UNREINFORCED MASONRY BUILDINGS IN SAN FRANCISCO

— During 1992, the San Francisco Board of Supervisors will consider the recommendation of a city task force on unreinforced masonry buildings (UMBs) to require virtually all private owners of "UMBs" to strengthen their buildings structurally or demolish them, at their own expense. The City has targeted slightly more than 2,000 structures. Together these buildings contain over 36 million square feet of floor space. They provide 22,000 housing units, the majority of which are among the city's most affordable; house 4,500 businesses that provide 46,000 jobs; and include the sanctuaries of many long-established San Francisco churches. The alternatives under consideration propose engineering solutions with enormous potential social, economic, political and aesthetic implications.

Historical Background

Unreinforced masonry structures—first adobe and then brick and stone—existed in California from the earliest days of European settlement. The frequency and destructiveness of fires which plagued cities and towns throughout Northern California encouraged brick construction. Although masonry buildings existed in San Francisco as early as 1848, following the city's fourth major fire, in 1850, about twenty brick and stone structures were built in an effort to design buildings that would withstand future conflagrations.

In 1851, fire destroyed an estimated 1,500 to 2,000 buildings but proved the fire-resistant properties of masonry structures and gave impetus to their construction. By 1869, contemporary accounts estimated the city had a total of more than four thousand brick buildings. While San Francisco saw its first reinforced concrete structure in 1884, its first metal frame building in 1889 and its first steel frame in 1891, brick continued to be widely used.

Beginning in 1853, the City defined areas of the business section within which it prohibited new wood frame construction. The original "Fire Limits" were Union, Powell, Post, Second and Folsom Streets. By the turn of the century, they had expanded to include the waterfront, a larger area south of Market and Market Street west to Gough and Valencia. Although nineteenth century enforcement appears to have been inconsistent and subject to political influences, these "Fire Limits" explain the geographic concentrations of existing UMBs.

Construction of unreinforced brick buildings dropped dramatically after 1933. While available information does not permit assessment of the role of other possible causes, such as depression or war shortages, the destructive 1933 Long Beach earthquake played a major role in changing perceptions of the desirability UMB construction.

San Francisco's UMBs Today

In 1987, the City's Bureau of Building Inspection and the Seismic Investigation and Hazards Survey Advisory Committee completed an inventory of unreinforced masonry buildings. The study defines UMBs to be structures which have exterior load bearing walls of brick, concrete block or similar materials which were built or received permit rights prior to 1948 and which have not received specific types of steel or other reinforcement in ensuing years. Building code changes which San Francisco adopted in 1948 included "seismic design provisions" for all new buildings, effectively ending the construction of UMBs.

The inventory identified approximately 2,200 structures, the vast majority of which are brick. After excluding structures containing one to four residential units and those owned by governmental agencies, and with other adjustments, 2,007 remained targeted for proposed new laws.

The inventory shows that of all existing UMBs, 123 were built before 1906. Concentrations occur in the Jackson Square area and at the foot of Brannan...
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Technologies for resistance to earthquake forces.

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The Los Angeles

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The law required local building departments to complete identification of UMBs and propose a plan by January 1, 1990, and to report their findings to the local legislative body, as well as the State. At that time, nearly 50 percent of affected jurisdictions had completed. Their plans ranged from posting notices on buildings of the potential risks, to imposing mandatory upgrades which are expected to lead to extensive demolitions.

San Francisco’s Response

Following the completion of its inventory of all UMBs, City staff specified and then attempted to evaluate three different levels of possible mandatory structural upgrade. Public documents have presented these alternatives in ascending order of the extensiveness of work required and therefore of cost to property owners. According to engineers, none can guarantee that damage to UMBs will not occur in an earthquake. There remains controversy in the engineering community on the merits of one approach over another. The first alternative significantly reduces the risk of injury. The second alternative accomplishes progressively smaller reductions in risk but at progressively and dramatically higher costs. Out of plane wall strengthening (also referred to as Alternative C or Alternative 1). Requirements under this scenario would mandate anchoring all floors and roof surfaces to masonry walls as well as seven other work items that walls could collapse perpendicular to their length ("out-of-plane"). Most often such work involves only the exterior walls, although this prescription would apply to interior masonry walls in larger buildings, as well. In addition, this alternative would require strengthening the upper-story walls of multi-story buildings, if the plan of the structure exceeded a standard set by formula.

