

BEHAVIOR OF THE LATINAMERICAN TOWER IN MEXICO CITY

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SUMMARY

This paper presents the main observations of the behavior of the Latinamerican Tower in the last 27 years since the completion.

INTRODUCTION

The Latinamerican Tower was the first tall building designed with the resultant actions of a dynamic analysis (Ref. 1), the design started in 1948 and the construction was completed in April 1956, a soil investigation (Ref. 2) was the first report. It stated an admissible total load of --- 25 Ton/m², achieving a proper architectural and structural design, this --- was accomplished at that time (Ref. 3) for a building with 44 floors, the highest in Mexico City and in the world on a strong earthquake volcanic --- zone (see photo 1).

ARCHITECTURAL DESIGN

The building was designed symmetrical, a square tower with setbacks at --- the 9th floor, 14th floor and 38th floor. The facade was designed with --- aluminum and glass, all the windows were pivoted at the center top and --- bottom, and can be opened to maintain them clean. The partition walls and the fire-proof protection of the steel structure are made of light con--- crete and fibreglass. The water supply was designed with an hydroneumatic system of three zones. The electric instalation has special ducts in the --- whole layout. The airconditioning was designed with individual units with air inlets on the facade. All the piping of the instalations is of copper.

FOUNDATION

The soil investigation (Ref. 2) reported a volcanic clay with water con--- tents varying up to 400% water and sand layers with a drop of the water --- pressure corresponding to 20 meters. This condition was causing a subsi--- dence of 20 centimeters per year in Mexico City. A hard sand layer 33 me--- ters deep was found to be a good stratum to rest the piles. A depth of --- 13.5 meters was necessary to fix the foundation into the ground for late--- ral load resistance. In order to perform this excavation in this kind of --- of the soil, it was necessary to drive a shored wood sheet pile to protect the adjacent buildings; the wood sheet pile is 16.0 meters deep.

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An hydraulic system was installed to lower the water level in the excavation (original 1.0 meter deep) and to inject this water outside the excavation in order to maintain the original water level at 1.0 meter deep. Lowering the water level in the excavation was used to control the expansion of the clay by increasing effective stresses during the excavation, - for each meter of excavation the water level was lowered 1.6 meters inside the wood sheet pile walls. The foundation is a combination of point bearing piles (Ref. 3) to a depth of 33 meters and water pressure of 12 Ton/m² under the foundation slab at a depth of 13.5 meters, 361 piles of 30 centimeters indiameter with a point diameter of 43 centimeters, were necessary to carry 13000 Ton. These piles were of concrete with a steel shell. Each pile can support a working load of 36 Ton and a ultimate load of 50 Ton. To have the total load on the piles, the drop of 20 meters of the water level was maintained until the construction was so advanced that 13000 Ton of material where on the site. The foundation is a reinforced concrete box with a continuous slab with a thickness of 60 centimeters with beams - - - 4.5 meters high and 1.2 meters wide.

STRUCTURE

The solution for a good earthquake response of the building (Ref. 1) was a steel structure with concrete slabs, these are bound to the steel structure by shear connectors. The slabs were special reinforced with diagonal bars pre-stressed. The ground period for an earthquake in downtown - - - Mexico City are estimated from 1.5 sec to 2.5 sec. An estimation of the - - - different modes of vibration of the building was done; for the first mode, the period is 3.5 sec, for the second 1.5 sec, for the third 0.9 sec, for the fourth 0.7 sec (Ref. 3). It was considered that the building responds - during an earthquake in the second mode. It was considered that the horizontal differential movement between floors should not exceed 1.5 centimeters, this deformation could be absorbed by the architectural design of - - - windows and partition walls (Ref. 4,5). To prevent additional stresses in - - - the steel structure, the riveting of the connections in the setbacks of - - - the building were postponed until 80% of the load of the columns was - - - applied (see photo 2). The analysis of the structure was performed by the Department of Civil Engineering of the Latinamerican Insurance Company - - - (owner). With these computations the Bethlehem Steel Company did the detailed design and supplied the steel structure that was erected by Jeffrey, S.A. a mexican corporation.

BEHAVIOR

The building was completed in April 1956, with a total cost of - - - - - \$ 4'000,000.00 dls, and only 10% of the total area 28,000 m² of the - - - building was occupied. The people in Mexico were afraid to occupy the - - - highest building in Mexico City: The Latinamerican Tower.

