

GUATEMALA EARTHQUAKE OF FEBRUARY 4, 1976

SUMMARY OF IMPRESSIONS BY F. R. PREECE

DURING EERI TRIP OF FEBRUARY 6 THROUGH 12, 1976

There appeared to be some buildings that were designed to SEAOC concepts of ductile moment resistant concrete frames that had no damage. If this is true, then we should get plans and make an attempt to analyze them in detail. Especially if it is also true that this is a "major earthquake".

Where there was a conscious effort made to keep in-fill brick partitions isolated free of the structure, there was no damage to structure nor partitions nor glass.

Most of the larger buildings if irregular in plan were separated into regular symmetrical and rectangular units by carefully designed separation joints. This undoubtedly helped the performance of those buildings.

4. The absence of any power ventilation, heating or air conditioning is the consequence of the marvelous spring-like weather. This means that the normal large openings for ducts and pipes for mechanical equipment just aren't there. It certainly simplifies the design and construction of the buildings and improves their quake performance in some immeasurable manner.
5. The seismologists must content themselves with largely speculative discussions as must the structural engineers because of the absence of strong motion records. However, there is plenty of real evidence for the geologists and geophysicist, such as a beautiful long major fault and plenty of landslides! It should help clear up some questions relative to interactions between the Caribbean, Cocos and America's tectonic plates.
6. The architecture-structure interaction lessons are obvious and it is high time the architects start learning on their own that earthquakes may require more energy absorption from the cladding than from the structure if not consciously designed to be free of the structure.
7. The influence of the depression years (30's and 40's) appeared to have a positive beneficial effect on governmental buildings. The long-term of the then President for 14 years may have also influenced the construction of large monumental public works buildings of reinforced concrete and stone much like our own public works projects during the depression years. They performed beautifully, no damage and maintained their function throughout the quake and afterwards. The National Palace, The Church at General Hospital, the National Police Headquarters, the Church of Maria Theresa, the Central Post Office are examples of this type of building.

3. Registration in Guatemala is controlled by the Colegio De Ingenieros which is pretty much made up of graduates of Universidad de San Carlos de Guatemala. There are about 1300 registered in all disciplines of which 2/3 are general civil engineers and about 30 specialize in structural engineering for buildings.

9. Building plan review is done by the City Building Department for which they charge a plan checking fee. This fee goes into the general fund. They are consequently understaffed and primarily check planning and siting. There is great reliance placed on the registered architect and/or engineer for design. The Building Department makes little if no inspection during construction. As is the case elsewhere in the world, there are many ways of planning, designing, financing and constructing a building. Different combinations of architect, engineer, contractor appear for each building. The engineering community pretty well knows who is taking liberties with accepted practice and there are subtle pressures attempted to keep them in line. In general, the practitioners are well aware of and use the SEAOC Earthquake Recommendations (Blue Book) and because of the 1917 quake, there seems to be a conscious effort to keep building units separated and to have regular uniform structures.

I asked for a copy of the Building Code at the City Hall. The inquiry was made through Averel Lemus, who had worked there for 9 years. However, it appears the old one is out of print and the new one has not been adopted yet.

0. The buildings appear to be more conservative in design than those in Caracas and Managua with larger columns and fewer buildings trying to perform "acrobatics". Of course, there are only a few high-rise buildings; I counted only about 30 on the skyline over 4 stories when I looked over the valley from the mountains southwest of the City.

11. After Shocks

I felt 4 shocks during the night of February 6th; 3 the night of February 7th; 3 the night of February 8th; one the night of February 9th, and one at dinner the evening of February 11th at our farewell dinner. I would say the intensity of shaking was Richter II to IV and duration from 5 to 10 seconds. We occasionally felt quakes during the day also when sitting still. Obviously, we missed many while we were in motion.

On two occasions at night I would be awake, hear dogs barking and begun to wonder if they were aware of small quakes that I could not feel when suddenly the shock would arrive, after 1 to 2 second delay. Precursor warnings?

Usually, I would describe the direction of shaking as being 90° to the direction felt by one of my roommates, even though his bed was identical and was lying parallel.

