

## CAPSS Public Advisory Committee Meeting

April 8, 2009

### Introduction

John Paxton, committee vice chair, called the meeting to order at 11:10AM. He asked attendees to introduce themselves. He reviewed the last meeting summary and asked for DBI to discuss the status of the recommendations with the Mayor's office. Mr. Hanson Tom said that DBI has not heard from the Mayor's staff on the matter.

Mr. Paxton introduced the panel members and described the purpose of the meeting. He referenced his four-page background paper (attached). He said the purpose is to discuss whether material deterioration reduces the earthquake capacity of existing buildings to an extent requiring additional CAPSS consideration. He explained that wood, cementitious materials and steel were all subject to changes with time, but the extent and consequences of deterioration should be considered.

Mr. Paxton also announced that the session would be video taped by SFGTV and that the video of the session could accessed through the CAPSS web site, <http://www.sfcapss.org/>, or the following link: [http://sanfrancisco.granicus.com/ASX.php?publish\\_id=467&sn=sanfrancisco.granicus.com](http://sanfrancisco.granicus.com/ASX.php?publish_id=467&sn=sanfrancisco.granicus.com).

Members of the panel were the following persons:

- Mr. Ron McGinnis, architect and principal with Mc Ginnis Chen Associates, San Francisco. The firm specializes in the evaluation and rehabilitation of the building envelope.
- Mr. Wayne Wilcox, a forest products pathologist and retired professor from UC Berkeley, who conducts studies on wood decay and its affect on structures. He does consulting and litigation support.
- Mr. Armen Tajirian, principal with Applied Materials and Engineering, Oakland, focus on materials engineering. He is a specialist on concrete, structural and reinforcing steel. His focus is in forensic work and testing materials for structural strength.
- Mr. Gary Gray, architect and structural engineer, no longer does design, but serves as an expert witness. He has extensive experience with building deterioration and effects of leaks.
- Mr. Dave Hoska, a principal with Lingruen Associates, a pest control and licensed general contracting company in San Francisco and member of the CAPSS Public Advisory Committee. His company does inspections, chemical treatment and repairs.

Mr. Paxton posed the first question: How do buildings age and how do materials change and deteriorate over time?

## Wood

Mr. Wilcox said the primary cause of material strength loss is contact with water. Wet wood will decay and lose strength because microorganisms, or fungi, use wood materials as food and destroy the host materials in the process. He said that because most wood is hidden by finishes, it is often not possible to observe deteriorating wood directly. Instead, observers seek indicators such as watermarks or the presence of water in unexpected places. Wood, such as siding, will withstand the effects of getting wet and drying, the danger occurs when water is trapped for a lengthy time in areas that cannot be seen. He said inspection for and detection of wood deterioration are the problem.

Mr. Hoska said damage from dry wood termite infestation is a problem; perhaps not so much in San Francisco as it is in other localities. He said that some pest species that cause problems in southern California are not found in San Francisco. He said that wood decay, not pest infestation, causes most of the wood deterioration problem in San Francisco.

Mr. Gray added that under some circumstances heat (not fire) could weaken wood.

Mr. Wilcox said ultra violet light, and chemicals can affect the surface of wood, but deterioration of structural wood occurs by decay and infestation that occur throughout the cross section. Where organisms are active, there is loss of strength. He said that water is the primary cause. He said a piece of wood could lose its strength more rapidly in the laboratory, than what would be before being diagnosed in the field. The consequences of deterioration depend on the role of the deteriorated wood element and its location in the structure. For example, he said that decay in the center of a column might be less important than decay in the lower side of a beam. If major, structurally significant members are decayed, there will be a structural problem. He said that decay stays away from the surface making it hard to detect, and that by the time wood decay when decay becomes field detectable, the wood would have lost between 10 to 15 percent of its weight and effectively all most of its strength.

## Concrete

Mr. Tajirian said Portland cement is a relatively new construction material being introduced in the 1850s. Before that time, lime was mixed with water to bind masonry. The other product is gypsum plaster. Plaster made with cement is a hard product not affected by water. However, lime is affected by water and when in contact with water tends to revert to original sandy state.

