At 4:45 p.m. Monday, May 2, 1933, an earthquake which registered 6.5 on the Richter scale struck the rural oil and farming community of Coolinda, California (Fig. 1). The earthquake destroyed the central downtown area and seriously damaged 563 of the 2200 homes in the area. This was a disaster that was unexpected and caused devastation throughout this small farming community. There was a miracle, the miracle was that no deaths occurred. It was reported that approximately 45 people were injured, but only one seriously.

In surveying this devastating earthquake, it came to mind that here was the 1933 earthquake of Long Beach, California, all over again. The size of the earthquake, 6.5 on the Richter scale, was approximately the same that hit the city of Long Beach in 1933. The devastation, the collapse of buildings, the falling of unanchored masonry walls was seen in Long Beach (Fig. 2) as well as in Coolinda. The old, unanchored masonry buildings suffered much damage throughout the downtown area called Coolinda Plaza. These buildings were the viable merchandising center for the community. They were constructed in the early 30s and were built of quality masonry for that time. Face brick, bond patterns, fancy and skilled detail were used in the bricklaying of these walls. However, there was no reinforcing, lime mortar was used and the floor systems and not diaphragms were not invariably secured to the walls.

The general downtown area suffered major devastation from 4th Street to 7th Street and from Forest Avenue to Durham Avenue. This was the area that was well secured by police and highway patrol (Fig. 3).
Coolinga. Other buildings were evaluated and, depending on their conditions, were ruled safe or not. This provoked merchants with opportunities to maintain their business or carry on limited business if the buildings could not be entered by the public at all times.

Underground water pipes and gas lines were damaged. The National Guard set up distribution points to supply fresh drinking water. Gas lines were secured throughout the area and people were notified to turn off the gas lines in their homes due to potential leaking of gas in rupture lines.

Old Masonry Buildings Toppled

The similarity between the 1933 Long Beach earthquake and the Coolinga Quake of 1983 is the severe damage to the old, unreinforced masonry buildings. These multi-story brick structures constructed with little mortar and no reinforcing and only government anchor ties to the roof or floor system suffered damage from the susceptible collapsing, waves of the masonry walls peeling off, cracks in windows collapsing, and interesting corners falling.

Much of the damage to unreinforced masonry buildings was in the Coolinga Plaza, which is the central shopping business district. Other unreinforced masonry buildings that suffered damage were along Forest Avenue. Businesses such as a Mexican food restaurant, Poe's Automotive Parts and Garage, and the Youth Center (Fig. 6).

Close inspection of connection details indicated that government anchors, the large concrete perimeter block going from a jut through the brick walls with a plate on the front, were installed approximately every four to six feet. These government anchors maintained some integrity between the wall system and the floor system.

The State Theatre building is an old, unreinforced concrete masonry building constructed in the 1930s. Suffered masonry building was in the area of the State Theatre building. Buildings knocked down the high scenery loft and then the front of the building.

Contrast — Old and New

In Coolinga Plaza there was a dress shop in an old, unreinforced masonry store on the west side of the street.
Modern Masonry Performs

One of the many lessons that was learned from this earthquake is that buildings constructed in accordance with the techniques of present-day design and construction are performing. Modern masonry structures, reinforced and well tied together withstand the vigrants of this serious earthquake. It was reported that the ground acceleration was approximately 0.5g and that there were no significant undulations or uniform earthquake waves.

There were a number of modern masonry buildings that performed extremely well, such as State's Market (Fig. 11). John Kandels, structural engineer of Pasadena, reported that the equipment on the roof was displaced and moved around, indicating that the building was subjected to very high seismic velocity, but the masonry walls came through unscathed.

The L&M Equipment building, still in operation, performed well, as did the hardware store on Forest and 5th. Whereas the Trinity Drug Store (Fig. 12) suffered serious damage at the suspended ceiling, however, the main concrete masonry building performed very well.

Government Buildings

The government buildings performed extremely well, such as the Department of Motor Vehicles (Fig. 13) and the Forest Fire Station building of four-inch high concrete masonry units.

One of the very fine buildings was the police station. This was in the heart of downtown, and the inquiry to the desk sergeant indicated that they had suffered serious damage of bookcases thrown over, desks moved around, and disruption of equipment; however, there was no damage to the building itself. Personal inspection confirmed this statement (Fig. 14).

The concrete block fire station garage next to the main coast-in-place concrete building performed very well, as did the local library of reinforced grouted brick masonry.

The West Hills College of reinforced grouted brick masonry (Fig. 15) was a prime example of fast rate masonry performance. These grouted brick buildings subjected to the same ground acceleration and seismic velocities as other buildings in the area had no damage. There was cracking around the ceilings of the wall lines, and that was all. The performance of reinforced, grouted brick masonry demonstrated well its capability of resisting earthquakes.

