SIMPSON GUMPERTZ & HEGER
Engineering of Structures
and Building Enclosures

25 July 2019

Dr. Gregory Deierlein
318 Parkside Drive
Palo Alto, CA 94306

Project 147041.10 – Millennium Tower, Perimeter Pile Upgrade
Comments from Dr. Robert Pyke

Dear Dr. Deierlein:

This letter responds to comments raised by Dr. Robert Pyke in an e-mail, and attached memo, forwarded by the City Attorney's office to Mr. Peter Meier on 23 July. I prepared these responses in consultation with Mr. John Egan, who serves as my principal geotechnical consultant for our work on this project.

The e-mail raises three primary points associated with Mr. Egan's characterization of the site and recommendation of MCE_R ground motion spectra. Specifically, these are:

1. *Characterization of the site as Site Class D rather than E*.

   This point was extensively reviewed by the EDRT and is addressed in the comment log under comment 34.

2. *Use of 80% of the default spectrum specified by the building code, rather than relying on site specific study, noting that ASCE 7-16, which will be adopted by the City of San Francisco in January 2020 will require site specific study*.

   In the course of their geotechnical study, Mr. Egan and his support team did indeed perform site-specific response analysis to develop a response spectrum appropriate to the foundation level of the Tower. ASCE 7 requires that when site-specific response analysis is performed, the resulting spectrum cannot be taken as less than the 80% of the default spectrum. Mr. Egan's site-specific response analysis resulted in a spectrum with spectral ordinates generally less than 80% of the default spectrum, but with longer-period (i.e., 2 sec ≤ T ≤ 4 sec) energy content exceeding 80% of the default spectrum; thus, the greater of the 80% limit or the site-specific response study was adopted as the recommended spectrum, as required by the building code. This was reviewed by the EDRT and is logged as comment 3 in the log.

3. *Dr. Pyke's personal belief that characterization of ground shaking at the site using the V_{s-30} parameter will underestimate the likely energy content of shaking in the period range 1 to 1.5 seconds. Dr. Pyke notes that Engeo's proposed design spectrum did have increased energy content in this period.*

   We note that the building's fundamental period of response is approximately 5 seconds and more than 60% of the building's mass is mobilized in modes that have periods in

excess of 3 seconds. Only 20% of the building's mass participates in the period range between 1 and 1.5 seconds. Regardless, in the course of our design, we evaluated the building for Engeo's ground motions as well as those recommended by Mr. Egan. The building performed adequately for both sets of ground motions.

Dr. Pyke's memorandum dated 17 July raises the following technical points:

1. *An allegation that our team purports that a disproportionate fraction of the building's weight is carried by the perimeter columns, and this fails to take into account the sequence of construction*.

   We are not sure what Dr. Pyke is referring to. We have never made statements suggesting that a disproportionate amount of the building's weight is carried by the columns. We independently computed the amount of building weight carried by the individual columns and the central core and compared these with similar computations made by DeSimone Consulting Engineers in their original structural design. Our calculations suggest that roughly 45% of the building's weight is carried by the central core and 55% by the perimeter columns. This is consistent with distributions of load we have observed in other tall buildings.

2. *The suggestion that transfer of 20 percent of the load form the existing piles to the new piles would result in immediate rebound of about 1 inch*.

   Geotechnical analysis conducted by Mr. Egan and his team confirm that approximately an inch of rebound will occur when the load is removed from the building. We concur that this will not occur immediately, but rather may take approximately 1 to 2 years to occur, consistent with the time-dependent rebound behavior of clay soil when overburden confining stress is reduced. The expression of immediate recovery of settlement alluded to was made in the context of the 40-year period over which our team has evaluated the building's future settlement behavior.

3. *Arresting the settlement of the north and west sides of the building while the center and the south-east corner of the building continue to settle can only increase the stresses in the mat that underlies the building and the outriggers when the mat is already dished and cracked, and the condition of the outriggers is uncertain*.

   In the course of our design, we conducted extensive analyses of the post-retrofit settlement of the building, and the effect of this settlement on the mat foundation and structure. These analyses suggest that post-upgrade settlement will counter the settlement that occurred to-date and in the process of doing so, tend to relieve, rather than increase, stresses which have accumulated to-date. We have demonstrated through our extensive analyses, reviewed by the EDRT, that the mat is capable of resisting stresses associated with the addition of the new piles, as well as the building's response to MCE_R shaking, as specified by the building code.

4. *The proposed fix cleverly provides for backing off the underpinning of the north and west sides of the building, should settlement of the south-east corner catch up with and overtake the settlement of the north west corner*.

   While it is true that the design would accommodate reduction in the amount of jacking applied along the north and west sides, this was never the intent of the pile head detail. Rather, the intent of this detail was to allow jacking of additional force onto the piles if rebound resulted in reduction of the effective jacking force. We note, however, that since the settlement experienced to-date is due to consolidation of the underlying soils, as the building settles, the consolidating soils will ultimately become normally consolidated and the rate of settlement will naturally diminish significantly with time. In fact, this behavior is evident in review of settlement data collected over the past 18 months.

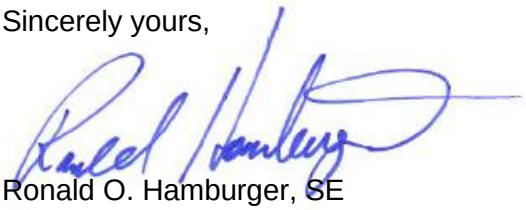
5. *The proposed fix creates an asymmetrical foundation which is bad enough under static loads but will create unpredictable and likely adverse response under seismic loads.*

   The perimeter pile upgrade adds vertical and lateral stiffness and strength to the foundation along the north and west sides of the building foundation. We have extensively and rigorously studied both effects in our analyses of the design. The upgraded building does not qualify as an "irregular" building under the definition of the building code. Further, the building's response to earthquake motion is superior with the perimeter pile upgrade in place, compared with that of the un-retrofitted building.

6. *The proposed fix requires complex and difficult construction on City property which houses many existing utilities and ties backs and will require new dewatering.*

   The required construction is neither complex nor unusual. It requires installation of drilled piles around the perimeter of the building. Piles of this type are routinely employed in building construction. The tie-backs, which will be cut, were installed to permit the original excavation for the building's construction. They serve no purpose at this time and were intended to be sacrificial when installed. No dewatering will be required to enable the construction. Ground water will be controlled by soil grouting as has been successfully done in the construction of other nearby projects.

Sincerely yours,



Ronald O. Hamburger, SE
Senior Principal
CA License No. 2951
I:\SF\Projects\2014\147041.10-301S\WP\027ROHamburger-L-147041.10.jdi_Response to Comments.docx

cc: Shah Vahdani
Craig Shields
Marko Schotanus
Tom Hui – SF DBI
Naomi Kelley – City Attorney