Foundation

A bench mark 70 meters deep was installed before the construction, a complete control of the soil was obtained during the construction of the - - -

foundation, since then the observations have been continued are as follows (see figure 1):

Total subsidence from 1949 to 1983:

Alameda Park	3.50 meters
Palace of Fine Arts (across the Latinamerican Tower)	2.82 meters
Latinamerican Tower	1.45 meters
The side walk (in front of the Latinamerican Tower)	1.70 meters

These observations are less than the estimations in the project (Ref. 3) - it was necessary to build only one step at the entrance of the building -- until now, it was estimated that four steps would be necessary in 20 years. The water pressure below the foundation slab of 12 Ton/m² has been - - - maintained all the time automatically with a water tank, with a supply and 50 lts/month of water is necessary to keep the pressure. With respect to - the vertical of the building the report is as follows: the initial measure^ument after the building was constructed reported 3 centimeters out of - -- plumb, after 26 years the measurement indicate 12 centimeters out of plumb, an inclination of 12/18100 = 1/1508, not noticeable.

Structure

Several devices in different floors were installed to measure the movement between floors to estimate the lateral forces during an earthquake. In - - Mexico no strong earthquake had occurred since July 7, 1911 an earthquake - measuring 7.9 on the Ritcher scale (Ref. 6); this earthquake was considered during the dynamic design of the steel structure of the Latinamerican - -- Tower. The first strong earthquake was a test of the structure of the - -- Latinamerican Tower was on July 28, 1957 at 2:45 a.m.; it was a severe - - earthquake that measured 7.9 on the Ritcher scale (Ref. 3). The damage in Mexico City was tremendous; 1800 buildings (from 1 to 17 floors) were - -- damaged, 10 collapsed totally, 1000 people were injured and 54 were reported dead. Many buildings were closed (Ref. 4) a total revision of the buildings was performed by the authorities. The report on the Latinamerican Tower was positive, the structure worked as designed, no window panes broken, no - - cracks on the partition walls or on the marble covers; no problems in the fire protection on the steel structure, the elevators on the 37th floor -- worked normally, immediately after the earthquake, everything was in order. The devices to measure, the lateral forces worked as expected, the - - - estimate was that this earthquake caused stresses in the structure up the 83% of the design forces. The earthquake proved that the dynamic design -- for tall building structures is sound (Ref. 1). The Latinamerican Tower -- was occupied immediately; people were not afraid anymore of the highest -- building in Mexico City. After the earthquake on July 28, 1957 Mexico City has suffered many earthquakes, but not as severe at this one, there were - earthquakes up to 6.5 on the Ritcher scale, some buildings have been - - - damaged in the city with these earthquakes. The Latinamerican Tower over - these 26 years has worked perfectly, no damage has been reported due to -- earthquakes. Some window panes have been broken due to shots in the - - -- street. A carefully maintenance of the steel structure is taken, the loads in the different floors are checked, the total load of the files of the -- tenants are controlled. Tests on the riveted joints have been performed, -

over 2000 rivets on different joints were tested to be to the correct -- pressure and working in good conditions. Since 1957 the occupancy of the -- building has been 100%

