1995 Annual Report to the Legislature

Status of the Unreinforced Masonry Building Law

(Government Code Section 8875 *et seq.*)

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SSC 95-05

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Adopted June 1995 by the

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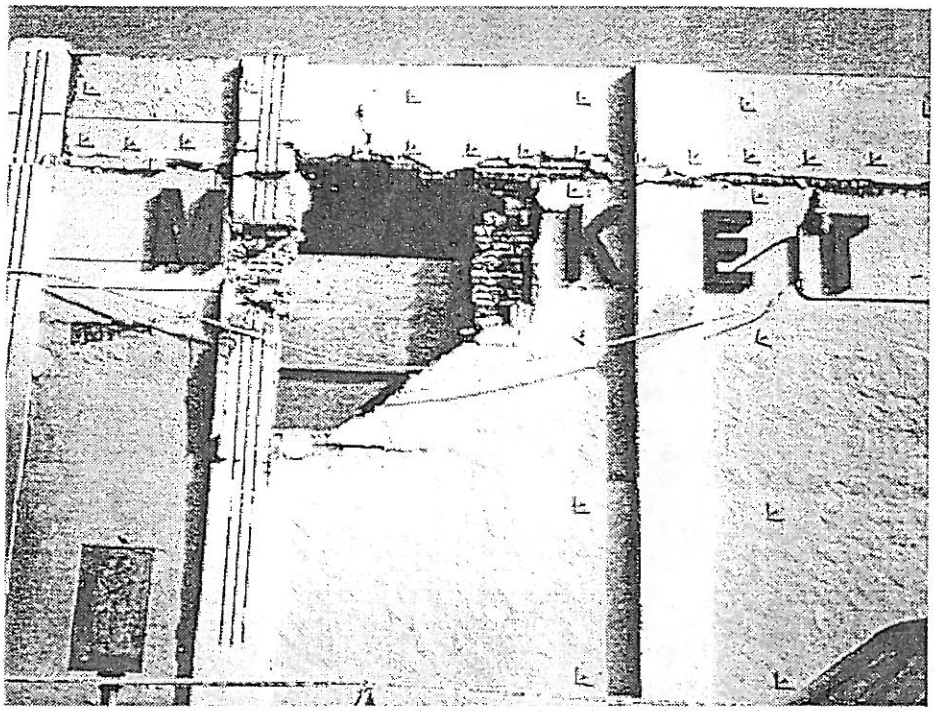


Photograph 1: Although this retrofitted building lost a few bricks and may be difficult to repair, damage was significantly less than in similar unretrofitted buildings during the 1994 Northridge earthquake... *(Photograph credit: Schmid)*

Introduction

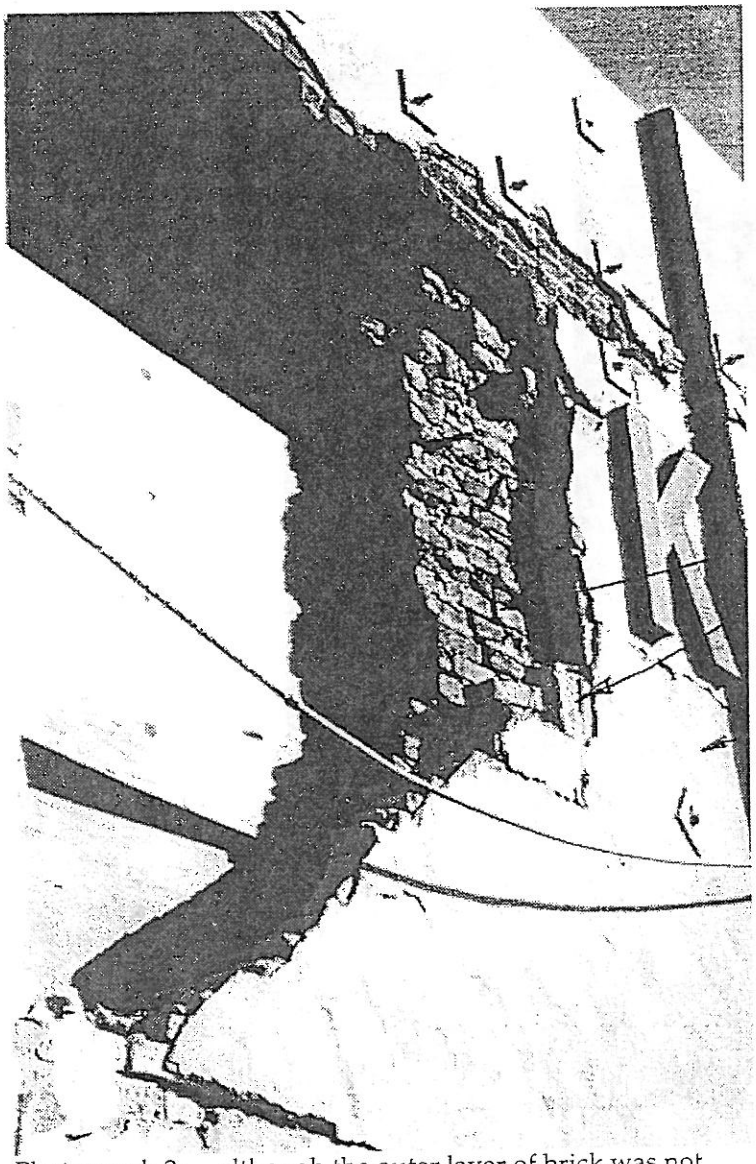
The Unreinforced Masonry Building Law was authored by Senator Alquist as Senate Bill 547 and was signed into law by Governor Deukmejian in June 1986 (See Appendix D). It required local governments to inventory unreinforced masonry buildings and establish earthquake risk reduction programs for these buildings by January 1, 1990. Approximately 1 million occupants in 25,000 buildings are affected by the law. As of June 30, 1995, 81 percent of the affected jurisdictions have substantially complied with the law. This report describes the status of compliance of local governments implementing this law and compiles a history of the law using excerpts from past Commission documents.

The Unreinforced Masonry (URM) Building Law was a significant step taken toward reducing the earthquake threat to the people of our state. Over 94 percent of the URM buildings in the areas of California with the highest seismic risks are now in local risk reduction programs. 223 local governments have established URM programs. However, 58, typically smaller, vulnerable communities have yet to comply fully with the law, and still others have established ineffective programs that will do little to reduce risks.

The challenge remains to effectively reduce risks in URM buildings now that these programs are established or underway. The California Earthquake Hazard Reduction Act of 1986 set a goal of significantly reducing risk by the year 2000, and we have made significant progress toward that goal.

The state made notable progress in 1992 when it established a uniform building code for the reduction of earthquake risks in those URM buildings that have load-bearing walls. However, the state still lacks a uniform code for retrofitting nonbearing-wall URM buildings.

In the ninth year since the passage of the URM Law, the Seismic Safety Commission notes five



Photograph 2: ...although the outer layer of brick was not adequately connected to the inner layers. *(Photograph credit: Schmidt)*

significant issues that affect URM seismic risk management:

- Risk reduction efforts by the City of Los Angeles and neighboring communities greatly reduced the economic losses and threats to life in URM buildings during the 1994 Northridge earthquake. In stark contrast, communities like Fillmore, which do not require URM risk reduction, suffered greater losses.
- Financing remains difficult to obtain and costly for most owners.
- Many local governments are hesitant to enact mandatory URM retrofitting ordinances and nearly all are disturbed that the state government has exempted its own buildings from similar requirements.
- The lack of a uniform code for reducing seismic risk in nonbearing-wall URM buildings has hampered many local government programs, owners, designers, and contractors.
- While there have been several notable efforts to improve the training of building professionals about reducing risks, the lack of training and understanding is still a major impediment to the success of the URM Law. This issue manifests itself in poor quality retrofit designs and construction which exacerbated damage in the Northridge earthquake.

Overview—Making Existing Buildings Safer

(excerpt from Turning Loss to Gain, SSC 94-09)

The Commission believes that the greatest seismic risk in California today comes from vulnerable existing buildings. Though only a small proportion of these are likely to have life-threatening failures or collapse in an earthquake, the risk they pose is great.

Only a small percentage of existing buildings are demolished or renovated in any year. The numbers may vary from locale to locale and for different types and uses of buildings, but it is likely that, unless a major urban earthquake occurs, at least 90 percent of the buildings existing in California today will still be in use ten years from now—and posing the same threat that they pose today.

With each new earthquake, including Northridge, we gain greater understanding of which building types, structural systems, details, and nonstructural elements are particularly hazardous. We know the types of

"older" buildings that pose potentially significant life safety risks. The 1976 UBC is often used as the benchmark for identifying older engineered buildings. Many engineered structures built to pre-1976 codes are fine, but some pose unacceptable risks. The 1976 date, generally applicable to engineered structures, is not a valid date for conventional light-frame construction, which includes most homes. Conventional construction is considered "older" if built to codes older than 1949-1960, depending on the jurisdiction.

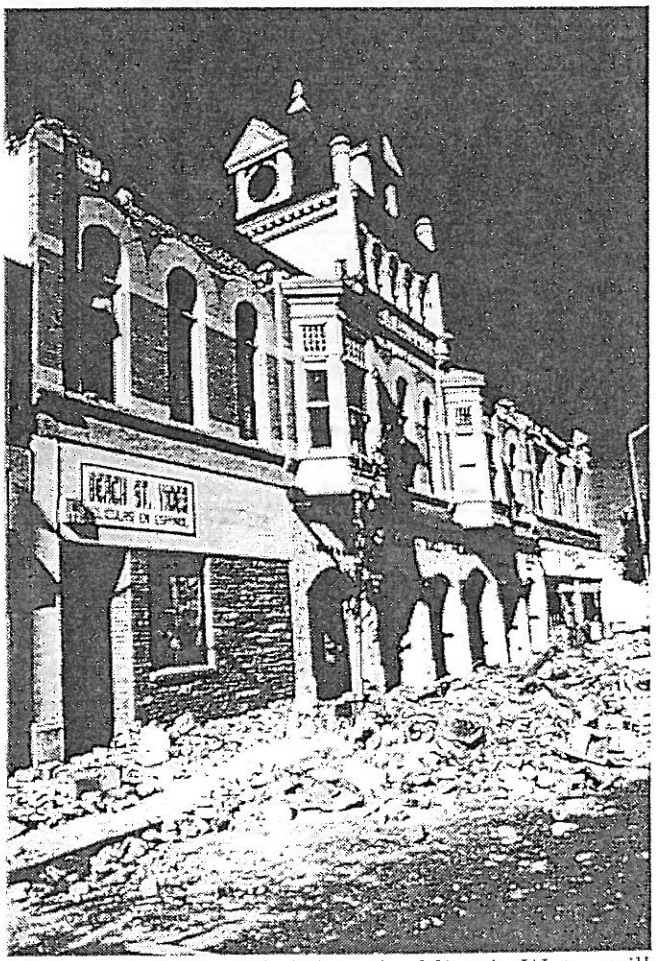
A number of building types are vulnerable to earthquakes, and in the Northridge earthquake they again demonstrated their potential to collapse and pose significant threats to life and loss of building functions. For example, the concrete columns and beams in buildings erected before the mid-1970s often lack reinforcing steel to keep them from collapsing or being damaged beyond repair in earthquakes. These buildings can pose the greatest threat to life in earthquakes because, while there are just a few of these buildings throughout California, they often house large occupancies, and just one collapse could cause hundreds of deaths. In the 1971 earthquake, three such hospital buildings in the San Fernando Valley collapsed, killing 52 people.

High-risk building types include nonductile concrete frames, URMs, tilt-up concrete walls, precast and prestressed concrete elements, and inadequately braced or "soft" first stories. Above-grade concrete parking structures and concrete or steel-frame buildings with URM infill are also commonly regarded as potentially hazardous in earthquakes.

Unfortunately, little information is available concerning the total number of buildings of various types and their locations to help in planning and carrying out retrofit programs. The experience after the Northridge earthquake shows that there is no systematic collection of information on good or poor performance of the various building systems. Much of the information collected has been anecdotal and thus is likely to be incomplete and biased. Each community should consider developing a database containing information on structural type, age, size, location, and occupancy of each vulnerable building to estimate number of buildings expected to be damaged in an earthquake and to encourage owners to retrofit buildings. In addition, the database would allow for much more realistic use of hazard mapping results and emergency planning scenarios.

Efforts to seismically upgrade or retrofit existing structures pose complex policy and engineering issues including identifying and evaluating specific vulnerable structures, setting priorities for retrofit, establishing uniform retrofit standards and performance objectives or acceptable damage levels, providing appropriate incentives to encourage mitigation, and in some cases mandating action.

It is important to stress that though the state and local government will suffer indirect losses



Photograph 3: The Oddfellows building in Watsonville lost its upper wall during the 1989 Loma Prieta earthquake and caused one death.

caused when private structures are damaged, it is the building owner—public or private—who bears the brunt of the loss and liability for injuries. Owners have the most to lose in earthquakes and the most to gain from retrofitting.

Building owners, whether individuals or companies in the private sector, school and hospital boards, or state or local agencies are responsible for the performance of their buildings. Legal defenses based on not knowing of a structure's vulnerability will fall on deaf ears. A 1985 legal opinion by the Attorney General states that an engineer who determines that there is an imminent risk of serious injury to the occupants of a building and who is advised by the owner that no disclosure or remedial action is intended, has a duty to warn the identifiable occupants or, if that is not feasible, to notify the building official or other appropriate authority of such determinations (*The Right to Know*, SSC 92-03).

State and local governments can help building owners manage seismic risk by encouraging planning and providing decision-making methodologies, retrofit standards, and incentives.

Photograph 4: Closeup of photograph 3.

The URM Law

The URM Law requires cities and counties within California's Seismic Hazard Zone 4 to do two things. First, they must inventory all unreinforced masonry buildings in their jurisdictions; second, they must establish local programs to mitigate the earthquake risks in those buildings. These programs must include notifying the building owners of the potential earthquake risks and should also include steps to mitigate the risks. The law recommends including the following:

- *Adoption of a mandatory strengthening program by ordinance to reduce the risks of unreinforced masonry buildings.*
- *Standards for the seismic retrofit of these buildings.*
- *Measures to reduce the number of occupants in these buildings.*

Variations in the details of the risk mitigation programs can be adopted by local governments to reflect local conditions and economic constraints. One intent of the URM Law is to provide local governments the flexibility to manage effective earthquake risk-reduction programs.

Seismic Hazard Zone 4 includes the major metropolitan areas of the Los Angeles Basin and the San Francisco Bay Area, and roughly 24 million people, or 80 percent of the state's population. This is the region of highest earthquake vulnerability in the nation.

Approximately 25,000 URM buildings with an average size of 10,000 square feet have been inventoried in Zone 4's 365 jurisdictions. Carrying out this program requires thousands of officials in hundreds of jurisdictions, thousands of civil and structural engineers, architects, building contractors, tens of thousands of buildings owners, and millions of tenants in these buildings to understand, to differing degrees, why these buildings are dangerous, and how they can be strengthened.

In the 1980s it was estimated that the URM Law would result in $4 billion in expenditures into the next century to reduce earthquake risks. This cost, although large, pales in comparison with the $200 billion in anticipated damage from a single major urban earthquake in California. Future earthquake losses can be greatly reduced by establishing effective URM risk-reduction programs.

Status of the Law's Implementation

The Seismic Safety Commission is encouraged by the response of local governments to the URM Law. All except one of the jurisdictions affected have begun to take steps to comply with the law:

- *84 percent of the communities are in substantial compliance with the law, up slightly from 78 percent in 1992. Of those, 64 percent have established their mitigation programs. These communities include most of the URM buildings—94 percent—affected by the law. The other 20 percent of the communities have no URM buildings.*
- *12 percent have completed their inventories and are still working on establishing programs.*
- *4 percent have their inventories in progress.*

Table 1 provides a summary of the law's implementation. "Substantial Compliance" includes some cities that have established mitigation programs for most of their buildings but have not completed their inventories.

Table 1 shows that we have 12 more mandatory strengthening programs than in 1992. This reflects the efforts by several local governments to make substantial improvements to their existing programs. Many local governments have also updated their risk reduction standards by adopting the State's Model Code, the Uniform Code for Building Conservation's Appendix Chapter 1.