Mr. Tajirian said that concrete increases in strength with age and does not decrease even with water contact. Hydration, the chemical process that creates the binder in concrete, continues with exposure to water. However, water in combination with other materials, such as chemicals found in a marine environment, can affect the tensile and compressive strength of concrete. He said water that becomes acidic when mixed with carbon dioxide can attack concrete. He said that other cementitious materials such as plaster and mortars have different characteristics

because of their chemistry. He said the quality of concrete in the 1906 era produced compressive strengths of 1,000 to 1,500 psi (pounds per square inch), now the code requires 2,000 to 2,500 psi concrete. He said concrete quality, or compressive strength, has improved since the 1930s and 1940s.

Mr. Gray added that improper placement of concrete can lead to exposure of steel to water because of air and gravel pockets, insufficient cover (thickness of the covering concrete) and shrinkage cracks.

Mr. Tajirian said that spalling generally does not cause much structural damage because the concreted cover, that is the concrete covering the steel is not taken into account in flexure (bending). The progressive effects, loss of reinforcing steel capacity and further cracking of concrete leads to problems.

Mr. Gray added that the lime in masonry construction ages, especially on the outside when lime mortars leach from water exposure.

## Steel

Mr. Tajirian said environmental corrosion of reinforcing steel is a different problem. Initially corrosion cannot be observed because the rebar is covered by concrete. He said that the primary cause of steel deterioration is poor quality concrete in which rock or air products increase permeability. He said that concrete and the lime concrete protects the steel, but with enough water and oxygen reach the reinforcing bar, corrosion will occur. Corrosion depends on permeability, and how close is the steel to the exterior face of the concrete member. Current practice requires 2 inches of concrete cover. Past practice allowed less cover, a 3/4 inch cover leaves the steel more exposed to water. When water seeps in through small cracks it can cause the steel to corrode. As steel corrodes, it expands. The corrosion products are eight times the volume of steel. When the corrosion products expand they push the concrete cover away causing more cracks and "spalling." He emphasized that for corrosion to occur, the steel must be exposed to both oxygen and water.

Mr. Tajirian said deterioration in reinforcing steel results in a loss of the "section." In other words, the area of steel viewed in a cross section is reduced as it corrodes, but the strength of the remaining uncorroded steel is not reduced. The strength of the steel member is reduced by the loss of steel through corrosion.

## Questions

### **Mr. Paxton asked, how fast does deterioration occur?**

Mr. Wilcox said the rate of decay depends on size and exposure, but in larger structures it usually take four to six years to develop enough decay for occupants to notice it generally because of significant weakening, by which time the wood would have suffered a significant loss of strength. In the laboratory, decay can be produced in two months.

He said about five fungi species cause decay above ground. One characteristic was that the peak age of the number of fungi isolates is six to ten years. Over 50 or 60 percent of isolates develop in buildings less than 20 years old. The decay process, if

it is to occur, manifests in the first 20 years. Eventually, the organisms die out. Even the newer buildings could be affected by deterioration.

Mr. Tajirian said that structural steel (beams and columns) generally does not deteriorate because it is difficult for water to penetrate to the steel. Buildings over 60 years old often have steel encased in concrete or masonry that prevents water intrusion. However, in instances where water could get in through the mortar and masonry, there might be corrosion.

Mr. Gray said the contact between masonry and steel masks the problem, so when corrosion is found, it generally is a problem that needs to be fixed.

Mr. McGinnis spoke about connecting wires. Clay tile roofing steel, terra cotta decorative elements, decorative sheet metal and brick veneers often are attached with steel or copper tie wires or metal clips. He said there generally is not much wire deterioration until the installation is 60 to 80 years old, but deteriorated steel wires can cause safety problems. These problems are seldom observed in the field and often not addressed in the field. He said not to worry about copper wire.

