



December 3, 2013

Mr. Ara Maloyan, P.E.  
Acting Director/City Engineer  
Department of Public Works  
333 West Ocean Boulevard, 9<sup>th</sup> Floor  
Long Beach, CA 90802

**Re:     *Seismic/Structural Peer Review of Long Beach City Hall Tower  
          (13190.00)***

Mr. Maloyan:

Nabih Youssef & Associates (NYA) have performed a peer review of prior seismic/structural assessment studies of the Long Beach City Hall Tower. In addition, NYA have performed an independent seismic evaluation of the tower building. This letter summarizes the results of the peer review and independent evaluation.

#### **Building Description:**

The City Hall and Main Library site consists of the City Hall Tower, City Hall Low-rise and Main Library. The City Hall low-rise building is directly adjacent, southwest of the tower building. The Main Library is southeast of the tower. All buildings are seismically separated above the Plaza Level, but share a common basement level.

The City Hall Tower has 15-stories above grade with one basement level and was completed in 1976. The building was designed to the 1970 edition of the Uniform Building Code. The building is irregular-shaped in-plan with a square floor plate measuring approximately 112 feet by 112 feet and rectangular wings measuring approximately 36 feet by 30 feet oriented at 45 degrees at each corner. The typical story floor-to-floor height is 14 feet except at the Plaza Level and penthouse where the height is 42 feet and approximately 23 feet, respectively.

The typical floors are constructed of metal deck with lightweight concrete fill spanning to wide flange steel beams and girders that are supported by steel wide flange and built-up box columns. The columns located within the square floor plate terminate at the 2<sup>nd</sup> floor where 9 feet deep steel trusses transfer the axial loads to steel columns in the four wings and four heavy interior columns below the 2<sup>nd</sup> floor that are continuous to the foundation. The foundation system consists of 6 feet thick reinforced concrete mat footings supporting each wing and heavy interior column.

The lateral system of the Tower consists of the metal deck with concrete fill roof and floor acting as structural diaphragms to transfer seismic inertia forces to welded steel moment frames, two 3-bay frames in each principal direction of the building. The frames are located within the square floor plate above the 2<sup>nd</sup> floor. At the 2<sup>nd</sup> floor, seismic forces are transferred from the moment frame columns through the diaphragm to perimeter steel trusses that transfer the forces to welded steel moment frames located in the building wings below the 2<sup>nd</sup> floor. There are two single-bay moment frames in each of the building wings. These frames are continuous to the foundation.

The building façade consists of ribbon windows with pre-cast concrete panels around the perimeter of the building wings.

#### **Seismic and Geologic Hazards:**

A geotechnical investigation of the site was performed by Earth Mechanics, Inc. The report indicates that the site is underlain by Quaternary deposits consisting of inter bedded sandy and silty sediments with clayey beds. These soils are not susceptible to liquefaction. The site is not located within any Earthquake Fault Zone. The nearest active faults to the site are the Newport-Inglewood and the Palos Verdes faults. The Cherry Hill segment of the Newport-Inglewood fault is approximately 2.8 miles northeast of the site. The Palos Verdes fault is approximately 4.3 miles southwest of the site.

**Prior Studies:**

FEMA 310, Handbook for the Seismic Evaluation of Buildings – A Prestandard, is a consensus document that provides a three-tiered process for the seismic evaluation of existing buildings. The tiers are Screening Phase (Tier 1), Evaluation Phase (Tier 2) and Detailed Evaluation Phase (Tier 3). The handbook was published by the Federal Emergency Management Agency in January 1998.

A Tier 1 evaluation allows for rapid evaluation of seismic systems using checklists with minimal calculations to quickly identify potential deficiencies. For a Tier 2 evaluation, a complete analysis of the building using simplified linear analysis methods is performed. A Tier 3 evaluation allows the use of nonlinear analysis procedures.

Erkel Greenfield & Associates, Inc. performed a FEMA 310 Tier 1 Preliminary Review of the City Hall Tower in April 2005 and concluded that the building did not comply with FEMA 310 Tier 1 criteria for life safety seismic performance due to significant structural irregularities of the lateral force resisting system at the 2<sup>nd</sup> level. Further investigation, including dynamic lateral force procedure was recommended to get a realistic distribution of forces along the height of the building.

TMAD Taylor and Gaines, Inc. performed a FEMA 310 Tier 2 Life Safety Review of the City Hall Tower in September 2005. The review included developing a computer model of the tower and performing analysis using the Linear Dynamic Procedure. The results of the analysis identified several seismic deficiencies and it was concluded that the building does not comply with FEMA 310 Tier 2 criteria for life safety seismic performance.

The prior reports and provided calculations were reviewed. The methodology and criteria used to evaluate the seismic performance of the building was the standard of practice at the time of the evaluation. The seismic deficiencies identified at each level of investigation were reasonable based on the results of the analysis.

**Independent Analysis:**

NYA have performed a Tier 3 seismic evaluation of the tower building using the procedures of ASCE 31 and ASCE 41. ASCE 31, Seismic Evaluation of Existing Buildings, is a national standard for the seismic evaluation of existing buildings in any level of seismicity (FEMA 310 is the precursor document). ASCE 41, Seismic Rehabilitation of Existing Buildings, is a national standard for the seismic rehabilitation of existing buildings. These standards are published by the American Society of Civil Engineers and represent the current state of practice.

Nonlinear response history analysis was performed using recorded ground motion records scaled to approximately represent the seismic hazard at the site. A computer model of the tower was developed that directly incorporates nonlinear load-deformation characteristics of individual members, and stiffness and strength degradation of the pre-Northridge moment connections. This provides reasonable building response to earthquake ground motion.

Seven pairs of ground motion records recorded during past earthquakes were selected from the PEER Ground Motion Database and scaled to represent a 475-year event at the site. These records need to be reviewed by a geotechnical engineer for their site specific characteristics. These ground motions were used as input excitation to the computer model to simulate the expected ground shaking at the site.

The results of the analysis indicate significant yielding of the pre-Northridge moment connections in the upper floors of the tower, which limit seismic force transfer at the 2<sup>nd</sup> floor (deficiencies identified in previous studies) - the steel trusses and moment frames below the 2<sup>nd</sup> floor remain elastic. Results also indicate significant inter-story drifts between 4<sup>th</sup> and 7<sup>th</sup> floors for 4 of the 7 ground motions.

The significant seismic deficiencies identified include the pre-Northridge moment connections, seismic load path at 2<sup>nd</sup> floor (truss elements and drags), connection of pre-cast concrete panel-to-steel frame and inadequate seismic load path at Mezzanine (Park level).

**Conclusion:**

A Tier 3 evaluation of the seismic performance of the City Hall Tower was performed using state-of-the-practice methodology and criteria. Nonlinear response history analysis, which reasonably captures building behavior, was performed. The results indicate that the building does not comply with ASCE 41 life safety seismic performance criteria and may not be occupiable after an earthquake.

**References:**

Life-Safety Performance Evaluation Based on FEMA 310, Tier 2, TMAD Taylor and Gaines (No. 4105014), August 31, 2005.

Preliminary Seismic Review Life Safety Performance Level Based on FEMA 310 Tier 1, Erkel, Greenfield and Associates, Inc. (No. 05-5061), February 21, 2005.

The City of Long Beach City Hall FEMA 310 Tier 2 Evaluation Final Geologic, Seismic and Geotechnical Report, Earth Mechanics, Inc. (No. 05-110), July 18, 2005.

Sincerely,

**NABIH YOUSSEF & ASSOCIATES**



Nabih Youssef, S.E.  
Principal

cc: File 13190.00