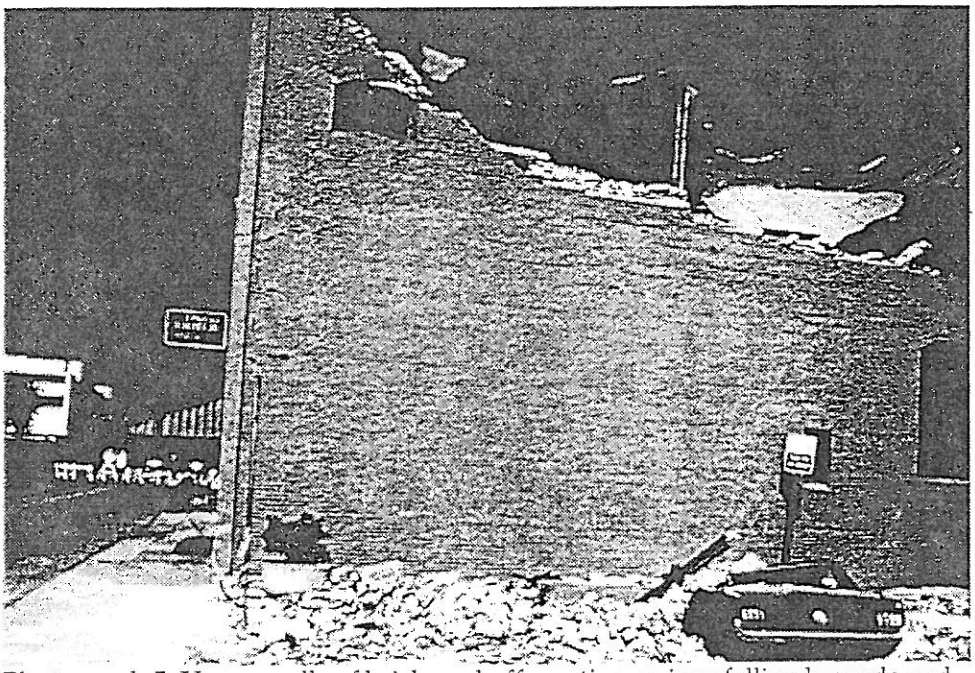
Table 1—State Summary of the URM Law Implementation

	Jurisdictions	Percentages	Population	Percentages	URMs	Percentages
Cities without inventories started	0	0.0%	0	0.0%	0	0.0%
Cities with inventories not completed	12	3.3	1,450,385	5.5	302	1.2
Cities with inventory completed—No mitigation program started	42	11.5	1,600,130	6.1	1,110	4.4
Cities with no URMs	70	19.1	2,123,815	8.0	0	0.0
Cities with mitigation programs	213	58.2	16,820,595	63.7	22,648	90.3
Cities in Zone 4 affected by the URM Law	337	92.1%	21,994,925	83.3%	24,060	96.0%
Counties without inventories started	0	0.0%	0	0.0%	0	0.0%
Counties with inventories not completed	2	0.5	32,100	0.1	26	0.1
Counties with inventory completed—No mitigation program started	2	0.5	63,625	0.2	13	0.1
Counties with no URMs	5	1.4	505,350	1.9	0	0.0
Counties with mitigation programs	20	5.5	3,821,500	14.5	971	3.9
Counties in Zone 4 affected by the URM Law	29	7.9%	4,422,575	16.7%	1010	4.0%
Cities and counties without inventories started	0	0.0%	0	0.0%	0	0.0%
Cities and counties with inventories not completed	14	3.8	1,482,485	5.6	328	1.3
Cities and counties with inventory completed—No mitigation program started	44	12.0	1,663,755	6.3	1,123	4.5
Cities and counties with no URMs	75	20.5	2,629,165	10.0	0	0.0
Cities and counties with mitigation programs	233	63.7	20,642,095	78.1	23,619	94.2
Total cities and counties in Zone 4	366	100.0%	26,417,500	100.0%	25,070	100.0%
Types of mitigation programs established						
Mandatory Strengthening Program	122	52.4%	14,475,685	70.1%	17,768	75.2%
Voluntary Strengthening Program	34	14.6	1,606,700	7.8	1,143	4.8
Notification Only	42	18.0	2,407,610	11.7	1,610	6.8
Other	35	15.0	2,152,100	10.4	3,098	13.1
Total cities and counties with mitigation programs	233	100.0%	20,642,095	100.00%	23,619	100.00%
Cities and Couties that replied to the 1995 URM Survey	223	60.9%	19,299,955	73.1%	20,216	80.6%

The status of the law's implementation is being monitored by the Seismic Safety Commission through telephone calls and written reports from cities and counties. Although the Commission received numerous reports over the last nine years, several of Seismic Zone 4's local governments still have not sent written reports to the Commission. Most of these non-complying jurisdictions, however, have few or no URM buildings.

The Commission has sent copies of Appendix A to each local government with URM buildings for their review and update. Many cities are now beginning to report the numbers of buildings that are retrofitted or in progress. See Appendix A.

Approximately 50 percent of the buildings have had their risks significantly reduced, the majority of which are in the Los Angeles Basin.



Photograph 5: Upper walls of brick peel off creating serious falling hazards and roof instability (1987 Whittier earthquake).

Earlier Legislation

(Excerpt from SB 547: A Political History, Tobin, 1990 and Building Code Requirements for Seismic Safety, SSC, November, 1985)

Although unreinforced masonry construction was recognized by codes in 1933 as an unsuitable structural material, and no new unreinforced masonry buildings had been constructed since approximately 1949, it wasn't until 1977 that the Seismic Safety Commission and Senator Alquist began a push for legislation to address the hazard posed by the tens of thousands of existing unreinforced masonry buildings.

In the spring of 1978, in a report to the Seismic Safety Commission, Commissioner Louise Giersch, Chairman of the Hazardous Buildings Committee, recommended "that the Seismic Safety Commission sponsor urgency legislation to amend the state law to authorize local governments to establish and implement 'life safety' standards for hazardous buildings retrofit."

The committee had determined that requiring hazardous buildings to be retrofitted to comply fully with modern building codes written for new construction was often both economically prohibitive and politically infeasible. This determination was based on the comments and recommendations of task groups consisting of local government officials, structural engineers, construction professionals and commissioners that participated in the Commission's Hazardous Buildings Workshop in 1977. The task groups recommended that an appropriate retrofit standard should improve life safety and not be concerned with property damage.

As a consequence of the above recommendation, a bill was drafted by the Commission. Senate Bill 445 (Alquist) was designed to relax the requirement that local building officials enforce the provisions of the California Administrative Code, Title 24, which is basically the latest edition of the Uniform Building Code. Thus, cities and counties could establish construction standards for the retrofit of existing buildings identified as being hazardous in the event of an earthquake without complying with the latest building code governing *new* construction.

The following are some of the other important provisions established in SB 445.:

- Each local agency may assess the earthquake hazard in its jurisdiction and identify hazardous buildings that
  - were constructed before local building codes required seismic resistant design;
  - are constructed of unreinforced masonry bearing wall construction and exhibit any of the following characteristics:

1. Exterior parapets or ornamentation that may fall (Photograph 5);

2. Exterior walls that are to anchored to the floors or roof; or
3. Lack an effective system to resist seismic forces.

- Local agencies may by ordinance establish higher standards for the reconstruction of structures or buildings needed for emergency purposes after an earthquake, such as fire and police stations and disaster operations centers.
- If a buildings is identified as a seismic hazard and is reconstructed with building standards adopted pursuant to SB 445, the building shall not, within a period of 15 years, be identified as a seismic hazard.

After SB 445 was signed by the Governor in 1979, newsletters distributed by such organizations as the League of cities, the Earthquake Engineering Research Institute, the California Supervisors Association, and the Office of Planning and Research alerted cities and counties statewide to the new legislation and the opportunity afforded to local jurisdictions. Hazardous building mitigation programs could then be undertaken, since the major impediment had been removed by the legislation. Such announcements were greeted with a lack of enthusiasm, since cities and counties were just beginning to realize the difficult fiscal consequences thrust upon them by Proposition 13.

In 1982, in response to a legislative requirement (AB 604, Rosenthal), the Seismic Safety Commission undertook a survey of all cities and counties in an effort to determine the number of potentially hazardous buildings as defined by that legislation. A cover letter that accompanied the survey, which went to managers and administrative officials of 430 cities and all 58 counties, outlined some of the features of SB 445 and cited the sections in it regarding legal immunity for local jurisdictions undertaking hazardous building surveys. In spite of concerted efforts to advertise widely SB 445, local agencies showed little interest.

SB 445 Did Not Work

When SB 445 was introduced in 1979, the Seismic Safety Commission believed that local jurisdictions were anxious to commence programs to relieve the hazardous building problem but could not because the seismic building codes were principally designed to regulate new construction. But after the legislation became law, there was little interest in pursuing any such programs. In fact, between 1979 and 1985, only three cities and no counties began hazardous building mitigation programs, and one of the three cities (Morgan Hill) was anxious to commence a program only after the April 1984 earthquake damaged many of its unreinforced masonry buildings. In other words, it took a damaging earthquake for this small city to realize the problem and attempt resolution.

A few cities have gone about solving the hazardous building problem in their communities without earthquakes, and on their own. Although their approaches to solving the problem vary and the financing of such programs differ, they all have the same goal: reduce the life safety hazard through rehabilitation—or as a last resort, demolition—of hazardous buildings.

Senate Bill 445 was not responsible for the programs that two of the cities began. When asked about motivation for beginning a hazardous building program, a Santa Ana building official said that he was unaware of any such legislation or law when they began. The other hazardous building program, begun in 1983 by the City of Los Angeles, had been in the proposal stage for about ten years. It just happened that in 1983 the political atmosphere was right for passing a hazardous building ordinance. SB 445 had no influence in motivating any city or county to initiate programs for dealing with the hazardous building problem.

The Commission realized by 1983 that the voluntary program was not reducing the hazard rapidly enough, and the Coalinga earthquake demonstrated once again the poor performance of unreinforced masonry buildings. The damage

was so dramatic that politicians could easily see the difference.

A successful hazardous building program that served as a model for the rest of California was the City of Los Angeles' program. Through the adoption of an ordinance by the city council in 1983, Los Angeles first conducted an inventory identifying approximately 8000 unreinforced masonry buildings in need of seismic rehabilitation. Owners of the most hazardous buildings were notified that their structures needed repair. The Costs of building rehabilitation, including building fees, plans inspections, and construction are paid by the building owners. Most of the city's $300,000 annual cost of administering the program was borne through construction filing fees.

The Los Angeles hazardous building ordinance was challenged in court in 1984 (Varenfeld V. City of Los Angeles). The trial court ruled in favor of the city and the court clarified that an ordinance requiring building owners to improve or demolish their buildings at their own expense does not involve the taking of private property without compensation. Rather, the court held that such an actin is simply an exercise of a community's police powers.

The Los Angeles program and programs administered by other cities have recognized the importance of incentives to make retrofits more attractive and motivate building owners to retrofit their buildings. State law (through referendum) provides that any reconstruction done for seismic purposes is not considered an improvement to property and is exempt from local property taxes for a period of 15 years. This tax incentive, and the certainty of a fifteen-year period during which retrofitted building will not again be identified as hazardous, has resulted in fewer demolished buildings and more retrofits.

Because the Seismic Safety Commission had sponsored SB 445 and promoted and publicized its existence, the lack of progress of adoption of such ordinances is a disappointment. In 1984, five years after SB 445 became law, the Commission concluded that the only way to initiate hazardous buildings programs was to create a state-mandated program; in other words, the state must *require* cities and counties to establish hazardous building programs.

Senate Bill 1797

In 1984 the Commission sponsored legislation (SB 1797, Alquist) to mandate local programs addressing unreinforced masonry buildings.

Under SB 1979 local governments were to do the following:

- Identify all potentially hazardous buildings.
- Establish a hazardous buildings mitigation program to include:
  - Notifying the local owner that the building has been listed as hazardous by the local building department.
  - Urging owners to seek out ways to reconstruct the buildings to a safer standard.

The legislation provided $5 million to cover the mandated costs to cities and counties to carry out the building inventories and propose mitigation programs.

This legislation passed both houses of the Legislature but found little support with the administration, which believed that a state-mandated local program should not be imposed. Citing the fact that there was already ample enabling legislation *allowing* cities and counties to implement hazardous building programs (SB 445), in September 1984 the governor vetoed SB 1797.

The Governor's veto message argued that local governments already had the authority to do what was called for, so that a state mandate was not needed.

Senate Bill 547

(Excerpt from SB 547: A Political History, Tobin, 1990)

In 1985, the Commission and Senator Alquist introduced Senate Bill 547 which was less comprehensive but very similar to Senate Bill 1797. It was amended to assure that the state would not assume a new financial burden. In return local governments were given flexibility in adopting mitigation programs rather than

mandating a uniform statewide program. This approach deferred hard choices to local governments by allowing flexibility for locally tailored mitigation programs, and it also placed additional political and financial burdens on local governments. A sophisticated analysis of the multiple policy issues involving engineering standards and practices, social considerations of affordable housing, historic and community values, and financial implications of the bill was not done by the legislature.

The bill proposed to give local governments additional flexibility regarding the mitigation program compared to the Commission's original desire to require mandatory strengthening ordinances. California has a long tradition of strong local government control and independence on most matters, especially matters of building regulation. Although the state has mandated local governments to enforce a minimum building code for over fifty years, codes to reduce seismic risk in existing buildings retroactively were not widely enforced.

The bill's proposed lead role for the Office of the State Architect was deleted after it took a position to oppose the bill unless it was amended to appropriate additional funds. The Commission reluctantly took on the responsibility of preparing a guidebook for local governments and monitoring the status of compliance.

When a state law mandates action by local governments, the California Constitution requires the state to pay the local government's cost. The reimbursement process, known as the SB 90 claims process, was also an issue; state officials believe local governments abuse this process by asking for too much, while local government officials claim the state pays only a portion of legitimate claims. Senate Bill 547 was originally written to appropriate $5,000,000 for reimbursing local governments. However, the Governor's Office questioned paying local governments for activities that they should already be doing and the equity of providing an incentive, or a reward, to local governments that had done nothing regarding unreinforced masonry buildings while the other jurisdictions that had faced the issue already had borne the full cost. Furthermore, the Department of Finance argued that $5,000,000 was too much money for this effort given a tight state budget and other priorities. At first, the bill was amended by the Assembly Ways and Means Committee to reduce the appropriation to cover just the first year's claims, with adjustments to be made through the annual budget process. The effective period for claims reimbursement was limited to costs incurred after the law became effective and before the inventory deadline of January 1, 1990. The amount to be claimed was limited to $100 per building. These compromises did not result in support from the Governor's office, or from several members of the Assembly.

The bill was further amended to apply only to Seismic Zone 4, rather than the entire state. By limiting the application of mandatory requirements to Zone 4, the state could limit its expenditures and spend its limited funds in the areas of greatest risk.

An amendment was suggested by the Department of Finance at an Assembly Ways and Means Committee hearing to avoid the funding issue by allowing local governments to cover their cost by charging a fee. The author accepted the amendment when it became clear that a majority of the members would not appropriate state general funds to pay for a mandatory program. Up until that moment, the League of California Cities and the California Association of Building Officials supported the measure; from then on they opposed it, because they believed it impractical to charge a fee for an inventory and they resisted local governments' undertaking a state mandate without state compensation. The amendment was a significant weakening of the bill because the money was the most important incentive for local governments complying in a timely manner. Timing in the legislative process did not allow the author to amend the bill back to statewide application.

The bill was also amended before the Assembly Governmental Organization Committee after a structural engineer, Mr. Stanley Mendes, testified that it should include unreinforced masonry walls that were nonbearing. The

committee struck the word "bearing" from the definition of potentially hazardous buildings and extended the bill to thousands of concrete- and steel-frame buildings with unreinforced infill walls, stair wells and elevator shafts.

An amendment excluding "historic buildings" from the inventory portion of the bill was accepted by the committee upon the urging of the City of Monterey with the backing of the League of California Cities. Although the outward purpose of this amendment was to exempt cities from re-inventorying early California adobe buildings which had already been placed on historical building lists, the exemption has been a serious weakness and confusing aspect of the law. While historic buildings are exempt from the inventory portion of SB547, they are to be included in seismic risk reduction programs (Photograph 6).

After these amendments, Senate Bill 547 was eventually signed into law in July 1986 (Chapter 250, Statutes of 1986).

