

## **Robert Pyke, Consulting Engineer**

Presentation to Government Audit and Oversight Committee  
of the San Francisco Board of Supervisors re The Millennium Tower Debacle

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By Robert Pyke Ph.D., G.E.

My name is Robert Pyke. I have a Ph.D. in Geotechnical Engineering from Cal and I am registered to practice as both a civil engineer and a geotechnical engineer in California. I have over 50 years' experience as a practicing engineer, mostly on high profile and high-risk civil engineering projects. I have also served as a design reviewer on a number of tall buildings in both San Francisco and Seattle, including 399 Fremont, on which I served as a member of the design review team along with Professor Deierlein, the chair of the Perimeter Pile Upgrade Engineering Design Review Team, or EDRT.

Prompted by what I had heard in the press conference announcing the Perimeter Pile Upgrade - which really surprised me – back in 2019 I wrote an article titled “The Proposed Millennium Tower Fix is a Farce.” I was, and still am, mostly concerned about flaws in the overall concept, but I also noted that the: “proposed fix requires complex and difficult construction.”

Although I did not know it at the time, Mr. Hamburger, the leader of the design team, was asked to respond to the points that I made in my article. In his response to Professor Deierlein, which I finally saw several months ago, Mr. Hamburger said: “we believe our design evaluations have addressed all of his technical concerns.” He also claimed that: “the required construction is neither complex nor unusual.” Neither of those statements was true. One of Mr. Hamburger's supporters has said on TV that underpinning of this sort is done in San Francisco all the time. Yes, but not with over 200-foot-long piles under a 600-foot-tall building. Subsequent events have shown that the installation of these piles is both complex and unusual.

When production installation of the casings and piles began in May it was quickly apparent that additional settlement was being triggered, but it was not until August 22 that the installation was put on hold. I believe that this resulted from pressure by the EDRT, who also recommended that a firm with more experience with pile installation be brought in. Subsequently, three “test” casings and three “pilot” piles have been installed. The design team has given changing

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explanations of the causes of the additional settlements and has made claims about the success of the changes that were made in the methods of installation which are not supported by the facts.

Just two examples: one is that it turns out that the 24-inch piles are being installed using a rock bit, which is necessary for drilling into the Franciscan formation rock at a depth of about 200 feet but is inappropriate for drilling through soils; a second is that the design team has been going on about vibration causing compaction of the Colma sands being a potential source of the additional settlements. It so happens that compaction of sands by cyclic or vibratory loading was the subject of my Ph.D. thesis, so I know at least something about it. That the installation of the new piles would compact the dense and clayey Colma sands, which had already had 947 piles driven into them, is just not credible. This is what lawyers call a red herring. One might have thought that for a building which already had a settlement problem, that the design team would have done the necessary research regarding minimizing additional settlements before beginning the production installation, rather than during construction.

Worst of all, Mr. Hamburger has said at various times that the additional settlement caused by the installation of the test casings and pilot piles using modified procedures was “negligible” and that the settlements had returned to “naturally occurring” rates, whatever that is. That is simply not true. It is true that the overall rate of settlement over the period of these installations was lower than it was in the production pile installation between May and August, but that is largely because there were greater intervals in between installing the recent test casings and pilot piles than there was during the production installation. My interpretation of the data is that there was little if any reduction in the amount of settlement caused by individual casing or pile installations.

In the long run this might not matter, as Mr. Hamburger has suggested at various times. Once the north and west sides of the Tower are underpinned, settlement along those two sides will be greatly reduced. However, settlement will continue on the south and east sides and the direction of the tilt will reverse. All might then be well except that the continuing settlement is now largely due to “secondary consolidation”, which can go on “forever”, so that the Tower may end up tilting to the south-east. This discussion about future settlements also assumes that the Asymmetric Fix is otherwise fine, which it is not.

Nonetheless, Mr. Hamburger has now reversed course, has apparently accepted that the additional settlements caused by the pile installation are not negligible, and is suggesting that as few as 18 piles should be installed, rather than the originally planned 52 piles, as called for in the settlement agreements which brought the various lawsuits to a close. Writing in the Q and A section of his December 27 letter to the Homeowners' Association he says: "we judge that the 18-pile solution offers an optimal solution between additional settlement and benefit gained." This does not pass the smell test. What is more likely is that the design team is panicking because they are out of time and the money provided under the settlement agreements. This judgment cannot be supported by engineering arguments, so it must be driven by something-else.

This sequence of events has gone from what at one point might have been written off as "spin" or "wishful thinking" to what can only be described as deliberate misdirection. There has always been a hint of this in Mr. Hamburger's non-responses to good questions asked by the EDRT, as well as by outside critics such as me. He has always seemed to have been answering questions in such a way as to maintain the narrative that was settled on during the mediation proceedings, rather than fully addressing the actual questions.

My technical concerns are documented in more detail in a 29-page document and several follow-up documents which are included in the public file for this meeting. I'll just briefly note two big issues about the long-term performance of the Tower if the Perimeter Pile Upgrade is completed in any fashion. These are perhaps more structural than geotechnical issues, but these two kinds of issues cannot be uncoupled. The two big issues are:

1. How is the mat, which is already dished and likely cracked, is going to respond to the transfer of load to the new perimeter piles, and
2. How are the mat and the rest of the Tower, in particular the outriggers, going to behave in a major earthquake.

Mr. Hamburger relies on advanced analyses to assert that they will both behave satisfactorily. Most lay people assume that this kind of engineering is like science and that advanced analyses are more correct than simple analyses, but that is not correct. The engineer running the analyses can get any answers he or she wants, depending on the input assumptions. And there are always assumptions. The analyses of the load transfer through the mat cannot be correct if they are still using linear elastic representations of the soils and the existing concrete pile

system. The analyses of the earthquake response of the Tower cannot be correct unless they are modeling the foundation correctly and they are including vertical motions. I believe Mr. Hamburger is correct in asserting that the Perimeter Pile Upgrade does not cause significant torsional asymmetry, but he is incorrect and unconservative in ignoring rocking asymmetry.

Thus, although Mr. Hamburger suggests that the optimal solution is to reduce the number of piles from 52 to 18, I would go further and suggest that the optimal course of action at this point is to reduce the number of piles that are connected to the Tower to zero! I believe that zero perimeter piles would offer better, although not completely satisfactory, long-term performance. As Supervisor Peskin has previously suggested, a complete review of this matter needs to be undertaken to see whether there is a better long-term solution to the original problem. The fact that the existing design team has so badly mismanaged the pile installation, gives no confidence in their assertions that the perimeter pile solution can still work. The options going forward might be complicated by the existing legal agreements, but the City needs to spell out what is acceptable and what is not.

Thank you for your attention. I'd be happy to answer any questions that you may have.

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