According to the City’s engineering consultants, Rutherford & Chiker, “Although some wall anchors may exist from the original construction of the building, or subsequent remodels, virtually all UMBs will require supplemental wall anchorage work.” The estimated that this level of upgrade would require a minimum of four weeks of construction work for even the smallest buildings, if vacant. Occupied buildings would require substantially increased time.

Alternative 1 Out-of-plane wall strengthening

Alternative 2 "The Los Angeles Approach”

Senate Bill 547

In 1986, California enacted legislation requiring all cities and counties in California “in Seismic Zone 4” to identify unreinforced masonry buildings in their jurisdiction and to develop a plan for these structures.

The only requirement of these plans was the notification of UMB owners that their building “is considered to be of a general type of structure that historically has exhibited little resistance to earthquake motion.” However, the law provided that such plans could also include provisions to strengthen buildings, to reduce intensity of use, and to demolish buildings, as well as to allow tax incentives, low cost loans or other incentives for building owners. Senate Bill 547 exempted warehouses, structures containing less than six dwelling units or qualifying “historical properties” from its provisions.

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The tests, funded by the National Science Foundation, resulted in an approach known as the ABK methodology. This method uses a different approach in analyzing the ability of wood floors and roofs to withstand motion from that of traditional engineering. The ABK research found many UMBs require less additional structural work to reduce safety risks. In part this is because tests indicate that wood interior walls add their own strength to buildings.

Vacant buildings undergoing this level of upgrade would require an estimated six to thirty weeks of construction time, depending upon size and individual characteristics. Work on occupied commercial and residential buildings may require twice as much time.

*San Francisco Building Code Section 104(f)* (Also known as Alternative E or Alternative 3). Section 104 (f) of the present San Francisco Building Code requires existing buildings to be rebuilt to meet the same seismic resistance rules in effect for new buildings in 1973. This requirement applies when, in the opinion of the Building Department, proposed repair or remodel work on an existing building meets any one of five tests, including that proposed alterations affect two-thirds of the floors or that structural alterations affect 30 percent of the building area. This alternative would apply Section 104 (f) rules to all UMBs irrespective of whether new construction work was proposed.

In addition to the work required under the “Out of Plane Wall Strengthening,” this approach would require strengthening of all roofs and floors. New foundations would frequently be necessary. Storefronts with little or no solid walls would require strengthening, such as diagonal steel braces provide. In general, steel and concrete components would be necessary.

Small, simple projects in vacant buildings require an average of eight weeks (estimated), and larger projects, twenty-four to thirty-two weeks, if the structure is vacant. Occupied commercial and residential buildings are expected to require twice the time.

The City of San Francisco, using engineering and economic consultants, has undertaken a substantial effort to develop estimates of construction time and average cost per square foot for each of the alternatives. These estimates have served as assumptions to evaluate the impacts of each alternative and to speculate upon the magnitude of dislocation and demolition which will result if mandatory requirements are enacted. A city task force of department heads has recommended mandatory structural work reflecting Alternatives 1 and 2 for privately owned UMBs, and city government has essentially completed the procedural requirements necessary to bring the proposal to a vote by the Board of Supervisors.

Persons familiar with recent construction costs have voiced strong disagreement with the estimates of construction costs, saying they are dramatically low. Disagreement also exists within the engineering community over the alternatives. Others have expressed concern that the City has not fully identified the impacts of the alternatives nor adequately understood the scope of mandated construction work and its impact on housing, small business and low and fixed income San Franciscans.

In a future publication, Heritage will attempt to illuminate the technical issues and controversies and to examine more closely the enormous potential impacts of San Francisco's proposals to address the seismic issue of unreinforced masonry buildings.

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