The URM Posting and Disclosure Laws

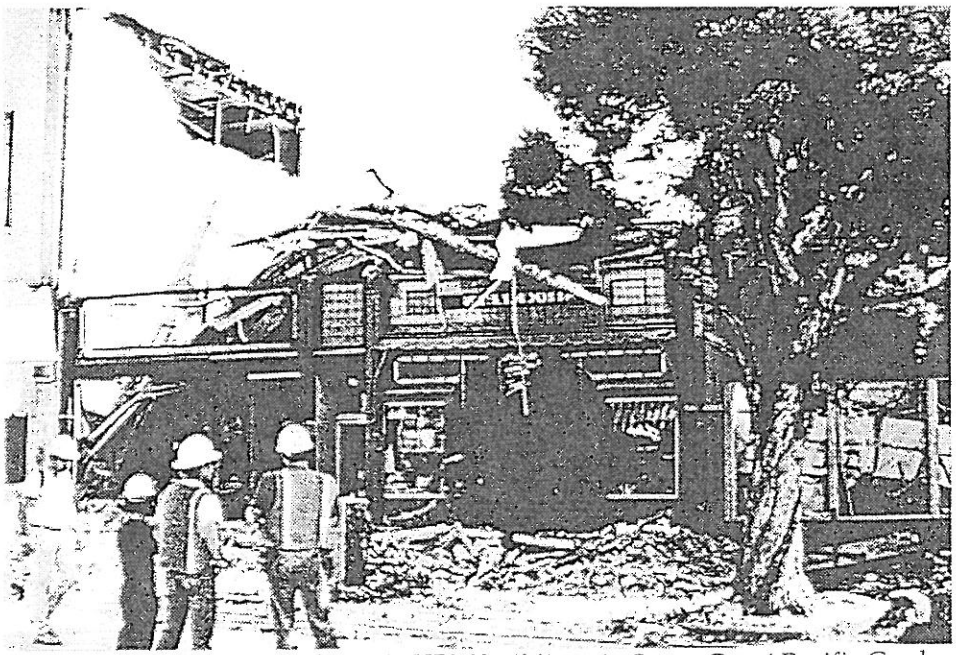
(Excerpt in part from Turning Loss to Gain, SSC 95-01)

A 1992 state law, (AB 1963, Areias, Chapter 941) requires sellers of unreinforced masonry buildings to provide the *Commercial Property Owner's Guide to Earthquake Safety* (SSC 93-01) to prospective buyers. This guide contains a recommended earthquake weakness disclosure form to enhance awareness during real estate transactions. Similar laws encourage the disclosure of earthquake weaknesses in older homes, tiltups, and concrete buildings.

This new law also requires owners to place placards at the main entrances to URM buildings warning the public about earthquake risk. However, no government agency is responsible for enforcing these laws, so compliance is spotty at best. As reported by the local governments who responded to the 1995 survey, only 2 percent of the URM buildings have placards.

Furthermore, AB1963 was written such that placards cannot be taken down once a URM building has been retrofitted. If this law were simply amended to allow the placards to be removed, owners would more likely be encouraged to retrofit. Recent Commission attempts to sponsor legislation to amend the state's posting law and further encourage retrofits have not succeeded.

Even if governments required a formal disclosure of seismic risk that included a clarification of the benefits and limitations of retrofitting, most building owners are still not equipped to understand or manage their seismic risk in any comprehensive way.



Photograph 6: Damage to historic URM buildings in Santa Cruz' Pacific Garden Mall after the 1989 Loma Prieta earthquake.

Building Code Laws Related to the URM Law

The URM Law required the Seismic Safety Commission to develop a guidebook to assist local governments in inventorying URM buildings and establishing risk reduction programs. The Commission published *The Guidebook and Appendix to Identify and Mitigate Seismic Hazards in Buildings* (SSC 87-03) and *Steps to Earthquake Safety for Local Government* (SSC 88-01). Due to the lack of uniformly accepted building codes for the seismic retrofit of URM buildings at the time, the Commission reprinted its *Draft Model Ordinance* (SSC 85-06), *The State Historical Building Code* (Title 24, CCR, Part 8), and Appendix Chapter 1 of the Uniform Code for Building Conservation (UCBC) (ICBO, 1987) in the *Appendix* to the *Guidebook.*

However, the Commission was aware that, despite all of these available documents, the state lacked a single widely accepted model code for seismic retrofit. So the Commission and the Building Standards Commission encouraged the California Building Officials and the Structural Engineers Association of California to develop a code change proposal for the International Conference of Building Officials that modified and updated the UCBC Appendix Chapter 1. This effort is described in further detail in the section titled Building Code Development.

In 1991, the Commission sponsored AB 204 (Cortese, Chapter 173), which made the UCBC Appendix Chapter 1 a model building code throughout California. This requires all building code enforcement agencies to enforce the code whenever a building permit is issued on bearing wall URM buildings.

Subsequent legislation, AB 2358 (Frazee) and AB 1904 (Brown) opened, closed, complicated, and clarified the applicability of this new model code to existing URM buildings. At present, because most local building departments prefer to rely on uniform codes these subsequent amendments to state law have not had a widespread effect on retrofit building codes.

Local Government Pioneers

(excerpts from 1988 URM Status Report, SSC 88-03)

The pioneering efforts of cities such as Long Beach, Santa Rosa, Santa Ana, Los Angeles, and Palo Alto showed that the hazards of URM buildings can be mitigated, and led to the development and passage of the URM Law. The cities of Gardena, Huntington Beach, Morgan Hill, Santa Monica, and Sebastopol also had hazardous building ordinances in effect prior to the enactment of the URM Law, and Anaheim has used a redevelopment program to reduce hazards.

Long Beach

Long Beach enacted the first of these ordinances. A 1959 change to the municipal building regulations empowered the city to require that existing earthquake hazardous buildings be retrofitted to a safe condition or be demolished. The standards used for retrofit were the then-current criteria for public school buildings. This standard was modified by a 1971 ordinance and was further refined in 1976 and 1990 to establish the current program, which affects 936 URM buildings constructed prior to 1934. As of 1995, 523 buildings in Long Beach had been retrofitted and 361 demolished.

Santa Rosa

After its damaging 1969 earthquakes, Santa Rosa adopted an ordinance that includes not only URM buildings but all buildings except one- and two-family dwellings built prior to 1958. Santa Rosa's ordinance was refined in 1979, and the program continues today utilizing the 1955 UBC, with some modifications, as a structural standard. As of 1995, 43 URM buildings had been retrofitted, eight had been demolished, and 14 had no progress.

Sebastopol

Sebastopol, which was also affected by the Santa Rosa earthquake, adopted a policy in 1969 that identified 39 buildings, 25 of them URM, and required them to meet the standards of the 1958 UBC upon sale of the property or a change in occupancy. In 1981, the policy was revised to speed up the process; four buildings were drawn in a lottery each year, and the "winning" owners are given a period of seven years to complete their repairs. As of 1995, 22 buildings were retrofitted.

Santa Monica

In 1978, Santa Monica adopted an ordinance requiring inventorying of the city's URM buildings and placing a notice on the title of each of the approximately 240 buildings involved stating that the building was not in compliance with the structural requirements of the 1933 Riley Act. The ordinance did not require the buildings to be strengthened. A 1981 ordinance requires the installation of wall anchors in URM buildings without such structural ties. The wall-anchor program has been fully implemented and approximately 50 buildings, representing nearly one-third of the total URM floor area in the city, have been voluntarily repaired to standards equivalent to those in the Los Angeles Division 88 building ordinance.

A 1989 ordinance required seismic risk evaluation reports and a 1992 ordinance established a mandatory strengthening program. 65 buildings still require retrofits as of 1995 and 14 were demolished after sustaining damage during the January 1994 Northridge earthquake.

Gardena

Gardena adopted an ordinance with structural provisions similar to those of Long Beach in 1979. Nineteen URM were affected, but due to lack of building owners' financial resources to pay for strengthening, only eight buildings had been repaired as of June 1995.

Huntington Beach

The city of Huntington Beach adopted an ordinance similar to that of Long Beach,

affecting 51 URM buildings, in 1979. An inventory and brief structural report on each building was made in 1980, but implementation did not begin until 1985, following the completion of a coastal redevelopment plan. The ordinance uses the 1976 UBC as a structural standard but reduces the seismic for factors to 75 percent of the 1976 code values. As of 1995, 42 buildings have been repaired or demolished under the program.

Santa Ana

In 1980, the city of Santa Ana adopted an ordinance requiring the repair of 208 URM bearing-wall buildings to a standard very similar to that of the city of Los Angeles ordinance, though Santa Ana's ordinance does not grant additional time for partial strengthening as was permitted in Los Angeles. As of 1995, 139 buildings have been completely retrofitted; 51 were demolished by the owners.

Morgan Hill

Immediately after its damaging earthquake of 1984, Morgan Hill adopted an ordinance based on the city of Los Angeles requirements. Six of Morgan Hill's 14 URM buildings have been demolished and the remaining six have been repaired and retrofitted.

Palo Alto

Palo alto's 1986 ordinance affect 49 URM buildings and about fifty other buildings built prior to 1976. It utilizes the provisions of the Uniform Building Code for Building Conservation for URM bearing-wall buildings and the 1973 UBC for all other construction types. The ordinance is unusual in that it does not require owners to make repairs, but does require a rigorous structural evaluation to determine the collapse potential of the building and specify its structural deficiencies.

A Commission publication titled *Earthquake Hazard Identification and Voluntary Mitigation: Palo Alto's City Ordinance* (SSC 90-05) describes this program, its evolution, and its advantages and disadvantages.

Los Angeles

In 1981, Los Angles adopted an ordinance, titled Division 88, affecting all URM bearing-wall buildings constructed prior to 1934, except for dwellings with five or fewer units. It provides for two levels of repair, the first comprising wall anchors only and the second addressing the overall seismic-resisting system. The ordinance covered approximately 8,222 buildings, of which 270 have since been exempted. It was revised in 1986 to reduce compliance time schedules in reaction to the 1985 Mexico City earthquake, and the structural standards were reviewed and revised with respect to the performance of URM buildings during the 1987 Whittier Narrows earthquake.

Land Use and Occupancy Impacts of L. A.'s Ordinance

(excerpt from ,Strengthening Unreinforced Masonry Buildings in Los Angeles, 1990)

In this National Science Foundation report, authors Martha Blair Tyler and Penelope Gregory studied the land use and occupancy impacts of Division 88. They identified impacts and interviewed URM building owners in four neighborhoods. Their key findings and recommendations are listed below:

Decisions to Retrofit

- General optimism about the future of the market area is often sufficient to justify seismic retrofits.
- Decisions are affected by specific real estate market conditions that may pertain to very small areas.
- Compliance comes first and easiest in transitional areas.

Land use changes

- Fewer owners than anticipated have chosen to demolish URM buildings.
- Demolitions of URM buildings are occurring in areas where non-URM buildings are also being demolished.
- Partial demolitions are a logical response to requirements to retrofit underutilized buildings.

- Seismic retrofits are likely to accelerate ongoing land use changes.
- Zoning regulations influence the choices of owners.
- The difficulty in meeting on-site parking requirements for a new building is often a factor in the decision to retrofit an existing building.

Occupancy Changes and Tenant Displacements

- Owners of both commercial and residential buildings often choose to do the seismic work with tenants in place.
- Rent increases displace both commercial and residential tenants.
- Displaced commercial tenants tend to be replaced with similar kinds of tenants.

Historical Buildings and Architectural Character

- Owners can be caught between regulations requiring them to preserve historic buildings and the seismic requirements.
- Architectural character is affected by seismic work.
- Bricking in windows impairs the character and livability of residential buildings.

The Strengthening Process

- Competent structural engineers and contractors are key to a smooth process.
- Inaccurate time and cost estimates are a problem for owners.
- Public assistance with too many strings will not be used.
- Cosmetic work is more likely to be done on residential than commercial buildings.

Recommendations for Other Jurisdictions

- Establish priorities for seismic retrofits by areas or by city blocks.
- Coordinate seismic retrofits with redevelopment.
- Seek alternative housing for low-income tenants.
- Make full use of land-use regulations.
- Develop a program to help owners of historic buildings.
- Consider grants or loans to defray engineering costs.
- Consider options for training local engineers and contractors.
- Develop an interagency plan for coordination.

In no case, do the impacts of Division 88 even approach those of an earthquake such as the 1989 Loma Prieta event.

Copies of this report are available for $15 from William Spangle and Associates, Inc., City and Regional Planners, 3240 Alpine Road, Portola Valley, California 94028.

Observations from Pioneering Cities

The city programs outlined above use eight different structural standards, and each uses a different time schedule. Three cities include buildings of structural types others than URM, two cities do not require strengthening but have succeeded in obtaining voluntary compliance, and one city has mitigated URM buildings through redevelopment and demolition without adopting an ordinance requiring retrofit. Three cities adopted ordinances after a damaging local earthquake.

The evidence suggests that individual communities will pursue mitigation programs best suited to their own local priorities and reflecting a local balance of economic and safety issues.

Types of Mitigation Programs

(excerpt from 1990 URM Status Report, SSC 90-03)

Earthquake risk mitigation programs for unreinforced masonry buildings typically consist of local ordinances with both technical and administrative provisions. The technical provisions specify the seismic retrofit standards that the buildings must meet, and the administrative provisions establish procedures, set priorities, and specify the time allowed for building owners to comply with the seismic retrofit standards.

The types of mitigation programs currently established are summarized in Table 2. They can be grouped into four categories: mandatory strengthening programs, voluntary strengthening programs, notification-only programs, and other programs.

Mandatory Strengthening

The most common types of programs adopted since the passage of the URM Law are based on the City of Los Angeles Division 88 ordinance, which is also the basis for the Uniform Code for Building Conservation (UCBC) Appendix Chapter 1 and the Commission's Model Ordinance that is recommended to local governments. Mandatory strengthening programs require building owners to strengthen their buildings within established time frames ranging from one to more than seven years, depending on the number of building occupants. The Commission updated its recommended model ordinance in June 1995 to incorporate changes to the UCBC as recommended by the Structural Engineers Association of California and the California Building Officials. See Appendix D for the Commission's latest model ordinance.

Nine mandatory programs were adopted before the passage of the state's URM Law in 1986. Cities in this category include Los Angeles, Long Beach, Santa Rosa, Sebastopol, Gardena, Huntington Beach, Morgan Hill, Santa Ana, and Santa Monica. Descriptions of these programs can be found in the section titled "Local Government Pioneers."

Voluntary Strengthening

Often modeled after the City of Palo Alto's program, voluntary strengthening programs establish seismic retrofit standards for unreinforced masonry buildings, require owners to prepare an earthquake risk evaluation report, and require them to write a letter that states their intentions to reduce their buildings' risks. The letters and reports are made available to the public, and the owners' risk reduction actions are monitored by the building official and reported to the local governing body. For voluntary strengthening programs to be effective, planning, zoning, and other incentives are necessary to encourage building owners to reduce their risk.

For more information on voluntary strengthening programs, please refer to the Commission publication titled *Earthquake Hazard Identification and Voluntary Mitigation: Palo Alto's City Ordinance* (SSC 90-05).

Notification Only

These programs consist of local governments' simply writing building owners a letter indicating that their buildings are potentially hazardous and known to perform poorly in an earthquake. Most jurisdictions with this type of program are contemplating more comprehensive measures, since building owners are not provided encouragement, alternatives, or seismic retrofit standards. Notification-only programs have proven to be ineffective for reducing earthquake hazards, as well as troublesome for cities and building owners.

The Commission believes that such programs do not meet the intent of the law, which is to provide local governments with the flexibility to develop unique yet effective risk-reduction programs.