Mr. Hoska said building stucco and wire might become a problem depending on the age and design of the building: The wire mesh could rust. He said that deteriorated stucco then could allow water to seep in and lead to a wood deterioration. He said that some buildings used wood lath for the exterior stucco and that the lath, and the attachment of the stucco to the building, can deteriorate. He said that stucco provides the building envelope and the resistance to water intrusion. He said that building design also leads to wood deterioration. For example, most of the houses in the Sunset and Richmond districts lack weep screeds that would let water out.

Mr. Tajirian spoke about nails and the importance of nail heads. He said that ferrous materials, e.g., steel, will not corrode when protected by lime or a lime based product. He said that nail heads are important because they resist pull out for out of plane forces.

Mr. Gray spoke about over-driven nails. He said over driving nails (the nail head is driven through the wood surface and is recessed) open the wood surface to water penetration, and can lead to rusting a loss of shear resistance. When a nail shank begins to rust it cannot bend repeatedly during earthquakes.

### Summary Remarks

Mr. Paxton asked for summary remarks from the panelists.

Mr. McGinnis said that the CAPSS project initial focus on soft story buildings correct. However, he believes the building enclosure, the cladding, is overlooked even though they can be problematic. He said that buildings can lose plaster, terra cotta cornices and overhangs when connecting materials deteriorate. He cited a recent failure at the Russ Building on Montgomery Street when a piece of terra cotta façade fell during rush hour. Failure of the building envelope walls, roof and flashing allows water to reach wood and steel. Although there are no studies on exterior cladding and chimneys in earthquakes, CAPSS should expect these failures.

Mr. Gray also agreed that soft story buildings are dangerous. He described another problem that was created when San Francisco allowed construction of an extra wood story that led to water intrusion problems. He warned that plywood should never be exposed to water because plywood sucks water up between the plies. He cautioned that traditional building practices based on the properties of original wood materials might no longer apply. He said that the old wood products were very good, better than the materials available today. Today wood from Douglas fir farms produce wood that is softer than the wood from older first growth trees. The new products have thicker soft wood rings. He described observations of older Glulam beams that were well connected, but split between the bolts. He also expressed concern about poor use of particleboard, or oriented strand board (OSB), and deterioration due to water exposure. He also expressed concerns about multiple re-roofing jobs that add weight and allow for water to be trapped, and post bases placed in a manner that will allow exposure to water and decay.

Mr. Wilcox reiterated his concerns. He said that water must be trapped next to wood and stay a period of time to cause deterioration. He said that wood shrinking while drying and swelling when wet generally a not a problem. He said that OSB particles will support growth of decay fungi and will loose strength from swelling after exposure to water. He said that a 25-percent thickness increase from swelling causes an 80 percent loss in bending strength. Mr. Wilcox said the base of shear wall base hidden at corners often leads to a structural problem.

Mr. Tajirian described his observations while performing safety assessments following the Loma Prieta and Northridge earthquakes. He said that the quality of inspection and construction is noticeably better in San Francisco than in Southern California. He observed shoddy construction in Los Angeles. He said that he advocates increased inspection of exterior cladding and architectural elements because connections are critical. He said that terra cotta, glass reinforced concrete (GFRC) panels and cladding connect to the building frame with a rod. If this rod deteriorates, it leaves elements loose. He said that the attachments of cladding to buildings need inspection. He also recommended inspection of stucco because the attachment relies on metal lath and nails. Mr. Tajirian said there are problems in some areas because unwashed dredged sand was used in concrete. The sand contained deleterious materials, sulfates and chlorites that cause deterioration. He reported that current concrete practice is generally very good and that rock and sand are clean and meet ASTM standards.

Mr. Hoska said that poor architectural design allows water penetration. He said that he has observed “rubble concrete” foundations, particularly in Bernal Heights. Concrete placed during the 1930s and 1940s when Bernal Heights was built out, had high a mineral content and overly large aggregates. He said that frequently he sees deteriorated structural materials, such as headers over entries and sill plates.

### Questions from the Audience

Mr. Paxton asked committee members for questions.