Chimneys and Fireplaces

One of the distressing features of this earthquake was the performance of the un-reinforced, un-chinked chimneys. These chimneys broke off at the roof line, they fell through the fireboxes, or they peeled away from the buildings themselves (Fig. 16). When the chimney was well anchored and reinforced, it did perform.

The anchored masonry veneer did not perform too well because of the way it was secured. The corrugated tile (Fig. 17) did not anchor the masonry veneer, which pulled away from the wall. Another of the fireplaces damaged throughout the area, as shown in B.I.O.'s Iron Works on Forest Avenue. At the Brazos...
There were two tank frames with three tanks in each. Luckily, they were empty and therefore did not suffer a compression elephant foot failure around the base or collapse due to weight of contents. However, all tanks at each location displaced approximately 8° (Fig. 18) and broke some of the piping attached to them. An elevated water tank behind the fire station also suffered distress. Approximately three cross-bracing rods were broken and the rest were very slack. It was a benefit that the tank itself was empty and thus was not subjected to as much stress as would be if it were full. The column broke also slid approximately 8-inch near each leg of the elevated tank.

Trailers
The Fairview Mobile Home Park on Thompson Street suffered much damage. The trailers were up on small shear metal pedestals and these pedestals collapsed or turned over and the trailers dropped approximately 18 inches (Fig. 19).

Homes
There were many warning signs posted on residential homes. These 'homes' were built in the 1950s and 1960s and were supported off the foundation on 4 x 4's cripples about 12" high. The ground motion caused the buildings to rock back and forth and collapse just like dominoes. The cripples gave way and the buildings all were displaced.

Fig. 18. Fuel tanks moved approximately eight inches.

Fig. 19. Approximately 80% of the trailers were displaced off their light steel gages with collapse.

Fig. 20. Home collapsed in the earthquake. (Fig. 20). In addition, many water pipes and gas lines to the homes were broken or fractured. These homes suffered chimney damage as well as displacement and falling away from the porches.

There were several very old concrete block houses with heavy concrete blocks, these suffered severe damage. Luckily, no one was killed, and the houses had to be torn down later.

P.G.&E. Power Station

Fig. 21. P.G.&E. Substation A Warehouse — un reinforced concrete Masonry Power Station showing diagonal cracks in plane failure.

On the outskirts of town at Herred and Jayne Avenue, the P.G.&E. Substation Warehouse was located. This old, small, unreinforced masonry building was significantly damaged (Fig. 21). In-plane forces were acting, causing high diagonal tension tears in the unreinforced wall. The significant ground accele rations imposed high loads upon this building.

Lessons We Have Learned
We have progressed a long way from the construction of the 1920s and the early 1930s of unreinforced masonry buildings, and should not be too critical for they have performed well for over 50 years. Even now with the damage they suffered, no one was killed. The buildings will be taken down and replaced with modern masonry, which proved to perform very well.

As we evaluate these buildings, it is evident that reinforcing steel is required to both resist the forces for overturning and out-of-plane sway-wang and also for in-plane horizontal shear forces. Buildings that are well reinforced horizontally performed very well while those that did not have horizontal reinforcing were subjected to damage.

We have also observed that newer anchorage must be improved. Corrugated metal ties do not hold the masonry. Adequate anchorage to the supporting wall (Fig. 22), where lateral forces were performed well as it is light, and with adequate admixture, did not cause any problems.

One thing that is continuously stressed is connections. Adequate connections between the roof diaphragm, the floor, and the walls are important. Where connections in weak diaphragms give way and walls fail, tripping the diaphragms to walls not only gives in flexibility and continues to a building, but it also keeps the building from being distorted and being damaged.

Fig. 22. J.C. Penney building — gable walls pulled tea from cast-in-place concrete piers collapse.

Ties around anchor walls are important, as shown in the J.C. Penney building (Fig. 22), where load transfer walls were pulled out of the cast concrete piles. Current requirements call for 3 or 4 ties to be immeasurable to tie the anchor bolts to the main reinforcing. Connections of tying to tripping must be improved. This is shown were the corrugated asbestos wall torn off the unreinforced gable frame in the Union 76 warehouse (Fig. 23). Better details, either flexible or rigid, are needed to ensure that the siding does not fail off.

Conclusion
We have learned much from the earthquake and it gives us confidence that the design and construction that is currently required is the right decision. We have improved the design and construction of our buildings to the point that, in a future earthquake like this, there were no fatalities and very few people were seriously hurt.

It now behooves us to consider improving our design and construction to reduce the damage to the buildings. However, this is similar to buying insurance: the amount of reduction in damage is proportional to the cost of construction. Under major earthquakes survival is all that is demanded. Under small or medium earthquakes, not only survive but minimal damage is desired.