## 12. Soils and Foundations

I was informed by the Guatemala Engineers and also Ray Rice and Dave Schwartz helped to confirm that Guatemala City is located on a level plain near the continental divide about 5000 ft. above sea level. This plain was built up largely by the descending airborne ashes from neighboring volcanoes. Subsequent vegetation decay and rain has produced a layer of clay which by leaching process has penetrated into the ashes to produce some cementation. Thus, we have loosely cemented conglomerates and layering of pumices, cinders, and volcanic effusion of all sorts. The rapid erosion of these layered volcanic deposits has produced steep canyons to the north, east and south of Guatemala and are called "Barrancos". The finger-like projections into the City on the north produces some exciting home sites which slid or fell into the barrancos when the earthquake struck. I visited one of these sites along Avenida Independencia in Zona 2, where for over 100 meters new houses of middle class families had fallen or slid into the canyon. Another location was near the end of Avenida Elena in Zona 3 overlooking the Rio La Barranco. Some breaking of ground across streets was evident here.

### Materials of Construction

One high-rise structural steel building 22 stories in this City can hardly be considered a test of structural steel performance, especially when a 21-story reinforced concrete building next to it also came through unscathed.

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The concrete aggregates were good, the coarse fractions composed of excellent limestone and some basalt-types. The fine aggregates were from stream beds and appeared to be a mixture of igneous and metamorphosed sources. There is apparently one major producer of cement who also owns the one major concrete supplier "Mixto Listo". They perform their own quality control testing. In spite of this or perhaps because of no competition, the concrete appeared to be of excellent quality; 2000 to 5000 psi concrete is readily available and from the fragments I saw, there was sufficient good paste to cause failure through a good percentage of the coarse aggregates. Some testing for auditing purposes is performed by the University.

I was told that most of the reinforcing steel was imported from Mexico, and I saw a large variety of deformation marks. I saw no evidence of brittle fracture of rebar, and no welded splices, poor or otherwise.

There was a full spectrum of building brick. Standard solid 2"x4"x8" was being used at the American school. A great deal of hollow, double cell brick 3"x6"x9" was used to construct reinforced brick walls. Only cells with reinforcing were filled, however. "U" shaped brick was available for bond beam units and a typical reinforced wall would have vertical cells filled and reinforced w/#3's at about one meter apart and bond beams placed about one meter vertically. Reinforcing varied from smooth #2 to deformed #6's, depending upon location. Some of the broken walls had every appearance of being carefully detailed and constructed to some design for lateral forces. Obviously, not for the forces they received.

As always, there is wide variation in quality of mortar. At a new hospital project under construction, I saw lime mortar being hydrated the old way, in large flat mixing tubs, by hand. Some of the mortar in this new construction could be broken by hand. There is sparing use of cement in the plaster also. The report being that cement reduces adhesion to the adobe bricks.

## 14. The People

Gentle climates produce gentle people! Everyone possessed a natural courtesy and dignity in their dealings with each other that was marvelous to behold. I spent 2 hours in the National Police Headquarters and never heard a voice in anger or saw anyone being pushed or forced around. The police have posters on the walls of each office proclaiming to the public ethical requirements for treating the citizens.

I never saw a driver given a traffic nor parking ticket. I was told that parking meters are a flop in downtown Guatemala City because everyone ignores them. Once a year they are all required to pay up their fines in an arbitrary manner that may be negotiated downward. I was told it was illegal for private citizens to own firearms of any kind, but most of the middle class have them anyway. There was no looting for the first three nights, but then the papers began to report some shooting of looters and vigilante committees were formed to protect property from interlopers and adventurers.

The people were not going hungry because there is plenty of home grown food available. Some of the remote canyon dwellers were on the end of the distribution line no doubt were without food for several days with no means to prepare cooked meals.

The real need is shelter, however, with over a million people homeless, the task of providing shelter before the rains come is monumental. The Indians in outlying villages probably do not see any help for permanent housing coming their way, so they are beginning now to break up the adobe bricks, relevel their pads and start erecting new adobe walls for their house on the same site as before. That's the way they will be for the next quake.

I am appending a list of names and addresses of those people who helped me and I believe will help a second team.