ARCHITECTURAL

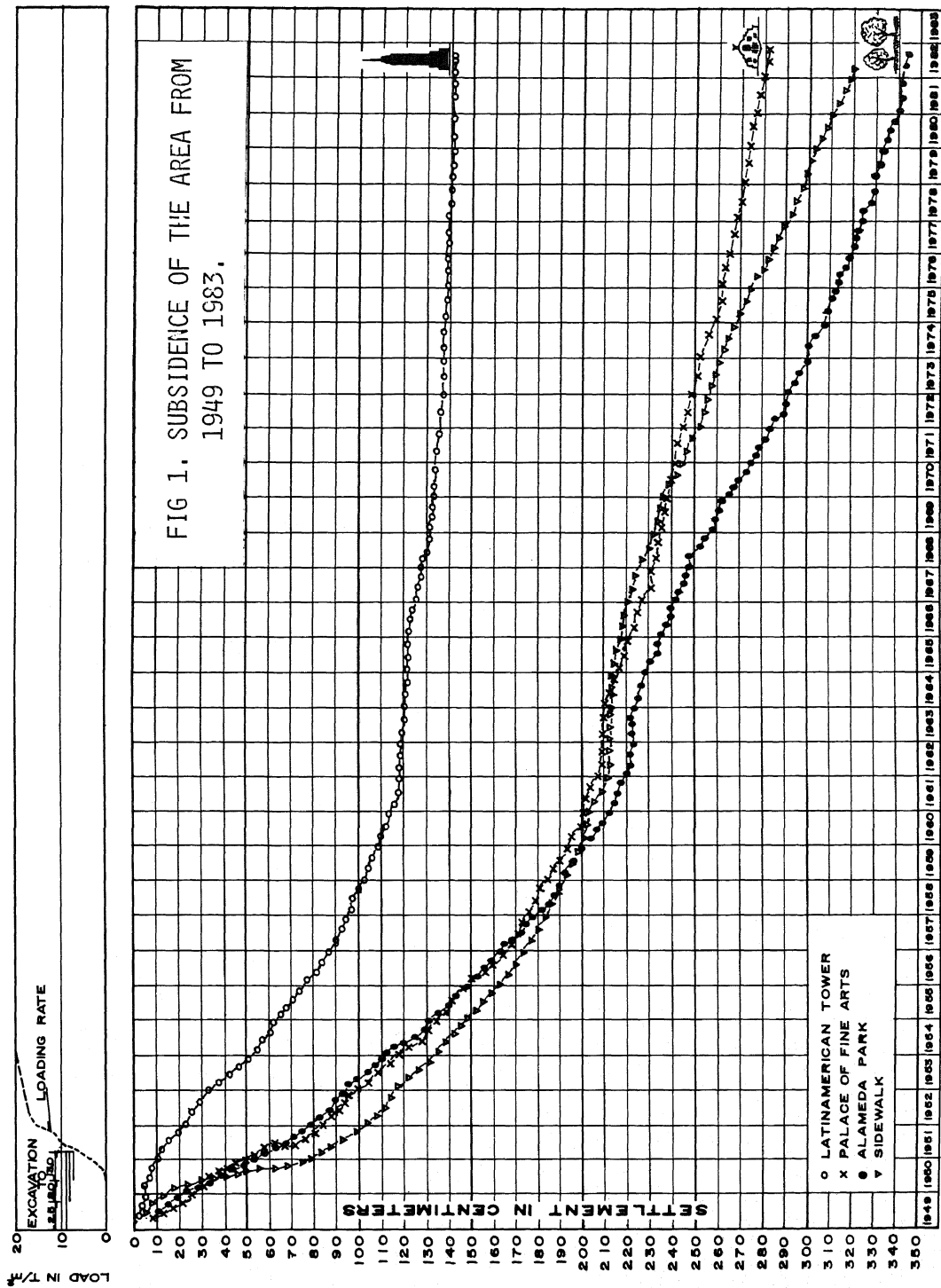
After 26 years it has been proved that the architectural design did work -- in accordance with the structural design. The symmetry of the building -- helped to estimate the real stresses. No damage due to movement of the -- structure has been reported on the interior decoration of the offices. Ninety percent of the materials used for the interior decoration are still in working condition and good appearance. The entrance floor of the main -- lobby out of natural granite is still in good condition after 26 years. The investment of \$ 4'000,000.00 has been a good one for the owner, gave a return of 20% per year plus a very good advertisement, for it is a very -- well known building.

The design and construction of the Latinamerican Tower in 1948, provided -- the Civil Engineering profession with means for design and construction -- with strong technical back-up in the following subjects:

- 1.- Knowledge of the subsidence of Mexico City 20 centimeters per year in 1949.
- 2.- A solution to perform deep excavations in clay with a high water content and high deformation characteristics, with minimal distress to -- adjacent buildings.
- 3.- Design and construction of foundations for tall buildings in clay -- located in strong earthquakes zones.
- 4.- Dynamic design methods of structures, mainly for tall buildings in a -- high earthquake zone.
- 5.- Interaction architectural-structural design in all faces of the construction to provide good response of all materials during a strong earthquake.

The Mexico City authorities used this knowledge to revise the Mexico -- City building code; some other countries after the earthquake of 1957 in -- Mexico City took the information of the Latinamerican Tower in consideration to modify their construction codes.