Table 2—Advantages and Disadvantages of Major Types of Mitigation Programs for Unreinforced Masonry Buildings

Program Description	*Advantages*	*Disadvantages*
Mandatory Strengthening Programs		
• Requires owners to reduce earthquake risks within established time frames • Time frames for compliance start when an order is issued by the Building Department • Establishes seismic retrofit technical standards • Sets a goal of risk reduction—not total elimination of the risks • Provides for appeals	• Local governments can effectively enforce the program and reduce risks • Building departments can monitor and report progress • Building departments can control compliance rates by slowing down or speeding up the issuance of orders to building owners • Compliance rates vary with the number of building occupants, with longer time frames for smaller buildings • Most other local governments have similar programs.	• Imposes arbitrary and at times inflexible deadlines on building owners • Compliance schedules do not necessarily reflect the limits of the local design and construction industry resources. • Can impose economic hardships on owners and occupants • Compliance schedules do not consider risks to passersby or risks from adjacent or unoccupied buildings.
Voluntary Strengthening Programs		
• Requires owners to prepare risk evaluation reports • Requires owners to write letters that indicate their intentions to reduce risks • Reports and letters are made available to the public • Establishes seismic retrofit technical standards • Owners set their own time frames for compliance with standards	• Provides effective disclosure of risks to owners and in some cases to tenants. • Flexible time frames for compliance can result in fewer economic difficulties • Rates of risk reduction can vary depending on owner's resources and demands on the design and construction industry • Provides an effective management and monitoring system to local governments • Local governments can always reconsider the program's progress and impose mandatory requirements if it is ineffective.	• Effective in reducing risks only if coupled with strong economic environments, and financial, planning, and zoning incentives • Not effective with owners who choose not to cooperate, and thus can be unfair to cooperative owners • May prolong overall risk reduction efforts and unacceptable earthquake risk exposure • Owners must pay higher fees to design professionals • Does not consider risk for occupants and passersby or from adjacent buildings.
Notification-Only Programs		
• Owners are notified by letter that their buildings are potentially hazardous.	• Some local governments state that it meets the minimum intent of the URM Law • Minimal initial cost to local governments • No direct cost to owners who choose to ignore risks • Can be effective if owners are few and cooperative and if governments adopt seismic retrofit standards	• Programs have been ineffective in reducing earthquake risks • Owners are not protected from future code changes if they choose to reduce risks • Owners are not encouraged to consider risk reduction • Owners are not informed of specific risks and are likely to react with disbelief • Local government can't easily monitor risk reduction progress • Imposes demands on local governments to deal with unhappy owners • Seismic retrofit standards are typically not adopted

Notification-Only Won't Save Lives

(excerpt from The URM Law Bulletin #2, Tobin, 1990)

When I visited Armenia after last December's devastating earthquake, I saw firsthand the reality of the hazard of unreinforced masonry buildings. Much of the billions of dollars in damage and thousands of deaths caused by that earthquake were the direct result of URM collapse.

The Loma Prieta earthquake of October 17 made earthquake hazards of unreinforced masonry buildings and what to do about them one of California's hot topics too. Armenia raised questions in quarters where they had not been raised before, and the Loma Prieta earthquake intensified the asking among those who are more familiar with the problem. I'd like to share my thinking about the intent of the URM Law with you.

At first glance the law seems to contain permissive language: "The Mitigation program *may* include the adoption by ordinance of a hazardous buildings program, measures to strengthen buildings . . ." The intent of this language is to allow local governments to tailor programs to fit the community. Local situations vary widely, from cities or counties with one or two unreinforced masonry buildings to cities with thousands. The intent of the URM Law is to give local government needed flexibility in designing mitigation, not a means of avoiding it.

Think of it this way: when you know a river will flood your town, you must decide how and where to build the levee; you do not have the choice *not* to build the levee. Likewise, if you know your city or county is at risk from earthquakes, you must decide how, when, and where to mitigate earthquake risks because you are responsible for the safety of your citizens.

Two references in the URM Law confirm that its intent is the mitigation of earthquake risks. First, the law requires earthquake risk mitigation programs to "include notification to the legal owner." This not only ensures that owners are informed of the effort and that they are given proper notice of what the jurisdiction plans, it also indicates that the Legislature intended that notification of the owner would be only one part of a mitigation program. Second, the law requires that the Seismic Safety Commission "review and assess the effectiveness of building reconstruction standards adopted by cities and counties pursuant to this article."

Does a mitigation program that consists of only notification of the building owners constitute compliance with the URM Law? Each jurisdiction is responsible for adoption of a program that fulfills the law's purpose of saving lives and reducing injuries in earthquakes. And each jurisdiction is responsible for determining whether the program that it adopts will achieve that purpose. However, a notification-only program would not include reconstruction standards that would give building owners acceptable approaches for reducing the risks in their buildings. And, even more important, so far notification-only programs have not worked.

Santa Monica attached a "potentially hazardous" statement to URM property deeds, angering many building owners, who challenged the city's evidence that their buildings were hazardous. After over ten years of deliberation (and untold hours of city staff and council time) over this issue, Santa Monica has significantly reduced the potential earthquake hazard from its URMs.

Fortunately, only a few of the cities and counties that have reported to the Seismic Safety Commission so far have adopted notification-only programs. The Commission recommends that mitigation programs include seismic retrofit standards, priorities, schedules, and incentives, as well as notification of owners. The Model Ordinance in Appendix D of this report describes elements of a mitigation program.

The report due to the Commission by January 1, 1990, did not spell the end of the program. Most mitigation programs will take years to complete. The Commission will review the mitigation programs and seismic retrofit standards adopted by cities and counties and will periodically report its findings on the effectiveness of the programs and standards to the Legislature.

In the ensuing years, we will track progress by periodically asking local governments how

many buildings have been strengthened or demolished and how many applications for strengthening permits have been submitted, and we will continue to make recommendations to the Legislature regarding the program.

We encourage you to share your plans and procedures with us, including your incentive and financial assistance programs, pitfalls, and successes. We at the state level need to know more about local problems; other at the local level need to hear that they are not alone and that there a solutions. The Commission is also interested in hearing and actively pursuing any problems, suggestion, or criticisms related to the implementation of the URM Law.

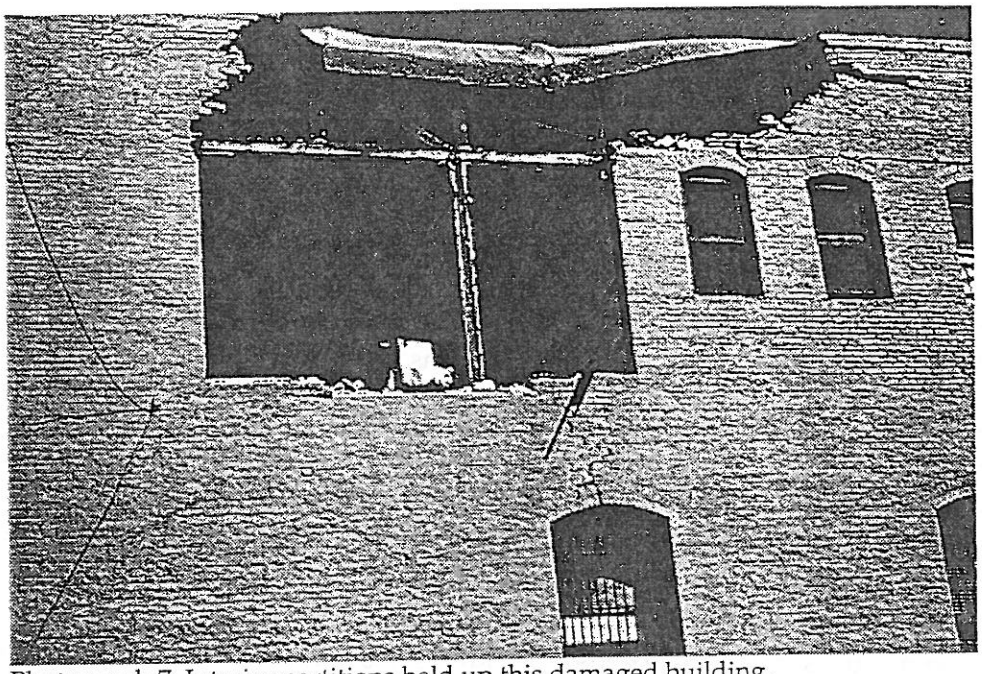
We would like to give credit to the local government staffs, committees, councils, boards, and building owners throughout the state for their understanding of the urgencies behind the law and their work to implement it. It is through their efforts in implementing this law that California will avoid a tragedy like the one that struck in Armenia.

Other Programs

(excerpt from 1990 URM Law Status Report, SSC 90-03)

There are a number of cities that have adopted programs that are in some cases variations of the above types. The cities of Bishop, Clearlake, La Verne, Lakeport, Ukiah, and Willits and Lake County have passed ordinances that require the placement of placards on URM buildings that warn occupants and passersby of the hazards.

Two jurisdictions have relied on demolition to eliminate their relatively few hazardous buildings. Elsewhere in the state, demolition has been considered a last resort. Far more buildings are being strengthened rather than torn down.



Photograph 7: Interior partitions held up this damaged building.

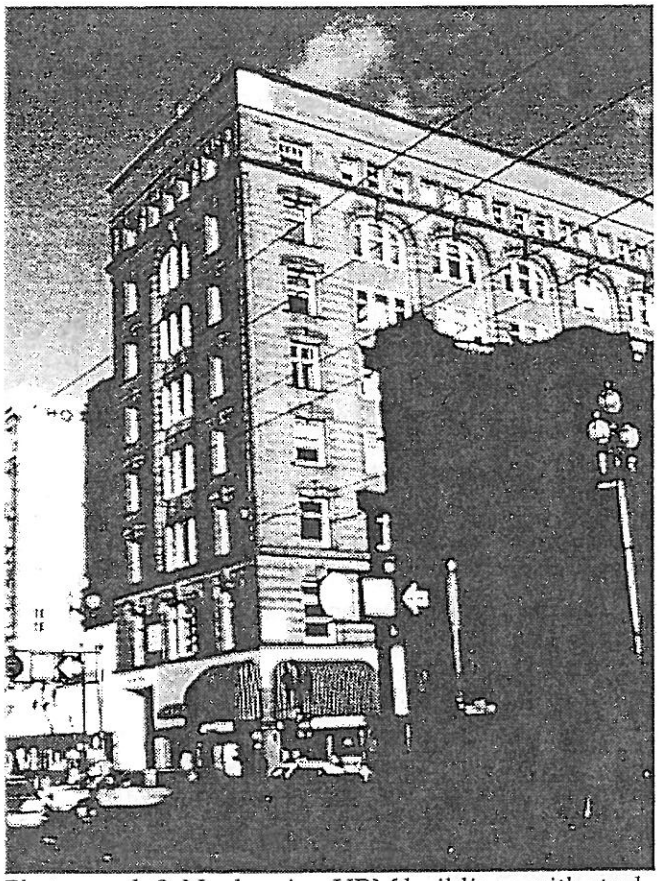
Obstacles to Implementation

(excerpt from SB547: A Political History, Tobin, 1990)

Local Government building departments are the agencies principally responsible for implementing the URM Law. They typically have few, if any, resources or staff to conduct inventories or research or to manage the process of developing mitigation programs. In many small jurisdictions, only one or two people are assigned to enforce local building codes, and even in jurisdictions with larger staffs, fluctuations in construction activity and limited budgets make it a real struggle to carry out basic code enforcement activities. Although the issues of seismic safety and existing hazardous buildings are clearly legitimate concerns for local building officials, most need additional personnel or consulting services if they are to perform the tasks required by the URM Law.

Moreover, local building officials feel the need to sell earthquake hazard reduction to their decision makers; 18 of the 39 officials responding to a 1989 questionnaire asked for video or slide materials on the URM Law for presentations to local elected officials.

The URM Law provides no state funding for local government action, but does authorize jurisdictions to levy fees to recover costs. However, many jurisdictions are unsure of who should bear the cost. If the inventory and program development costs are to be met by current building department fee collection mechanisms, an added fee for all building permit applicants would be the logical source. If the URM building owners are singled out, it would "rub salt in the wounds" of those who may later be required to spend substantial amounts to repair their buildings. It can also be argued that is unfair to assess all permit applicants for a program that may have little perceived benefit to, for example, a local resident requesting a permit for a home improvement. The jurisdictions that have programs have financed the initial costs without a recovery mechanism, but most others may not have this capability. In the face of current budget stringencies other city, and especially county, governments may be genuinely unable to allocate the resources needed to address this issue without reducing funding for basic



Photograph 8: Nonbearing URM buildings with steel or concrete frames are often not inventoried or included in mitigation programs even though state laws require them to be.

services. AB 2712 (Cortese), considered by the Legislature in 1988, would have provided low-interest loans to local governments for the specific purpose of implementing the URM Building Law.

Jurisdictions with large numbers of residential URM buildings are very concerned about the loss of low-income housing that mandatory strengthening programs may cause. They are seeking incentives, construction loans, and other financial assistance tools before establishing their mitigation programs to reduce the impacts on owners of URM properties. A sample of 16 building officials surveyed during the preparation of this report suggests that the limited quantity and availability of financial resources for building owners who are either required or might otherwise volunteer to strengthen their structures will be a major obstacle to carrying out mitigation programs.

Local governments developing hazardous building ordinances must decide on appropriate structural standards for strengthening buildings. The URM Law covers two significantly different types of buildings: those with URM bearing walls, and those with URM infill walls and concrete or steel frames. The state's model code, Uniform Code for Building Conservation, address only URM bearing-wall buildings.

Cities with mitigation programs that include nonbearing-wall URM infill and other structure types typically use an edition of the Uniform Building Code, ranging from the 1955 to the 1976 editions, with less-than-current-code standards. There is no clear consensus on the best choice, and efforts are underway to develop a statewide standard for nonbearing-wall URM buildings.

Key Factors for Local Government Compliance

(excerpt from 1990 URM Status Report and SB 547 Implementation Issues, Obstacles and Opportunities Facing Local Government, Russell, 2/88))

Four key factors appear to be necessary for the development of effective URM programs:

- *Funding*—Local government building departments must be adequately funded to initiate a new program for URM buildings. Lack of funding for local governments has delayed the implementation of the URM Law in many, especially smaller, communities.
- *Staffing*—Local government staffs must have sufficient technical background to recognize the potential impact of damaging earthquakes in their communities and that hazard reduction is both feasible and in the government's best interests. Staffs must also have the confidence and support of their elected bodies and the ability to present complex issues and alternatives.

  Some local building officials have had difficulty in obtaining additional staff, technical resources, and budget allocations

for URM programs. Many jurisdictions are experiencing a critical shortage of qualified building officials and inspectors.

In a few cases, local governments have been delayed by recent earthquakes. They must first focus on damage-repair efforts before establishing or continuing their efforts to retrofit undamaged buildings.

As an alternative to in-house technical expertise, some local governments have hired consultants to develop their URM programs.

- *Legislative Priority*—City councils and boards of supervisors must be willing to make earthquake hazard reduction a priority issue and devote time to develop an effective program that balances the needs and limitations of their community. The issues surrounding risk reduction are complex, and building owners, who will bear the financial brunt of the costs, are likely to be vocal critics of almost any program considered.
- *Concern for Liability*—Local governments and building owners are concerned about the potential for liability surrounding hazardous buildings; this has prompted many to take action.

  In California, the concept of governmental sovereign immunity has been seriously eroded, and jurisdictions that were found remiss in expediting seismic retrofits or adopting less-than-current-code standards for seismic rehabilitation could be subject to litigation, but the standard of care in this area has not been clearly defined.

  The key to avoiding liability is for government to legislate a standard to which the buildings must be retrofitted and provide immunity to civil suits to all professionals involved, including the peer reviewers working for the local jurisdiction's building department, regarding buildings retrofitted to that standard.

  Failure to comply with the URM Law by January 1, 1990, has the real potential to expose a non-complying public entity to civil liability if someone is injured. However, compliance with both prongs of the URM Law—inventory of potentially hazardous buildings and establishment of a mitigation program—may insulate public entities from a great deal of the civil liability arising from earthquake-damaged unreinforced masonry buildings.

Reasons for Local Government Noncompliance

There are a number of reasons why many cities and counties have failed to create an effective risk-reduction program. The Commission's responses to some of these concerns are given below:

- *Lack of staff or funding to inventory URM buildings.* In some cases, building departments have requested but failed to receive budget increases to fund inventories; in a few cases, departments have failed to request funding.

  Commission response: Many cities and counties are operating with severe financial and staffing constraints. The state URM Law, however, establishes a duty for local governments, and they should continue to make a good-faith effort to obtain the funds and personnel necessary to carry out their duties. Without a continuing effort, local governments may be held negligent in the event of an earthquake.
- *Lack of funding for building owners.* In some cases, local governments are waiting to adopt or enforce more comprehensive measures until more state and federal funding becomes available.

