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April 20, 2010 **DRAFT**

Ralph Boroff
55 River St #100
Santa Cruz, CA 95060
United States of America

Re: Santa Cruz Veterans Memorial Building
Response to Seismic Evaluation Report by Streeter Group

Dear Mr. Boroff,

This letter is to provide my response to the six-page (plus appendices) report by the Streeter Group, Inc. dated April 9, 2010, titled *Seismic Evaluation Report for the Existing Veterans Memorial Building Located at 846 Front Street, Santa Cruz, CA*. I received the report in the mail from the County of Santa Cruz on April 16.

Mr. Streeter has subjected this building to ASCE 31 Tier 1 analysis, and—as ALL buildings of the vintage of the Santa Cruz Veterans Memorial Building do—it failed the test. This is a weakness of the checklist approach of the ASCE 31: it may be marginally useful as a cookbook to direct retrofit efforts, but is not useful as an analysis tool to determine whether a building is safe. There are widespread efforts within the engineering community to change or eliminate ASCE 31 for that very reason. Even though Mr. Streeter can use it as a quick checklist, it is the CBC and the State Historical Building Code that are the authorities. Certainly the building has seismic deficiencies; I predicted as much in my March 4, 2010, letter. Certainly the building should be retrofitted on a non-emergency basis. However, the sky-is-falling tone taken by Mr. Streeter and the County is not productive—or technically correct.

First, none of the spalling damage that triggered shuttering of the building on January 21 contributes in any way to the structural deficiencies identified in the ASCE 31 analysis, and still has no effect on the safety of the building. This is despite the Streeter Groups rehash of their erroneous arguments about spalling caused by previous earthquakes. I explained briefly the mechanism by which this type of spalling occurs in my previous letter, yet Mr. Streeter "does not rule out the possibility that some of the damage may have been the result of an earthquake." I do rule it out. Perhaps there are examples of deficiencies on this building where reasonable people can disagree, but this is not one of them.

There is only one location of spalling on this building that occurs where the building could have experienced significant earthquake stresses, and that spall is very obviously not due to an earthquake. That location is at the top of the column supporting the back of the stage, Photo 11 of the Streeter report. The apparent reason for the spall at that location is that the reinforcement is at the surface. A reinforcement bar close to the surface will corrode much sooner and much more than a bar with sufficient concrete cover. One reason this is not also an indication of seismic damage is that this spall occurs only at the top of one of three columns. If an earthquake had caused the spall, it would have been because of rocking back and forth of the building relative

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to the ground causing the joint between the column and the wall above it to flex. If that had been the case, the other side of the column would also have been damaged and both of the other two columns would have been forced to rock also. However, this is the only spall along this line of action, which is proof positive that this spall could not have been caused by an earthquake.

Other spalls on the building are the very ugly corners of the pilasters. The apparent causes of the spalling again are that some of the stirrups or vertical bars are close to the surface. In my previous letter, I did not explain the mechanism by which chemical change occurs in the chemistry of the cement paste that ultimately allows the steel to corrode. Over time, the cement paste in the concrete absorbs atmospheric carbon dioxide—a process called carbonation. Carbonation alters the chemistry of the cement paste and lowers the pH from a very high 13.5-14.0 to a more moderate 9.0 or so. This drop in the pH of the paste makes it possible for the steel to corrode if oxygen and moisture are present. The process of absorption of the carbon dioxide progresses from the surface of the concrete inwards over decades, until it reaches the closest reinforcement bar and triggers corrosion. It is very often corner reinforcement that gets exposed to carbonation first, and it is also the portion of a concrete surface that is easiest to break away due to the internal pressures from the corroding bar—it is easier to break a piece off a corner than a piece off a flat surface.

Thus, simple reinforcement corrosion expansion is a perfectly good explanation for the spalling observed at the pilasters. However, earthquake damage is not. The corners of pilasters will not be the first or even second location of observable damage due to earthquake forces. In a concrete shearwall system such as along the walls of the auditorium where the spalling is present, lateral forces in the plane of the wall will cause shear cracking (X-cracks) in the "piers" between the windows and the pilasters where the wall is weakest. This will happen long before any damage is seen in the pilasters. For out-of-plane forces (forces perpendicular to the wall), the walls and pilasters will either rock on their foundations or they will be forced to bend, or some combination of rocking or bending. Rocking will cause damage at the base of the walls, while bending will cause a series of horizontal cracks in the pilasters as they yield at the locations of maximum stresses. In neither the rocking nor the bending cases will there be vertical stresses along the corners of the pilasters that could account for the observed spalling.

The third type of spalling occurs at a few locations on the flat concrete walls of the auditorium. Known as "popouts", these are universally due to steel too close to the surface of the concrete that has begun to corrode due to carbonation. The spalls do not relate to earthquake-induced cracking, since such cracks do not exist.

It should also be pointed out I observed none of the classic examples of earthquake damage in the Veterans Building, nor did the Streeter Group indicate that they found any during their investigation. While they pointed out, correctly, that the fact that this building survived the Loma Prieta earthquake with no apparent damage should not be taken as an indication of how it might behave in a design earthquake, they were wrong to discount its Loma Prieta behavior completely. There were several buildings in Santa Cruz County that collapsed in the Loma Prieta, and, more importantly, there were many that suffered severe damage that were patched up and put back into service. The Veterans Building has a measure of structural toughness that is not recognized by the ASCE-31 analysis.

I will not quibble with the details of the ASCE-31-driven non-conforming elements of the building; obviously and predictably there are many structural elements of this building that would benefit from a retrofit and building would be made safer thereby. However, the building is in relatively good condition compared to many others of its vintage in Santa Cruz County, and it does not subject a professional engineer to increased liability to say so or to recommend that the building remain open, as long as that recommendation is also accompanied by a recommendation to retrofit.

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I suggest that if the County of Santa Cruz is so concerned about life safety that they have to immediately close the Veterans Building, then they have an absolute duty to immediately subject all the buildings it owns or into which it places county employees to the same ASCE-31 tests. Undoubtedly a large fraction of them will also fail the tests, and—following this flawed logic to its conclusion—all of those that fail will also have to be boarded up immediately. At a minimum the County would then have a database from which to make a reasoned and logical assessment of its building stock and to develop a rational set of priorities for closures, demolitions, repairs, and retrofits. Instead, for whatever misguided reasons, the County has chosen to close a perfectly serviceable building to the detriment of the citizens of the County.

I am not advocating that the Veterans Building remain un-repaired or un-strengthened against the inevitable design seismic event—just that it remain open during the planning and financing stages of the process. It is irresponsible to do otherwise.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul Cox". The signature is written in a cursive, flowing style with a large initial "P" and "C".

Paul Cox, C.E. 45152