The two principal consultants for the design of the Latinamerican Tower -- where: Professor Dr. Natham N. Newmark and Professor Dr. Leonardo Zeevaert; the consulting architect was Arq. Augusto H. Alvarez, and the general manager on that time for the owner of the Latinamerican Tower was Mr. Lic. -- Miguel M. Macedo.



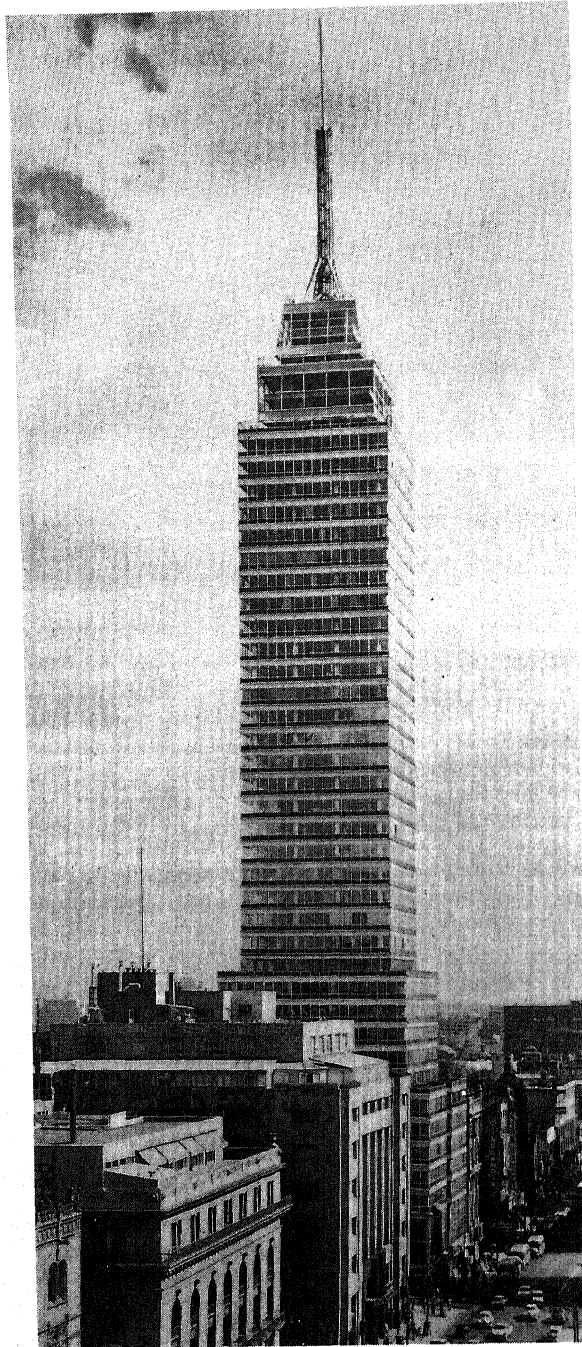


Photo 1. The Latinamerican -
Tower (1956)



Photo 2. Construction detail
showing the concrete slabs -
from the 14th to the 36th --
floor for preloading the --
center columns of the -- --
building.

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Photo 3. Rule Building 1951.

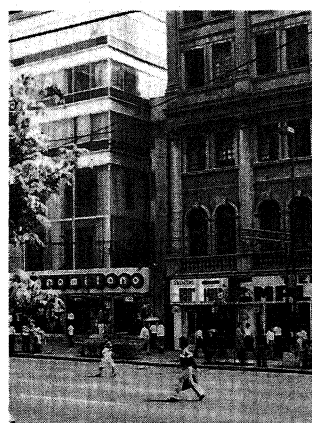


Photo 4. Rule Building 1983

No damage in this adjacent building.



Photo 5. Guardiola
Hotel eastside - -
(1951).

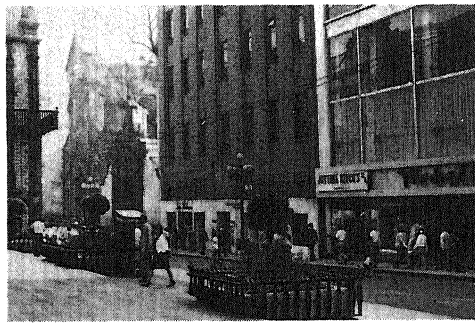


Photo 6. Guardiola Hotel 1983.
No damage in this adjacent building

Photo 7. Notice one
step. Building at -
the entrance in - -
26 years.