  Commission response: Rather than delaying risk reduction, local governments should establish programs with long time-frames for compliance to reflect the lack of funding. This would comply with the intent of the law and encourage owners with sufficient resources to proceed with retrofitting their buildings, while at the same time increasing demands for private and government funding.
- *Costs outweigh the benefits.* The costs to reduce hazards, when compared to property values, do not warrant the expense of seismic retrofit.

Commission response: While costs may outweigh benefits for some buildings, local governments should nevertheless disclose hazards and encourage owners to reduce them by providing alternatives, standards, and incentives such as financial, planning, and zoning incentives.

On the whole, communities will benefit from risk reduction efforts. The loss of lives, economic strength, and tax revenue is an unacceptable risk for local governments and their people. At a minimum, the Commission recommends that cities and counties adopt seismic retrofit standards and seek ways of encouraging owners to reduce their risks through long-term mandatory or voluntary strengthening programs.

- *Disaster aid will be available.* The state and federal governments will provide disaster assistance after damaging earthquakes, so some local governments don't see the benefits of risk reduction.

  Commission response: State and federal disaster aid programs will not—cannot—replace everything that is lost. After Coalinga's moderate earthquake in 1983, only about 25 cents was recovered through disaster aid for each dollar lost. Furthermore, both the state and federal governments require the damaged areas to have effective risk management plans in place before the earthquake to be eligible for future disaster relief.

- *Choosing among alternative programs.* In some cases, local governments are confused by the variety of programs being adopted by others and are waiting until they can sort out all the alternatives. The possible impacts of various alternatives are not clear, and this makes the decision process difficult.

  Commission response: The issues surrounding earthquake risk reduction are quite complex; it takes a conscientious effort by the many parties involved to weigh the possibilities and develop an effective program. Local governments should allow time to inform and involve their citizens in the development of a hazard-reduction program, and to evaluate the various alternatives thoroughly. If there are questions about the options, local governments should contact the Commission, BAREPP, SCEPP, or other local governments.

- *Waiting for others to decide.* Some local governments are anticipating the development of programs in larger nearby communities or their county before they consider their own alternatives. In some cases, cities with many URM buildings are waiting on counties that have few URM buildings outside the incorporated areas.

  Commission response: While it is prudent to strive for uniformity among an area's communities, it is recommended that each community consider its own particular circumstances. What makes sense for a county or nearby city may not be the best program for a small city nearby. Each jurisdiction needs to identify resources and priorities to develop an effective program.

- *Lack of uniform seismic retrofit standards.* Local governments delayed the adoption of seismic retrofit standards until the passage of uniform seismic retrofit standards by the International Conference of Building Officials in 1991.

  Commission response: The lack of uniform retrofit standards had indeed hindered risk-reduction programs in the 1980's. However, the 1991 Edition of the Uniform Code for Building Conservation, Appendix Chapter 1, has emerged as a widely accepted standard for bearing wall URM buildings, particularly after California adopted it as a model code in 1992.

  However, uniform retrofit standards for nonbearing-wall URM buildings are still not available. Although uniform standards are desirable, it takes time to develop and adopt them through the International Conference of Building Officials. Efforts to develop such standards have been stalled by the lack of research substantiate code requirements and technical complexities associated with steel and concrete frames that support nonbearing-wall URM buildings.

Current adoption efforts also depend on the votes from building officials throughout the western United States—many of whom are unfamiliar with California's seismic risk reduction efforts. A sufficient number of jurisdictions and design professionals must be familiar with and agree on a uniform standard before one can be adopted.

In the meantime, local governments should consult with the Seismic Safety Commission and nearby local building departments before adopting retrofit standards for nonbearing-wall URM buildings.

Adoption of interim retrofit standards is still encouraged as long as their use is independently reviewed, because they can significantly reduce risk and protect owners against future code changes. Owners who strengthen buildings in a jurisdiction without adopted standards risk being forced to comply to a future, higher standard than unadopted retrofit methods. If a city or county adopts a seismic retrofit standard—even if it is an interim standard—it protects building owners from future code changes. State law exempts buildings strengthened to earlier adopted standards from additional strengthening for a period of at least 15 years.

- *Earthquake damage has delayed implementation.* In a few cases, local governments have been delayed by recent earthquake damage, and they must first focus on implementing a damage-repair program before establishing a program for undamaged buildings.

  Commission response: Existing earthquake damage is a strong indication of the need for risk-reduction programs for undamaged buildings. Seismic retrofit in addition to repair is strongly recommended.

- *Earthquake damage is selective.* Some communities near recent earthquake damage areas were spared significant damage. Building owners in these communities are inclined to argue that their buildings have met the ultimate test and that a risk-reduction program is not necessary.

  Commission response: All earthquakes are not the same; earthquakes have been known to damage buildings that survived earlier ones. Several URM buildings that survived earlier damaging earthquakes were heavily damaged in the recent Loma Prieta earthquake.

- *Buildings have already been strengthened.* A few communities have URM buildings that have been repaired and even strengthened after surviving past earthquakes. Other communities have had a long history of voluntary risk-reduction efforts. However, since the methods used to strengthen these buildings were not actually adopted by the local governments or may not be acceptable by today's standards, these communities are faced with deciding whether or not to require additional strengthening.

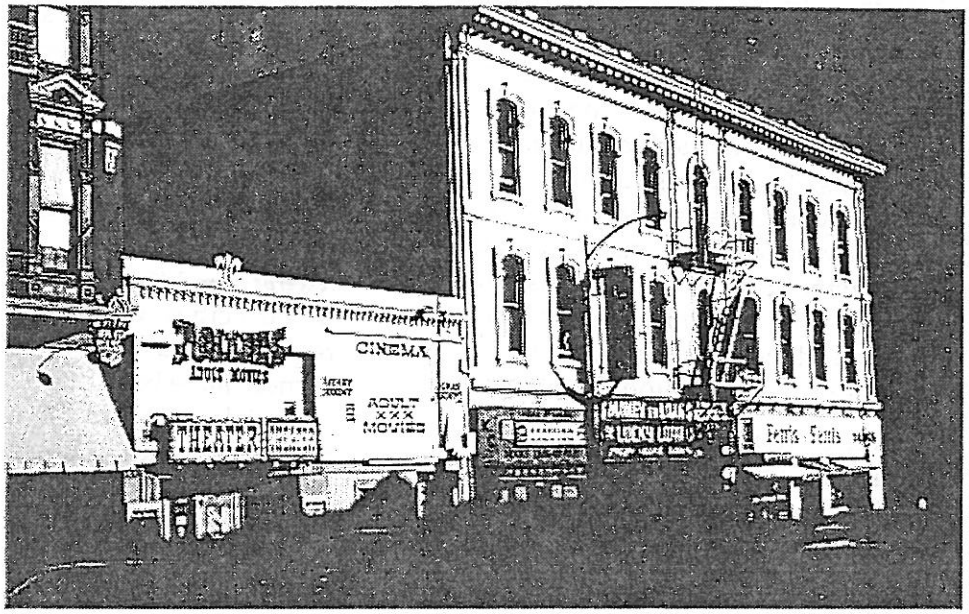
  Commission response: This is a particularly difficult situation. Nevertheless, local governments have a responsibility to ensure that buildings do not continue to pose unacceptable risks to the public. Local governments should review previously strengthened buildings and determine whether their safety is consistent with more recently developed risk reduction objectives.

- *Lack of sanctions.* Since the state has not imposed sanctions for cities and counties failing to comply with the URM Law, some local governments intend to wait until the state imposes more specific requirements.

  Commission response: Sanctions against local governments will not necessarily promote compliance. Efforts to improve financial assistance, information dissemination, and goal-setting for risk reduction are preferable.

- *State buildings are exempt.* Many local governments are concerned that state-owned buildings are exempt from the URM Law. Cities and counties are faced with major expenditures to reduce risks in their own government buildings.

  Commission response: State buildings should not be exempt from risk-reduction measures. The University of California, the California State University, and the



Photograph 9: URM buildings that are built immediately next to other buildings will pound together during earthquakes.

Department of General Services have seismic retrofit programs, have inventoried and ranked major buildings according to their risks, and have strengthened a number of buildings.

- *Earthquake risk varies in Zone 4.* Some communities were added to Seismic Hazard Zone 4 as recently as 1985. A few have argued that their earthquake risk is lower than that in the rest of Zone 4, and, therefore, a hazard-reduction program is not appropriate.

  Commission response: Earthquake risk varies within Zone 4, and there is uncertainty about the actual risk. However, the risk remains significant enough throughout the zone that risk reduction is appropriate and necessary. Many of the arguments about local variations in seismicity depend on assumptions about known active faults. The Commission believes that not enough is known about the earthquake potential on many active faults, and several recent earthquakes have occurred in Zone 4 on previously unknown faults or faults that did not rupture the ground. Reducing risks in Zone 4 URM buildings is the prudent thing to do.

- *The fear of demolition.* Communities are fearful that a URM retrofit program will alter the character of neighborhoods and encourage demolition.

  Commission response: Demolition can be minimized by establishing a program with appropriate time frames for compliance, financial assistance, incentives, and retrofit standards that balance the costs with the earthquake risk.

- *The potential loss of low-income housing, low-rent commercial space, and historical buildings.* Fears of losing URM buildings to demolition as a result of retrofit ordinances have delayed implementation. Concerns include neighborhood gentrification, new development, rent increases, and unwanted changes in the use of URM buildings. Some cities are still studying alternatives for incentives, construction loans, and other financial assistance tools before establishing or enforcing effective risk reduction programs.

  Commission response: Communities that risk losing low-income housing, low-rent commercial space, and historical buildings all at once in an earthquake will generally be better off adopting a multiyear hazard reduction effort that allows ample time for

owners to arrange retrofit financing and minimize demolition.

- *Apathy of building occupants.* When asked about their perceptions of the benefits of earthquake risk reduction, building occupants often express indifference. The temporary inconveniences of construction are annoying, and increases in rent that often finance part of the retrofits can force some tenants out. Some tenants believe that owners and local governments will benefit more from risk reduction than they will.

  Commission response: The lives of URM building occupants can be saved with retrofits. Communities should create incentives to lower costs of seismic retrofit. Building owners should attempt to improve the utility and architectural aspects of their buildings along with seismic retrofits to prolong and improve the use of these buildings. In these ways, tenants will benefit along with everyone else.

- *Concerns of building owners.* Building owners are faced with major costs to reduce risks and thus often oppose their local government's retrofit programs. Owners argue that local governments should either delay implementation or provide effective financial assistance measures. Owners believe that it is unfair to single out unreinforced masonry buildings while other potentially hazardous buildings such as older concrete buildings are not being considered.

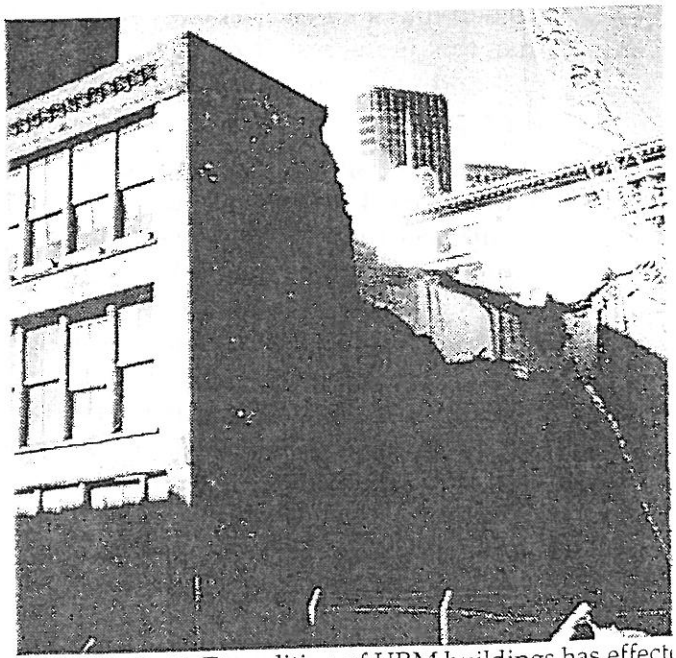
  Commission response: Local, state and federal governments, as well as all residents of a community, will share in the benefits of risk reduction and should work hard to help finance a share of the costs. However, government has the responsibility to ensure seismic safety in buildings, and building owners are ultimately responsible for their property.

  The Commission plans to propose programs similar to the URM program for several other types of hazardous buildings, particularly older concrete buildings. However, URM buildings were built prior to earthquake codes and have been the mos consistent poor performers in past earthquakes, which is why they have bee singled out.

Obstacles to Implementation for Building Owners

(excerpt from SB547: A Political History, Tobin, 1990)

In most cities with active mitigation progran requiring structural retrofit of URM building owners have been offered little in direct financial assistance. Owners must seek priva financing except in Los Angeles (with housi assistance programs), Torrance (with an assessment district), and the few jurisdiction using redevelopment or special assessment district funds. Lenders are unenthusiastic ab financing structural retrofits to a standard le than the current code, and all of the current programs use such below-current-code standards to provide a basic level of risk reduction at the lowest cost to the building owners. Unfortunately, this concept does no necessarily protect the building from future earthquake damage or otherwise enhance it immediate economic value, although both o these goals are vital from a lending institutic perspective.



Photograph 10: Demolition of URM buildings has effect leaset 2500 URMs or 10 percent of the inventory since th passage of the URM Law.

URM buildings are commonly owned by individuals and small businesses rather than corporations. These owners are usually limited in personal financial resources available for rehabilitation. The owner may rely heavily on rents for personal income, or rents may barely exceed debt service costs and operating expenses. Thus the ability of most owners to absorb additional debt depends on the increased rents the building will bring after its structural repair but, since most tenants will not pay increased rents for structural repairs alone, rent increases will be possible only if substantial cosmetic improvements are also made. To finance the strengthening of the building, the owner must increase the rent to recover the costs of both strengthening and cosmetic improvements. It is doubtful that any type of improvement in the amenities or appearance of URM buildings in the old downtown cores of many cities, which are currently renting at or very near the market maximum for their areas, will produce a meaningful increase in rental income. So it is difficult to obtain rent increases to recover the expenses of structural strengthening.

Owners who can neither obtain private financing nor substantially raise rents will no doubt seriously consider demolition or sale of the property as the only economically realistic alternatives. However, while demolition does effectively eliminate the building's risk, it may not be in the best interests of the owner, the tenants, or the community if the buildings is the owner's primary source of income, provides low-income housing, or holds a position of historic or architectural significance. Nevertheless, demolition has been a frequent alternative in cities with hazardous building mitigation programs.

Most owners are not familiar with the intricacies of managing a project as complex as strengthening a URM building, and may not even know how to find a qualified engineer. they will need guidance on these issues and on the sources of financial assistance available. Local building departments are the first place where owners come to make these inquiries.

URM Building Owner Issues

(excerpt from 1990 URM Status Report, SSC 90-03)

The biggest hurdle in implementing the URM Law is the high cost of seismic retrofit. The average cost in 1990 dollars is around $20 per square foot, and it can range from $10 to over $100 per square foot. For the average-size URM building of 10,000 square feet, costs can range from $100,000 to $1 million; they average around $200,000.

Many owners of URM buildings are struggling with the lack of affordable financing to retrofit their buildings for seismic safety. Several factors contribute to this problem:

- URM buildings are typically over 50 years old. Many are in economically depressed areas, and many are well past their prime in terms of their ability to generate rental incomes for their owners.
- URM buildings typically provide inexpensive housing and commercial space for tenants in older downtown areas who can ill afford rent increases. Strengthening URM buildings can result in displacement of occupants during construction and generally increased rents in areas where low-income units are already too few.
- Some private lenders will not accept URM buildings as collateral and are reluctant to offer loans. Seismic strengthening is not perceived by lenders as increasing the income-earning value of these buildings, nor does it guarantee survival or reparability of the buildings.

In some situations, owners cannot justify the seismic retrofit of their URM buildings on an economic basis, so many must think seriously about changing the use or selling or demolishing their buildings. The salvage value of used brick alone can often pay for the cost of demolition. However, most URM buildings are being strengthened rather than torn down.

The URM Law requirement that local governments disclose the potential earthquake hazards to owners is proving to be a strong incentive to mitigate the hazards because of liability concerns by owners. Many owners who

are concerned about maintaining leases with tenants are under pressure to reduce their risks.