Mr. Ned Finney asked about efforts to improve building envelopes. Mr. McGinnis responded that the City of Chicago adopted a Critical Examination Ordinance in November 2007 after there was a death from falling terra cotta. (See Municipal Code of Chicago, Title 13, Chapter 196, Section 031) The ordinance requires façade inspection and repair schedules for building cladding, brick, façade and ornamentation. He said there are new materials, especially green materials, with unknown deterioration characteristics.

Mr. Hanson Tom agreed that connector corrosion is a problem.

Mr. Carrico asked whether pressure treated wood should be required in areas potentially exposure to water. Mr. Hoska explained that the San Francisco building code did require the use of treated materials at one time, but no more. Mr. Gray said the chemicals used to pressure treat the wood were poisonous. Mr. Gray said that the problem is caused by poor design that allows water entry, rather than not using treated materials. Mr. Anderson agreed and said that proper flashing is critical. Mr. Hoska agreed, and said that there must be a drainage plane to get moisture out of the building and that proper flashing is needed. He said that design and construction practices were the important factors. Mr. Wilcox agreed and said poor design and execution are the problems. There was agreement that letting water enter buildings is the issue, not the lack of using pressure treated wood and caulking.

Mr. Anderson said that if stucco touches the earth, termites could enter the building. Mr. Wilcox said stucco that touches the ground also would facilitate entry of decay fungus, which behaves much like termites.

Mr. Finney asked if decay is faster in newer buildings using plantation produced Douglas fir rather than buildings with old growth wood? Mr. Wilcox said decay might be quicker because plantation wood is more permeable. He said that strength comes from the late wood, the dark part of ring.

Mr. Tom said that San Francisco has an inspection team that looks for wood deterioration on a large-scale basis and could file reports of findings to the City of the interior condition and exterior.

### Consensus

Mr. Paxton asked if there was consensus regarding the extent of materials deterioration and whether there was sufficient evidence to merit further investigation into the structural capacity of existing buildings? The panel members answered yes.

There was general consensus that moisture was the primary cause of material deterioration, and that of the materials discussed, deterioration of wood was the largest problem. Of next significance, was the deterioration of reinforcing steel, where water was allowed to reach the steel. Deterioration of cement rarely resulted in direct decline of strength, but could allow water to intrude, and damage reinforcing steel.

Mr. Paxton asked if materials deterioration creates a public safety problem, that is, the potential hazard of falling materials resulting from deterioration of wire, mesh, and fasteners? The panel members indicated yes, by nodding their heads.

Mr. Paxton and the CAPSS Public Advisory Committee expressed thanks to the panel members for volunteering their time and experience and for making informative and interesting presentations.

There was general agreement that the City of San Francisco should require or encourage structural pest inspection companies to file copies of inspection reports with the City. These data would help define the scope of deterioration and potential consequences.

### **Adjournment**

The meeting was adjourned at 1:05 PM. The next meeting of the Public Advisory Committee will be on Wednesday, May 13, at 11:00 AM.

### **Potential Implications**

1. Should San Francisco require a condition assessment of existing buildings to identify and correct deteriorated materials? Should this be part of the anticipated “structural evaluation form?”
2. Should any requirement be a separate requirement applying to a designated subset of buildings, or should it be a part of any program requiring assessment and/or retrofit of existing buildings not meeting adopted earthquake performance standards?
3. If deteriorated materials are found, should San Francisco require both repair and correction of the design or construction flaws that allowed materials to deteriorate?
4. Should San Francisco consider a critical examination ordinance similar to the Chicago ordinance?
5. Should San Francisco require or encourage Structural Pest Inspection Contractors to file a copy of all reports done on buildings in San Francisco in order to create a database that will allow a better understanding of the extent and consequences of deteriorated materials?
6. Should repair of deteriorated material trigger the same seismic upgrades (104f) as other types of damage and repair?
7. Should San Francisco address the dangers from falling materials due to gravity and earthquake loads in addition to the to the risk of building collapse during earthquakes?

### **Attachments**

1. Background paper
2. Municipal Code of Chicago, Title 13, Chapter 196, Section 031 et seq.