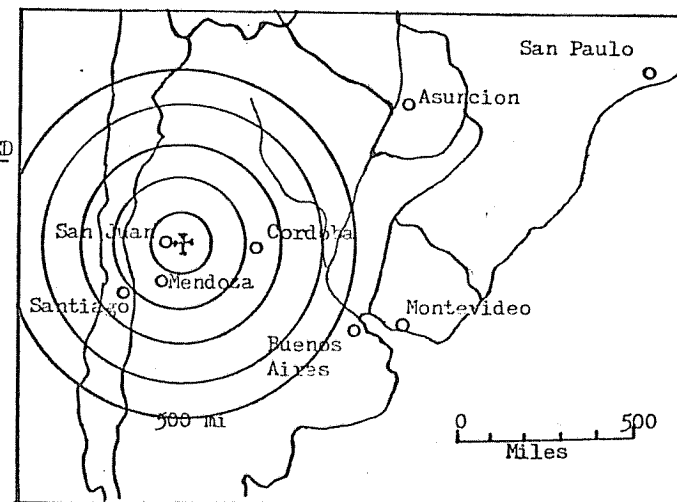
Figure 2 also shows a design spectrum that had been recommended by the Working Group of the Institute of Antiseismic Investigations to the subcommittee of Seismic Forces of the Committee of Structures of the Argentine Institute of Rationalization of Materials (IRAM). This spectrum corresponds to a ductility of 1, and it is the pseudo-acceleration response curve for 5% damping and a confidence of 84%.

San Juan, 28 November 1977

Juan S. Carmona, Director

(Translated from the original Spanish at the Earthquake Engineering Research Laboratory of the California Institute of Technology)

MAP OF REGION AFFECTED
BY THE EARTHQUAKE



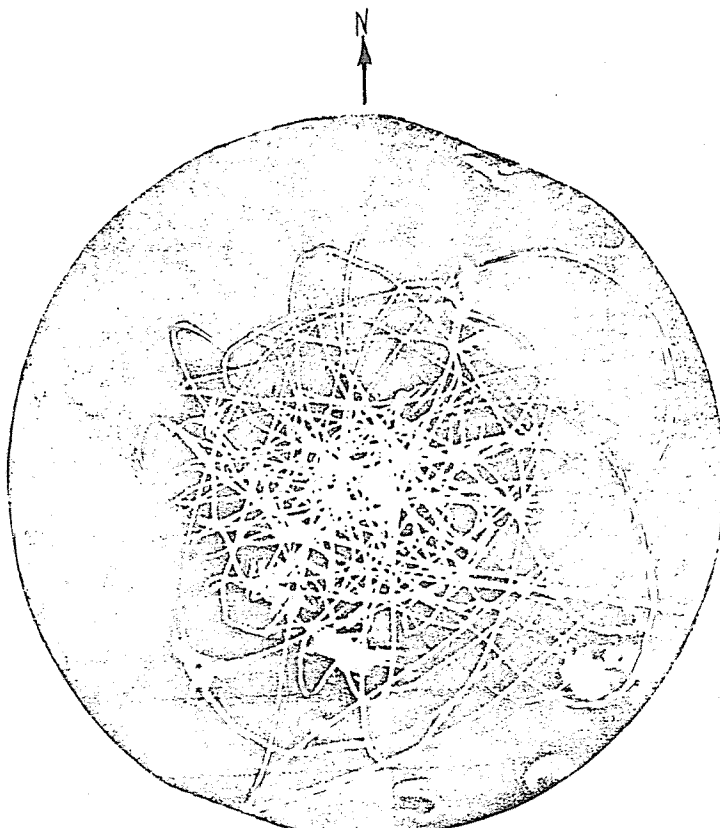


Figure 1.

Seismoscope record from the town of Cauçete.

Figure 3. Not reproducible.

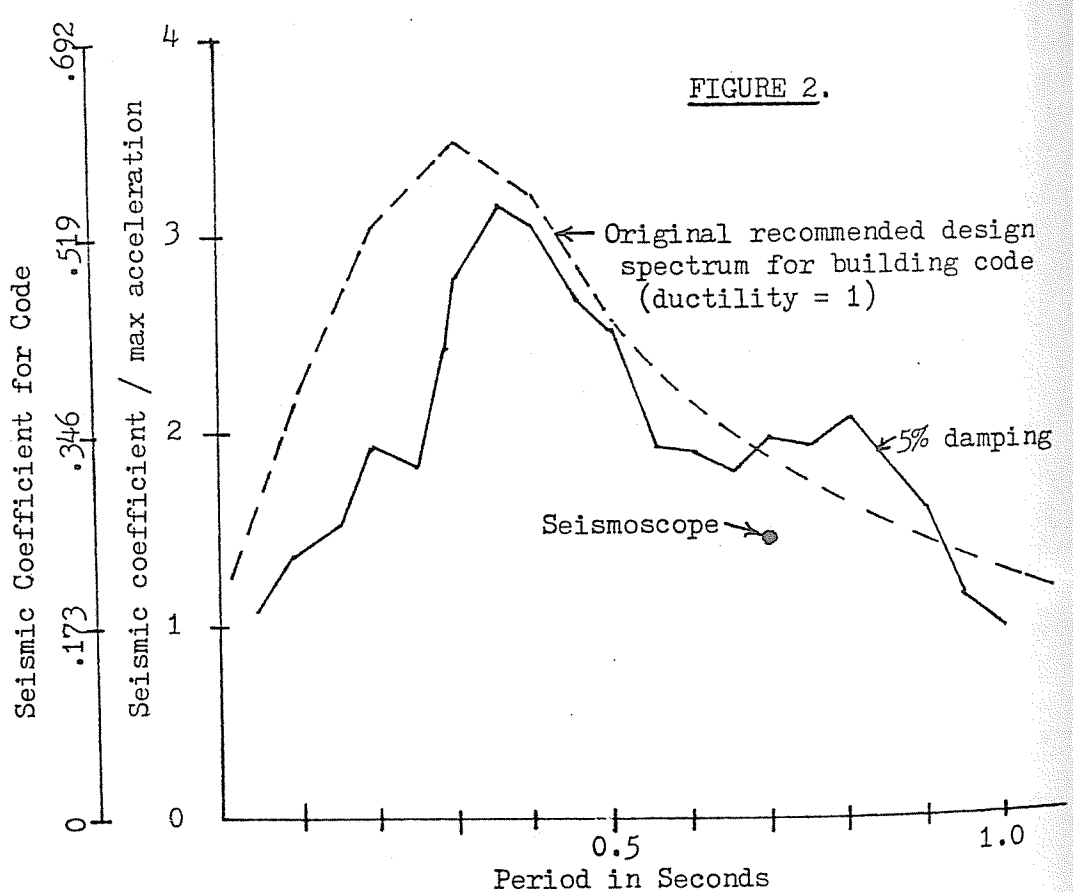


FIGURE 2.

Response Spectrum Calculated From San Juan Accelerogram
November 23, 1977

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