The private sector has other economic and contractual incentives to comply with the seismic retrofit provisions of a local government. Product deliveries that are disrupted by foreseeable earthquake damage that was avoidable may constitute a breach of contract for which a business entity may be held financially liable. Indeed, a business enterprise's use of safety measures that permit such an entity to continue conducting business after a damaging earthquake may have significant financial rewards. As an example, a hardware supply business that takes steps to mitigate earthquake damage to its facilities and inventory will be in a much better position to handle the revenue-producing demand for its inventory that will result from efforts to rebuild after a major earthquake.

Because of the state's new real estate disclosure law, owners and Realtors are now encouraged to disclose building earthquake weaknesses to prospective buyers. Many lenders are now requiring earthquake hazard evaluations of existing buildings in order to qualify for a mortgage. This increased awareness has influenced many owners to consider reducing their building hazards.

Personal Liability

It is also important to note that corporate directors and officers, particularly in smaller, closely held corporations where they are intimately involved in management, have the very real potential to be held personally liable for failure to mitigate earthquake risks.

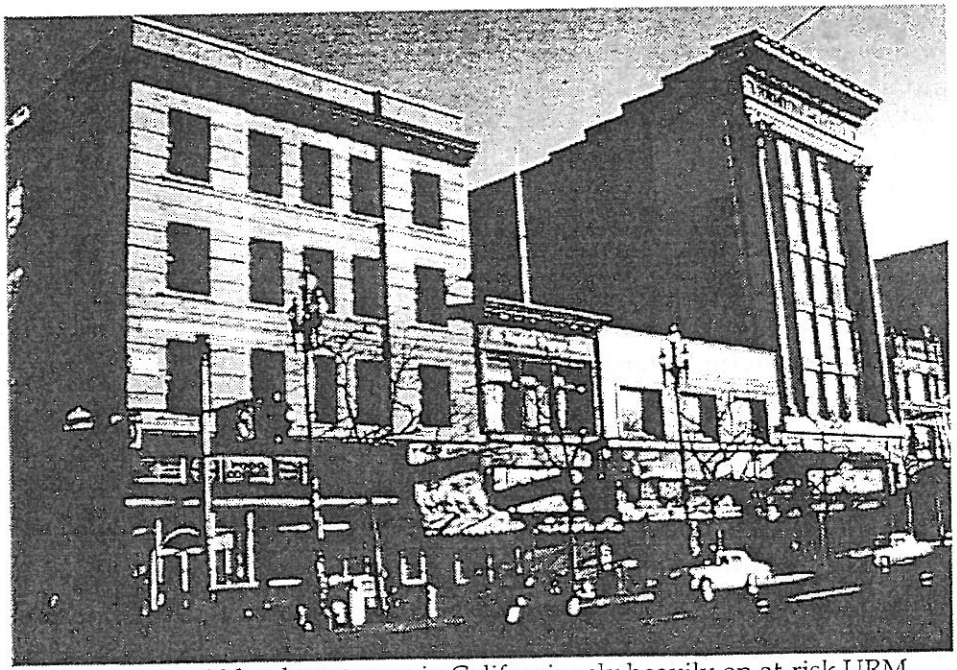
The URM Law requirement that local governments disclose the potential earthquake risks to owners is proving to be a strong incentive to retrofit because of liability concerns by owners. Many owners who are concerned about maintaining leases with tenants are under pressure to reduce their hazards.

A corporate director owes a fiduciary duty of care to the corporation that an ordinarily prudent person would exercise with respect to his or her own affairs. Unless there is bad faith, mistakes in business judgment are not a breach of the duty of care. However, if a director's decision is unreasonable, it will most likely not be treated as an honest exercise of business judgment. In any event, an honest business judgment has not been made if the director recognizes the existence of a problem that may have a serious negative impact upon the business and elects to ignore it.

Obstacles to Implementation for Tenants

(excerpt from SB547: A Political History, Tobin, 1990)

The two most frequent types of uses in URM buildings are residential (apartments and hotels for elderly, minority, and other fixed-income people) and small business (services, sales, and offices). In small- to medium-size cities most



Photograph 11: Older downtowns in California rely heavily on at-risk URM buidings for their economic lifelihood.

URM buildings are in commercial use, but in larger cities residential uses are a significant portion of the total. The city of Los Angeles has over 46000 hotel- and apartment-type housing units in its URM inventory, and San Francisco has over 25000 such units in its URM building stock. In San Francisco these housing units represent 37 percent of its URM buildings and nine to ten percent of the total city housing units.

All California cities are struggling to provide housing for the poor; loss of any significant amount of low-income housing due to demolition will place further demands on government and private resources for aid to homeless people. People occupying low-income housing are not very mobile and, even with the dislocation allowance provided in a few jurisdictions, are not likely to find alternative affordable housing. Seismic strengthening can cause substantial dislocations, since most of these buildings will require at least partial vacating during construction.

Medium-size cities typically have no or only a few residential URM buildings, but may have vital downtown cores such as the pre-earthquake Uptown area of Whittier with retail, theatre, and other businesses housed in URM buildings. Small retailers, especially those in the services sector, depend on continuity of location to attract and keep customers, and a one-month interruption in business can spell disaster for them. To survive, they will relocate permanently rather than await the completion of rehabilitation or reconstruction, especially considering the virtual certainty of higher rents.

Financing Obstacles to Implementation

(excerpt from SB547: A Political History, Tobin, 1990)

Funding problems are the major obstacle to seismic strengthening programs. While some financial assistance is available, there are severe limits and restrictions on such aid.

Rehabilitation bonds

In an early attempt to assist URM building owners, the state authorized the sale of local bonds to provide rehabilitation loans (AB 604, Rosenthal). Enacted 1982, this law so far has not produced a single assistance dollar, partially because of limitations on the specific kinds of costs to which such funding could be applied and partially because the bond underwriting market is reluctant to accept securities tied to URM buildings. Another problem is that federal tax law establishes relatively low volume caps on the sale of tax-exempt nongovernmental-purpose bonds, and it is not clear whether bonds for loans for seismic retrofit of private property can be defined as "governmental use."

In a joint program with Proposition 84, Proposition 77, a housing rehabilitation bond issue approved by the voters in June 1988, provided $80 million for seismic retrofit and rehabilitation of URM buildings containing multifamily housing. These loans required strong rent protection, and the bond proceeds were used for seismic loans by June 30, 1990, after which any remaining funds may be used for other types of housing rehabilitation. This time limit reduced the program's effectiveness since the buildings had to be included in mitigation programs adopted pursuant to the URM Law, yet most cities had not adopted ordinances by that time.

Tax Credits

Owners have used federal tax credits for rehabilitation of older and historic buildings to reduce the net costs of such work. In 1987, however, the tax credit was reduced to 20 percent for historic properties, and the 9 percent credit for non-historic housing was restricted to passive income only; it expired completely in 1990. In any event, where owner income is modest to start with, tax credits do not significantly reduce the overall cost of rehabilitation.

HCD Loans

The current California Department of Housing and Community Development (HCD) deferred payment rehabilitation loan program limits on the return of cash equity to owners, and individual loans are limited $200,000. This limit is too low to strengthen a large building, and the total funds available from the program are not enough to do any great number of small buildings. A second HCD loan program funded

with $9.5 million over the past six years provided deferred payment loans to rehabilitate substandard residential hotels at three percent interest; assuming average rehabilitation costs of around $11,000 per unit, this program could upgrade only 900 such units statewide, and San Francisco alone has 10,000 such units in URM buildings.

HUD Programs

the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant programs are available to local jurisdictions for grants or loans to building owners, but since 1981 the total funding has been reduced by over sixty percent. The HUD Rental Rehabilitation Program funds to assist owners of low-income housing have also been reduced. These programs require matching funds from owners and require that rehabilitated units be retained for 10 years.

SBA-Guaranteed Loans

Owners who use their building to conduct qualifying small businesses can apply for a Small Business Administration (SBA)-guaranteed loan of up to $588,000 for building repair. Interest rates are set 1 1/2 to 2 3/4 percent above the prime rate. The loans are made through participating lending institutions which may still not prefer to lend to such projects even though the SBA guarantees 90 percent of the amount of the loans.

Resources for Implementation

(excerpt from 1988 URM Status Report, SSC 88-03)

Seismic Safety Commission Resources

As required in Section 8876 of the URM Building Law, the Commission prepared an advisory report for local jurisdictions (SSC 87-03) titled *Guidebook To Identify and Mitigate Seismic Hazards in Buildings*. The guidebook provided a step-by-step approach to the tasks required by the URM Law and presented information on the potential costs to both local governments and building owners. It also includes a separate appendix containing the Commission's Model Ordinance, the State Historical Building code, and other useful reference materials. This document was distributed to all affected local building departments, to the 350 building officials who attended eight Commission-sponsored workshops on implementing the law, and at the 1988 Annual Business Meeting of the California Building Officials.

The Commission published three newsletters, which were distributed to all affected jurisdictions, to share information on the activities of other local governments, provide guidance on mitigation approaches, and to update information about available assistance programs.

The Commission has published edited transcripts of hearings held from December 1986 through March 1987 in a draft report (SSC 87-02) titled *Financial and Social Impacts of Unreinforced Masonry Building Rehabilitation*. This document contains a summary of the technical, economic, legal, and social considerations involved in rehabilitation of URM buildings and discusses proposals for removing the technical, financial and legal barriers that those considerations present.

The Commission supported the 1984 amendment that became Article XIII A of the State Constitution; it prohibits property reassessment when seismic strengthening improvements are made.

The Commission supported and helped to develop AB 604 (Rosenthal), which was enacted as Division 32 of the Health and Safety Code in 1982. This legislation was intended to enable local governments to sell tax-exempt bonds to provide low-cost loans to reconstruct URM buildings that belonged to owners who were unable to afford or to qualify for private financing, or that contained business that would suffer severe economic hardship, or that would otherwise be demolished.

In 1979, the Commission sponsored SB 445, which became chapter 2 of the Health and Safety Code. This law allows local jurisdictions to establish lower-than-current-code reconstruction standards for URM bearing-wall buildings, provides additional immunity for such actions, and prohibits a building reconstructed to the

adopted standards from being re identified as a seismic hazard for a period of 15 years.

Governor's Office of Emergency Services Resources

The Bay Area Regional and southern California Earthquake Preparedness Projects were cosponsors of the Commission's *Guidebook* workshops, assisted in their promotion, and participated as presenters. They jointly developed and distributed and illustrated six page pamphlet on the URM, Law for local elected officials, and their directors and staff have made numerous presentations to local organizations and individuals on the subject of hazardous buildings.

In 1987, SCEPP, a division of OES, in cooperation with the county of San Bernardino, published a report titled *Seismic Strengthening Implementation Program. It contains two handbooks, Handbook for Identification and Analysis of Potentially Hazardous URM Bearing Wall Buildings* and *Handbook for Seismic Retrofit Financing*.

Building Official Organizations Resources

The International Conference of Building Officials (ICBO) has published *The Uniform Code for Building Conservation*, 1987, 1991 and 1994 Editions, which each contain a chapter devoted to structural strengthening of URM bearing-wall buildings. This document is written in a codified format that state and local governments can readily adopt by reference. ICBO was also a co-sponsor of the 1988 guidebook workshops, and members of its staff helped the city of Whittier evaluate and inspect URM and other types of buildings damaged during the October 1, 1987 earthquake.

The California Association of Building Officials (CALBO) has a standing committee on seismic safety whose members have presented programs on the subject of hazardous buildings. CALBO also published a report written by James Russell, titled *SB 547—Implementation Issues, Obstacles and Opportunities Facing Local Government*, and distributed it at their 1988 annual meeting. Individual members of this organization have actively presented information on hazardous building mitigation programs to their peers through local ICBO chapter meetings.

Financial and Social Impacts of URM Retrofits

(excerpts from Financial and Social Impacts of Unreinforced Masonry Building Rehabilitation, SSC 87-02)

It is well established that many unreinforced masonry buildings will endanger the lives of their occupants and passersby in earthquakes. While several other types of buildings have also been identified as potentially hazardous, the consensus of the engineering community is that unreinforced masonry structures pose some of the most serious threats to life.

The Seismic Safety Commission has long recognized the risks associated with California's 30,000 unreinforced masonry buildings as one of the state's greatest threats to life safety in an earthquake, and is dedicated to eliminating the danger that they pose. Eliminating these dangers will cause social and economic impacts that must also be addressed.

Many unreinforced masonry buildings are located in Seismic Zone 4, where damaging earthquakes are very probable. Tens of thousands of Californians reside in these buildings. When earthquakes occur, lives will be lost unless these buildings have been strengthened. Many of the residents of these buildings have very low incomes; even at its least costly level, seismic retrofits can force the building owner to raise rents beyond what these people can afford. The choice could be between a dangerous roof over their heads or no roof at all. One challenge, then is to conserve scarce housing resources and at the same time deal with the problem of life safety. Ways to solve the problems of financing retrofits or replacement of these buildings must be found.

For building owners, seismic retrofits pose new expenses, often without any increased revenue to pay it. And commercial unreinforced masonry buildings often house marginal businesses; eliminating buildings, whether for seismic or other reasons, can also eliminate businesses, causing economic problems such as loss of jobs in the segment of society perhaps

least able to bear them. Moreover, many unreinforced masonry buildings possess architectural and historic values that lend charm and character to their communities.

In a series of meetings held between December 1986 and March 1987, the Commission heard from representatives of some of the California jurisdictions that have already begun programs aimed at reducing the hazards of unreinforced masonry buildings as well as experts in related fields. The purposes of the hearings were to learn more about the economic burden and social costs of retrofitting these buildings to improve their earthquake resistance and to determine on whom that burden falls, in order to assess what kinds of retrofit assistance or incentives might appropriately be offered by federal, state, or local governments or the private sector.

This summary is based on the remarks of speakers who testified before the Seismic Safety Commission and the accompanying discussions, as recorded in the following publications: *Rehabilitating hazardous Masonry Buildings: A Draft Model Ordinance,* Seismic Safety Commission, 1985; *The Politics and Economics of Earthquake Hazard Mitigation,* Daniel J. Alesch and William J. Petak, University of Colorado, 1986; and *Proceedings: Workshop on Reducing Seismic Hazards of Existing Buildings,* Federal Emergency Management Agency, 1985.

Economic considerations

Costs per square foot of seismic retrofits of unreinforced masonry buildings vary widely, depending on a host of factors. Some of these factors are:

- Number of stories in the building
- Building's design and "footprint" (i.e. square, rectangular, H-shaped, E-shaped, etc.)
- Quality of its original construction
- Skill and experience of the architect or engineer who designs the retrofit and of the contractor carrying out the construction
- Familiarity of the local building department with seismic retrofit projects and how well inspections are coordinated
- Location of the building (is it so close to other buildings that they interfere with the work:)
- Local wage rates (union pay scales can add 30 percent to the cost of retrofits)
- Whether the owner can do any of the work him/herself
- How the retrofit is financed (federal funding may require use of more costly union labor even if nonunion labor is available)
- The seismic standard up to which the building must be brought
- Whether other work (such as bring the building's mechanical or electrical systems up to code, or cosmetic remodeling) is done at the same time

Costs for seismic retrofit varied from $4.50 to $25 per square foot (in 1986 dollars). The cost of anchoring walls to floors and ceilings, the standard mandated by Phase I of the Los Angeles ordinance, was estimated to be about 25 percent of the total cost of bringing a building up to compliance with both Phases I and II, which was described as between $16 and $25 per square foot; however, the costs of bringing the buildings into compliance with the health and safety codes could push costs into the $30-plus range.

Without very substantial public subsidy financing, seismic retrofit ordinances leave owners with some hard choices. They can make the improvements with private financing and pay for them by increasing rents, or disinvest—milk the building for all it is worth until ordered to vacate, then demolish the building and convert the site to other more economic uses.

Financing seismic retrofits of some unreinforced masonry buildings, particularly those in residential use, continues to be a major problem. Financing can be found to rehabilitate buildings that are located in areas where they can be rented, though probably to different, and more affluent, tenants at rates to recover the full cost of the upgrade; and some buildings are in such

poor condition that they must be razed. But financing the retrofit of those in the middle—buildings being used for marginal businesses or as housing for low-income people that are already being rented at or near the prevailing rates in their areas—is difficult. These buildings often have been owned by a single family for a long period, and the owners don't have funds or inclination to spend money on them; even if upgraded, the buildings cannot command much, if any, more rent since their rents are determined by the areas in which they are located; and financial institutions are unwilling to make construction loans for seismic retrofits.

Banks are not developers; they want to make construction loans only if they can be confident that the project will be completed on time and within budget so that their equity is protected, and many unreinforced masonry building owners are inexperienced at managing construction projects. Retrofit projects typically begin with actions that actually decrease the building's value, such a removing floors or tearing holes in walls, and the banker wants assurance that the borrower will be able to carry the project through. Financial institutions are more willing to make a loan on the building once it is finished, if the owner can qualify, but the owner must still secure interim construction financing to do the work. Los Angeles has had some success with packaging loans, or acting as go-between to arrange financing from private lenders; similar active programs are needed in other jurisdictions

In addition, banks are not interested in financing work that is aimed only at reducing risk to life in an earthquake. To protect its investment, the bank will want the building itself to survive the earthquake, which means that additional strengthening work—and much higher costs—will often be required.

Another problem is that the financial services industry now acts more as a processor of loans than a lender, reselling the loans it makes in the secondary market. The secondary market thus far has shown no interest in buying loans to retrofit unreinforced masonry buildings.

To protect its interest, the bank wants a building that meets all codes; if the rents that determine a building's value cannot be raised because of the building's location, a renovated building may have no greater market value after seismic retrofit. The cost of the retrofit may exceed the value of the building, making the deal risky for the bank even if the retrofit work comes in under budget.

Financing should include an allowance for tenant relocation costs so that the work can proceed more smoothly, tenants will suffer less in the process, and the owner will not have so much of a cash flow problem due to lost rents and delays for expensive eviction proceedings.

Legislation passed 1984 (AB 604, Rosenthal) which authorized local jurisdictions to sell up to $200,000,000 in revenue bonds to finance retrofits. These "Rosenthal bonds" have not been used because the funds can only be used to finance seismic retrofits; they cannot be used to acquire a building, correct other code violations, or refinance existing debt, and lenders prefer first trust deeds as collateral. The 1986 changes in the federal tax law that limit the amount of tax-exempt bonds issued for "nongovernmental uses" further clouds the use of these bonds.

Federal and state government assistance for seismic retrofit is virtually nonexistent. Federal housing programs that have been used in the past are being phased out, state funds are relatively inconsequential, and the new federal tax law has substantially reduced incentives for building retrofits and rental property ownership in general. Moreover, restrictions on the use of various governmental fund sources can make them unsuitable vehicles for seismic retrofit. Bond financing is difficult to arrange and has a larger up-front cost for the borrower than conventional financing. Active state and local government programs are needed to make these financing sources available to owners.

Tax credits have worked best as state tax incentives in California. Advantages of sing credits, or some type of tax incentive, are that they influence investors and channel funds toward the type of investment desired; you can create programs without exceeding the state's

"Gann limit;" you avoid the need to creating a new state bureaucracy, since the credit is administered as part of the existing tax apparatus; and a tax change requires only a legislative majority rather than a 2/3 approval. disadvantages are that there is no control of cost; the credit may be inequitable, giving some people a gain at the expense of all other taxpayers; tax incentives run counter to the current trend in taxation philosophy, which holds that the market rather than the government should dictate economic behavior; they may be perceived as unfairly enriching some businesses and not theirs; and they may lack the stability that's desirable for a long-term investment.

Many owners of unreinforced masonry buildings have little cash equity in the buildings and do not have sufficient funds to pay for upgrading them. If they cannot get private financing or government assistance, they may have no option but to demolish the building. Moreover, they may not be able to recover the cost of upgrading by increasing rents; their tenants may not be able to afford the increased rents, and the buildings may not be in areas that can command them.

Los Angeles has also used tax increment funds generated by a nearby redevelopment project to fund a corporation to purchase and rehabilitate residential units for low-income people. A few other California cities—San Diego, San Francisco, and Santa Monica—have similar corporations.

Speakers testifying before the Seismic Safety Commission in 1987 recommended that the Commission help get financing for seismic retrofit programs by:

- Encouraging the state to put some resources into saving low-income housing stock, rather than regarding it as primarily a local problem.
- Working to raise state Department of Housing and Community Development loan limits for the Deferred Payment Rehabilitation Loan Program, currently $200,000. cost of both phases of seismic rehabilitation for a 30,000-square-foot building under the Los Angeles ordinance would be in the neighborhood of $600,000.
- Working to change the 8 percent HCD limit on allowable return on investment so that long-time owners who have little cash invested in the building can use the program.
- Sponsoring legislation to describe bonds for seismic retrofit as "governmental purpose" bonds to that they escape the volume cap on tax-exempt bonds recently set by Congress.
- Working to change the federal tax code to favor seismic retrofits.
- Sponsoring legislation to establish state and federal tax credits or rebates for seismic retrofits.
- Sponsoring legislation to establish a state loan guarantee program.
- Ensuring an ongoing search for financial solutions and assistance.

Social Considerations

Unreinforced masonry buildings make up a substantial portion of the housing stock for low-income people in San Francisco and Los Angeles, and alternative housing for their residents is not readily available. In San Francisco, the overall vacancy rate is about 1 percent, so even people with higher incomes have difficulty finding apartments; in Los Angeles, low-income people cannot afford the $450 average rental of a 1-bedroom apartment, versus the $250 now being paid for a 1-bedroom apartment in a low-income housing unit.

Half of the state's SRO (single room occupancy, hotel-type accommodations with shared bath and sometimes kitchen facilities low-income housing were lost from 1985 to 1987; this has been paralleled by a great increase in the number of homeless. Seismic retrofits could add to this problem if they decrease the amount of available low-income housing stock. Only San Francisco, San Diego, Los Angeles, and Santa Monica currently have SRO corporations dedicated to preserving or increasing this form of housing.

Some jurisdictions require landlords to pay relocation costs to assist tenants of housing units that are being converted. In Los Angeles, some owners have used the notices issued under the ordinance to evict the tenants without having to pay the relocation costs that would otherwise be required in order demolish the building.

In the long run, there is no question that requiring seismic retrofits of unreinforced masonry buildings is a social good, improving a city's housing stock and benefiting the community. but in the short run, retrofit programs can create hardships for both owners and tenants, and ways to ameliorate these should be identified and implemented. If a damaging earthquake comes before such programs are completed, there will be substantial loss of life and injuries, and the surviving residents of these buildings will be homeless.

Speakers testifying before the Commission in 1987 suggested that the Commission could assist seismic retrofits by ensuring that state programs address social considerations, and by advising local jurisdictions on ways to ameliorate social impacts while strengthening buildings.

Legal Considerations

Although it is legal to adopt a less-than-current-code standard for seismic retrofits, it nevertheless may subject the engineer or architect, owner, contractor, and city to lawsuits if the retrofitted building is damaged in an earthquake, or somebody is killed or injured. Earthquakes are no longer necessarily regarded as "acts of God" in the traditional or legal sense; now, it is recognized that they are expectable happenings and that measure can be taken to mitigate their effects. The law appears unclear as to the liability of design professionals, owners, or contractors who retrofit a building to less than full code compliance or elect not to make it as safe as it can be made using the current state of the art.

Technical Considerations

While much has been learned about the technical aspects of seismic strengthening in the last ten years, there is evidence that more experience and research could bring further gains in developing more cost-effective approaches. Any legislation or ordinances should be flexible enough to use improved methods that may be developed, both for unreinforced masonry buildings and for other types of seismically hazardous buildings.

How safe must a renovated building be? All cities include buildings built to changing building standards. Given the variety of buildings involved, it is difficult to set a single minimum standard of strengthening by ordinance; each building should be reviewed and its individual problems solved by an engineer who can exercise a proper standard of care in reducing risk to an acceptable level. A basic and relatively inexpensive approach to improve life safety is the anchoring of walls to floors and ceilings; more extensive work would make the building itself more likely to survive and earthquake, but at triple or quadruple the cost.

Minimum levels of retrofit need to reduce risk in a cost-effective manner allowing for some flexibility, along the lines of the state Historic Building code, and giving the engineer some leeway in designing seismic bracing.

It is important for city agencies to work together in enforcing seismic strengthening ordinances to speed the work, reduce costs, and minimize disruption for the tenants and owners. Successful seismic retrofits depend not only on technical feasibility but on the knowledge and experience of the owner, selection of the most cost-effective technology, and visible evidence, such as help in arranging loans or technical advice, that the city is serious about the program.

Speakers testifying before the Seismic Safety Commission in 1987 suggested that the Commission could assist in the technical area by working to:

- Establish an acceptable standard for seismic retrofits that takes into account life safety, economic and technical considerations. Additional model ordinances might be appropriate.

- Determine whether it is appropriate to require rehabilitation in other areas such as mechanical, electrical, and health and safety when seismic retrofits are mandated.
- Determine whether it is appropriate to develop less-than-current-code standards for other aspects of building rehabilitation—mechanical., electrical, health and safety—and, if so, working to get such standards developed and adopted.
- Establish a procedure for peer review of projects in conjunction with the jurisdiction's building department plan checking efforts.
- Provide information to local government on ways to encourage coordination among the various city departments concerned in a retrofit, such as the Rent Board and the Building and Safety Department, to reduce costs and owner problems.
- Encourage or sponsor and disseminate ongoing research on he use of new techniques to reduce the costs of retrofit.
- Develop a plan for identifying and dealing with seismically hazardous buildings other than those of unreinforced masonry.

Financial and Social Strategies to Address Impacts

(excerpt from 1990 URM Status Report, SSC 90-03)

Financial Alternatives

Several factors influence the financial feasibility of strengthening an URM. Among the possibilities that owners must consider are:

- *Restructuring existing owner debt*—Owners can reduce overall project costs by refinancing existing debts at lower interest rates.
- *Increasing Revenues*—Owners can consider changing the building use or raising the rents to finance seismic retrofit.
- *Taxes*—The benefits from tax credits for historical buildings, increased depreciation and interest payments resulting from seismic retrofits can greatly affect their feasibility.

Federal Funds and Programs

A number of government financial assistance programs are applicable to seismic retrofits, but many are limited to historical or low-income residential buildings. However, requirements that work be done with Davis-Bacon wage rates may offset the attractiveness of government programs.

- *HUD Community Development Block Grant Programs*—Many local redevelopment agencies are incorporating seismic retrofit into their redevelopment programs. Deferred loans, direct loans, and combination loans have been financed.
- *HUD Rental Rehabilitation, Sections 8 and 312, and Housing Development Action Grant Fund Programs*—In exchange for certain restrictions on rent in residential buildings, owners can be eligible for federal funding.
- *Historical Façade Easements*—A federal program for façade easement prohibits a more intense development for a historical building listed on the National Register of Historical Places while controlling the exterior architectural character. It reduces the value of a taxpayer's property by the value of development and use rights foregone in the easement. The gift of a preservation easement provides an immediate income tax deduction equal to the reduction in property value attributable to the easement.
- *Federal Tax Credits*—The largest tax credit given for rehabilitation of buildings is the Federal Investment Tax Credit, which allows a 20 percent tax credit for restoring historical buildings listed in the National Register of Historic Places. Tax credits can reduce an owner's taxes considerably and improve the economic feasibility of a seismic project.

  As with any tax credit, there are also limitations. Changes in the 1986 income tax law created limitations on "passive" income. But rehabilitation, especially for historical buildings, coupled with low-income housing credit, can bypass some of these limitations on tax credits.

- *SBA Loans*—Small Business Administration loans are available up to $588,000 maximum for 1.5 to 2.75 percent above prime interest rates through private lenders, with 90 percent of the loan value is guaranteed by the SBA.

State Funds and Programs

There were several state programs created to assist in financing URM retrofits.

- *Propositions 77 and 84*—These are new general obligation bond programs passed by the electorate in June of 1988. Proposition 77, in a joint program with Proposition 84, allocates $80 million in low-interest loans for the low-income, multiunit residential unreinforced masonry buildings. Seismic retrofit is an eligible cost under Propositions 77 and 84 and for URM buildings in cities and counties with mitigation programs. Applications for these funds are available from the state Department of Housing and Community Development (HCD). So far $35 million has been allocated and an additional $49 million will be issued soon. These programs provide loans at three percent interest for 20- or 30-year terms.

  Proposition 77 funds were an incentive for many jurisdictions to establish mitigation programs since the money was allocated partly on a first-come, first-served basis. HCD indicates, however, that demands are low for Proposition 77 because few buildings are eligible and even fewer owners are willing to commit to long-term, low-income housing agreements. However, program restrictions have also severely limited demands for seismic retrofit funding. Although Proposition 77 was advertised as a seismic retrofit funding source, very few seismic projects were funded.

  The Commission estimates that only five percent of all URM buildings are residential and only a portion of those have low income housing. Furthermore, state law requires twenty percent of all Proposition 77 money to be set aside for rural, low-income, multi-unit residential URM buildings. The Commission is not aware of any rural URM buildings that are eligible for the bond money.

  Only 6 out of 43 projects approved under the Proposition 77 and 84 program as of 1990 had included seismic retrofit. Only $3.6 million in seismic retrofit loans had been approved out of a total of $43 million as of 1990. HCD made an effort to locate candidate URM buildings for seismic retrofits, but they may ultimately shift the unused seismic funds to other housing programs. Similar financial assistance does not exist for small commercial buildings.
- *Exemptions from Increased Property Tax*—This exemption from property tax reassessments applies only to seismic retrofits of bearing-wall URM buildings. Nonbearing-wall URM building retrofits are currently not exempt from property tax increases.
- *HCD Deferred Payment Loans*—This program provides loans up to $200,000 but it has not been strongly funded.
- *HCD Residential Hotel Loan Program*—This is a small program of $9.5 million statewide.
- *Mills Act Agreements*—State law provides that an owner of a historical building may enter into an agreement with the city or county to restrict the use of the building and require preservation and maintenance in order to reduce property taxes.
- *Marks Historical Rehabilitation Act*—This offers a financing strategy with low-interest rehabilitation loans for historical buildings.
- *Geologic Hazards Abatement Districts*—State law allows for assessment districts to be created that can help finance seismic retrofits.

Local Funds and Programs

A number of cities and counties have created local financial incentives to lessen the economic impact of the seismic retrofit of older buildings. These incentives are often geared to rehabilitating older commercial districts and existing low-cost housing. Many governments have not actually taken advantage of the state and federal assistance programs, since demands

from building owners prior to the URM Law may not have warranted participation. Local financial incentives have come in the following forms:

- *Local Government Revenue Bonds*—The state allows local governments to sell revenue bonds to fund low-cost loans to private owners for the seismic retrofit of URM buildings. Although technical corrections in 1989 (AB 810 by Costa) broadened the definitions of residential structures and essential services buildings and eligible costs, the Federal Tax Reform Act of 1986 prevents their use for refinancing existing debt. Tax-exempt bonds are limited in size by a state volume cap, which limits fund availability.
- *Special Assessment Districts*—This type of program allows building owners to participate in an assessment district and finance seismic retrofits through increased property taxes.
- *Transient Occupancy Taxes, or Tax Increment Financing*—Several local governments have considered using motel, hotel or other taxes to help finance seismic retrofits.
- *Low-Interest Loans*—These are loans to building owners from the city or county at interest rates at or below the normal market rates. Jurisdictions can fund a portion of a loan package through private lenders to reduce the effective interest rates.
- *Grants*—These involve direct payments to owners for a portion of the seismic work and are usually funded by the city. Typically, the costs permitted may be for engineering analysis or work on the facade, where it contributes to the safety of public thoroughfares.
- *Project Management Services*—Some cities are considering providing project management services to building owners by pooling many seismic retrofit projects and hiring single design professionals and contractors in the hopes of achieving economy in scale.
- *One-stop Governmental Services*—Building owners with seismic retrofit projects must often communicate with several different local government agencies. When confronted with a large number of buildi owners, some local governments have ta steps to streamline the application and approval process with one-stop governmental services.
- *Zoning Incentives*—Existing planning and zoning ordinances can create disincentiv for seismic retrofits by restricting or ever preventing the change of use of building Waivers of these disincentives can impro the feasibility of seismic retrofits by allow more ways to finance the work.

  For example, if a building were to be changed from an office to a restaurant, increased revenues could help finance th seismic retrofit. Additional parking woul normally be required, thereby discouragi such a change in use, since the space for additional parking is usually not availabl A conditional use permit that does not require additional parking on the conditi that the building is retrofitted can be an extremely attractive incentive.

  Other zoning incentives include allowing greater density and/or relaxing height limitations in certain redevelopment zone to encourage rehabilitation, thus allowing owners the option of adding more space stories as a part of the renovation project.
- *Demolition and Reconstruction*—Some jurisdictions allow for demolition of buildings and reconstruction of safer buildings with the same story height and size.

Table 3 shows examples of seismic retrofit incentive programs that eight cities have implemented. For more information, consult publication titled *Seismic Retrofit Incentive Programs* published by the Association of Bay Area Governments in 1992 and financed by th Commission, FEMA and OES.

Private Financing

While there are a number of government programs to assist in financing and encouragi seismic retrofit, most URM building owners v rely on private financing.

Table 3: Seismic Retrofit Incentive Programs

Jurisdiction	Program Description
Arroyo Grande	• Flexible with its deadline for compliance • Offers reduced permit fees • Charges fees based on actual costs incurred by the city • Allows continuance of non-conforming uses • Waives other aspects of updated zoning regulations
Berkeley	• Imposes 1/2% transfer tax on property sales with proceeds used to retrofit the structure • Waives permit fees • Posts clearly visible warnings
Inglewood	• Offers two options for reimbursement: • Up to $1000 for plans plus 25% of construction costs or • Up to $3000 for plans plus 50% of cost above $3000 plus city fees
La Verne	• Offers up to 50% grant to cover engineering and construction costs
San Diego	• Voluntarily reviewed the URM situation in the community • Appointed City Manager's Committee on seismic retrofit • Requires that property owners may have to retrofit a structure when it changes use or increases occupancy
San Jose	• Exempts permit fees • Offers design grants • Forming Special Assessment district to provide bond financing • Developed two grant programs • Developing tenant assistance program • Hired one individual to serve as full-time liaison with URM owners and community
San Mateo	• Simplified LA model by creating two hazard categories and changing time limits • Ties some storefront improvements to retrofit projects • Provides grants and loans
Vacaville	• Offers 3% 25-year loans for seismic retrofit and tenant improvements • Offers façade loans

But seismic retrofits are not typically viewed by financial institutions as increasing the value of a building. From a lender's viewpoint, a strengthened building does not necessarily generate additional income on the basis of the seismic retrofit alone. In most buildings, there may be no additional cash flow resulting from a seismic retrofit, unless cosmetic improvements are also included. Financial institutions are reluctant to lend funds unless owners can demonstrate that the loans can be repaid through cash flow or other means.

Owners typically need to secure a short-term construction loan followed by long-term financing after the retrofits are complete. Construction loans can be difficult to find on attractive terms because of lender reluctance.

URM Law Frequently Asked Questions and Answers

(excerpt from URM Bulletin Winter 1990)

Here following are some of the most frequently asked questions about the URM law.

Q *When do we have to comply with the URM Law?*

A January 1, 1990 was the law's deadline.

Q *How many jurisdictions have already complied with the law?*

A See Table 1.

Q *What must I do to comply with the URM Law?*

A Three things: (1) inventory all potentially hazardous buildings of unreinforced masonry wall construction built before the adoption of building codes requiring earthquake-resistant design; (2) establish a mitigation program to reduce earthquake

risks in URMs; and (3) send a copy of the inventory and a description of the mitigation program to the Seismic Safety Commission.

Q *Who determines compliance with the URM Law?*

A Each local government is responsible for determining whether it has complied.

Q *Are historical buildings exempt from the URM Law?*

A No. Historical buildings are exempt only from the inventory portion of the law because they are already inventoried on existing lists of historic buildings. These lists generally include sufficient information to determine whether a building is potentially hazardous as defined by the URM Law. Historic URM buildings must be included in mitigation programs.

Q *How should a local mitigation program account for historic buildings?*

A Strengthening of historic buildings must comply with the State Historical Building Code (SHBC), Title 24 of the California Code of Regulations, Part 8. Refer to the Commission's Guidebook and Appendix for more explanation and a copy of the code. Earthquakes will affect historic buildings much the same as non-historic buildings, so the Commission recommends that historic buildings be required to comply with the same seismic safety standards, the UCBC Appendix Chapter 1, in addition to the SHBC.

Q *What are the consequences of noncompliance with the URM Law?*

A Although there are no specific enforcement or penalty provisions in the law, building owners in cities and counties that have not complied cannot take advantage of Proposition 77 bond funds for seismic retrofit. Each jurisdiction also should consult with its attorney about any increased liability for not adopting a mitigation program that effectively addresses these known risks. Biannually, the Commission reports to the Legislature on the effectiveness of the mitigation programs established under the URM Law, identifying the jurisdictions that have not submitted their inventories and programs and may make recommendations to the Legislature on the need to improve statewide efforts to reduce the risks from these buildings.

Q *What about buildings with nonbearing walls of unreinforced masonry?*

A Nonbearing-wall URMs must also be included in inventories and mitigation programs. Los Angeles, for instance, has re surveyed its building stock and has extended its mitigation program to include nonbearing-wall buildings.

Q *If my city or county has already adopted a version of the model ordinance for bearing-wall buildings and completed an inventory of bearing-wall buildings, are we in compliance with the URM Law?*

A Not necessarily. While determination of compliance is the responsibility of each local government, if your jurisdiction has any URM buildings with nonbearing-walls, you should consider including them in your inventory and mitigation program. This may require some cities and counties to recheck their inventories. We recommend that they consider adopting strengthening guidelines for nonbearing-wall buildings such as the ones on pages 29 and 30 of the guidebook.

Q *Does the Commission have any written information about the URM Law?*

A Yes. See the list of references in Appendix G of the Guidebook (SSC 87-03).

Policy on Acceptable Levels of Risk in State Buildings Relevant to California at Risk Initiatives (SSC 91-01)

(excerpt from Winter 1991 URM Bulletin)

The Seismic Safety Commission adopted a policy on acceptable levels of earthquake risk for state government buildings. The policy establishes earthquake performance objectives for existing buildings (Table 4).

The policy recommends time schedules for evaluating hazards, posting placards on state buildings that have very poor life safety, and mitigating unacceptable hazards by the year 2000. It also emphasizes the need for emergency

response and recovery plans that focus on redirecting and restoring state government functions after earthquakes.

Risk: Fire Vs. Quake

(excerpt from Winter 1991 URM Bulletin)

In 1983 Rakesh Sarin conducted an analysis of the Los Angeles URM ordinance to compare the risks of death and injury from earthquakes to the risks of death and injury from fire for occupants of URMs. Although his analysis is based on very limited data, his approach to this question is quite comprehensive, and his results are interesting:

> Risks [from earthquakes] to the occupants of the unreinforced masonry buildings are significant. If no upgrading [were to take place] an individual occupant faces an approximately 5-in-1000 chance of death and 25-in-1000 chance of serious injury due to an earthquake in the next ten years. This risk is about ten times the risk due to fire and flames...during the same period.

The report, "A Social Decision Analysis of the Earthquake Safety Problem: The Case of Existing Los Angeles Buildings," appears in *Risk Analysis*, Volume 3, No. 1, pp. 35-50, 1983.

The Unreinforced Masonry Law of 1986 provided a backdrop against which many different types of programs can be examined. Apart from mandatory inventory and notification requirements, the URM Law left determination of whether risk mitigation should be required to the local jurisdiction. Although this provided significant flexibility, it also resulted in a high level of conflict between building owners and local governments. In addition, it created a variety of unequal strengthening programs across the state, resulting in significantly different levels of risk to life and property. Most communities with retrofit programs use some method of establishing priorities that involves at least occupant exposure and building type and occasionally geological considerations.

Building Code Development, Technical Efforts

(excerpt from 1990 URM Report, SSC 90-03)

The general approach of the URM retrofit programs established to date has been to require strengthening to a standard lower than that required for new buildings. Nearly all programs state or imply something similar to the following as their purpose:

> The provisions of this chapter are intended as minimum standards to *reduce the risk of life loss or injury*. Compliance with these standards will not necessarily prevent loss of life or injury or prevent earthquake damage to rehabilitated buildings.

In the process of complying with the URM Law, local governments are deciding what level of risk is acceptable in strengthened URM buildings by balancing safety with economic and social constraints.

This risk is greater than the earthquake risk in new buildings; strengthened URM buildings are more likely than new buildings to suffer earthquake damage that will not be repairable (Table 4). The potential for deaths and injuries, economic loss, and damage in an earthquake can be significantly higher for strengthened URM buildings than for new buildings. However, cost-effectiveness and practical considerations—especially the brittleness of unreinforced masonry and the high cost of strengthening—generally make it infeasible to strengthen existing URM buildings to higher standards.

Variations in Local Government URM Programs

Considerable variations exist in both the technical and administrative provisions throughout the state. These variations reflect that local governments have taken conscientious steps to tailor their programs to their communities.

For example, unlike any other city, Santa Barbara has chosen to strengthen its buildings in a phased program, district by district, to encourage coordination between owners and ultimately reduce and localize construction disruption.

Table 4. Performance Objectives From the Seismic Safety Commission

Earthquake Performance Objective	Post-Earthquake Functions Period	Building Standards	Occupancy Categories [2]						
			Hospitals, Essential Services	Hazardous Materials	Public Schools	Nursing, Prisons	University, Research	Offices, Courts	Other Occupancies
Fully Functional, no significant damage	Immediate	Nuclear Reg. Commission	*	*	*	*	*	*	*
Immediate Occupancy, minimal post-earthquake disruption, some non-structural cleanup required	Hours	Title 24 I = 1.50, 1.25	♦ [3]	O [4]	O	O	O	O	O
Repairable Damage, some structural and nonstructural damage, will not significantly jeopardize life	Days to Months	Title 24 I = 1, 1.15 Current UBC [6]	●	O [4]	O	O	O	O	O
Substantial Life Safety, significant damage may not be repairable, will not significantly jeopardize life	Year(s)	75% of the 1988 UBC; ATC 14 & 22; or 1973 UBC [7]	●	♦ [4]	♦	♦	♦	♦	♦
Life Hazards Reduced, unrepairable damage very likely, some falling hazards, building may be a total loss, low life hazards	No Limit	UCBC Appendix Ch.1 for URM Bearing Wall Buildings	●	●	●	●	♦ [8]	♦ [8]	♦ [8]
Very Poor Safety, collapse likely, unrepairable damage and total loss highly likely, significant life hazards	No Limit	None	●	●	●	●	●	●	●
Unsafe for Occupancy	No Limit	None	●	●	●	●	●	●	●
Unknown Performance	No Limit	None	●	●	●	●	●	●	●

Key

- ♦ Minimum Acceptable Earthquake Performance Objective
- O Acceptable Earthquake Performance Objective
- ● Unacceptable Earthquake Performance Objective
- * Typically does not apply, except to nuclear facilities

Abbreviations

- ATC — Applied Technology Council
- I — Occupancy Importance Factor (pursuant to Ch. 23, Title 24)
- Title 24 — (Part 2 California Code Of Regulations)—California Building Code
- UBC — Uniform Building Code
- UCBC — Uniform Code for Building Conservation
- URM — Unreinforced Masonry

Footnotes

1. Most building standards are not currently required by law for existing buildings, unless triggered by voluntary or mandatory strengthening, major alterations, additions, or changes of occupancy. This policy recommends that all existing state government buildings meet minimum earthquake performance objectives by the year 2000.
2. Emergency and recovery plans required for all occupancies.
3. Communications, emergency services, and acute care services hall be capable of functioning after earthquakes, as well as having immediate occupancy throughout the building.
4. Acceptable if chance of release of hazardous materials is remote.
5. Acceptable if anticipated earthquake damage is repairable, and the building also complies with the State Historical Building Code.
6. Applies to state leased buildings.
7. A uniform seismic retrofit building standard must be developed.
8. Acceptable for strengthened URM bearing wall buildings only.

Source: Policy on Acceptable Levels of Earthquake Risk in State Buildings (SSC, 1991d)

Administrative variations of this sort are encouraged by the Commission as a way of involving the community. Perhaps the most common administrative variations have occurred in the time schedules for the compliance with seismic safety standards. The majority of these time schedules still fall within the Commission's suggested goal of issuing seismic retrofit permits by January 1, 2000.

Variations in technical standards have also been prevalent. Since there was no uniform standard until 1992, most jurisdictions referred to standards from one of five major sources:

- *The City of Los Angeles Division 88 Ordinance*—Other jurisdictions have adopted various editions and allowed the use of the Rules of General Application (the ABK Method). The County of Los Angeles has a similar ordinance titled Chapter 96.
- *The Uniform Code for Building Conservation (UCBC)*—This is recommended by the International Conference of Building Officials. The 1987 edition was developed by Melvyn Green and is largely based on early versions of Division 88. The 1991 and subsequent editions have been amended to reflect a statewide consensus among SEAOC and CALBO members and are now referenced by the state government as a model code.
- *The Seismic Safety Commission's recommended Draft Model Ordinance*—The 1987 edition was based in part on the 1985 edition of Division 88. In February 1990 the Commission updated its Draft Model Ordinance to reflect recent UCBC code change efforts. The current 1995 version references the 1994 UCBC.
- *The State Historical Building Code*—This code is required by state law for historical buildings and allows for flexible standards to encourage their preservation. However, there are no detailed seismic safety provisions in this code.
- *Earlier Editions of the Uniform Building Code*—These are typically referenced for nonbearing-wall URM buildings and other potentially hazardous buildings.

These variations have had several effects on the hazard reduction effort:

- They have encouraged jurisdictions to explore many different alternatives.
- They have complicated and prolonged the program development process in some jurisdictions.
- They have increased the cost and caused delays in the design, review, and construction because of the many and mostly minor variations in technical standards.

In a few cases, local governments have lowered the above technical provisions to reflect their concerns over the cost of seismic retrofit or local variations in anticipated ground shaking.

The Commission discourages these types of variations because they are often based on recommendations that lack consensus or have not received a thorough independent review. Also, the costs for seismic retrofit are not very sensitive to minor variations in the technical provisions.

The Commission believes that variety in administrative standards is acceptable and can reflect the uniqueness of communities. But when it comes to the technical standards, the state as a whole would probably benefit from a uniform technical standard, which would promote lower costs, reduce design and construction delays, and allow more consistent education in the building industry.

Bearing-wall URM Building Standards

Major refinements have occurred in seismic retrofit standards for bearing-wall URM buildings. Since most URM buildings are of the bearing-wall type, bearing-wall strengthening provisions have evolved at a much faster pace than provisions for other hazardous buildings.

Two decades ago, comprehensive provisions for strengthening URM buildings did not exist. Largely through the pioneering efforts of volunteer committees assisting the cities of Los Angeles, Santa Ana, and Long Beach, strengthening provisions were developed. The origins for bearing-wall strengthening

provisions can be found in the rulings of the State Historical Building Code Advisory Board, which allowed lower-than-current-code strengthening standards for historic buildings because of the high cost of seismic retrofit.

The passage of Senate Bill 445 (Alquist) in 1979 further legitimized the local government's enforcement of lower-than-current-code standards for seismic retrofit.

Since the late 1970s, bearing-wall URM strengthening provisions have evolved considerably. New methods of design, testing, and construction first tried in the Los Angeles area have been introduced and approved for use by many other local building officials. They allow strengthening options not specifically delineated in earlier versions of Division 88.

At the Commission's request, the Structural Engineers Association of California and the California Building Officials (SEAOC and CALBO) formed committees to study these new strengthening options and to develop recommended revisions to the Commission's Draft Model Ordinance. They incorporated key observations from the 1987 Whittier Narrows earthquake, provisions for buildings that are inadequately separated from adjacent buildings, and other refinements to design and construction procedures into Appendix Chapter 1 of the Uniform Code for Building Conservation (UCBC). The Building Standards Commission also assisted these organizations by providing travel funds and code development support. The 1994 edition of the UCBC reflects the latest consensus on uniform standards and should be used for retrofits in the near future.

In February 1991, the Seismic Safety Commission's recommended Model Ordinance was revised to reflect the recommendations by SEAOC and CALBO. It contains technical and administrative risk reduction provisions for bearing wall URM buildings in both Seismic Hazard Zones 3 and 4. The Commission's *1995 Recommended Model Ordinance for the Seismic Retrofit of Hazardous Unreinforced Masonry Bearing Wall Buildings* (SSC 95-05) adopts the 1994 edition of the UCBC Appendix Chapter 1 by reference and updates and renumbers the California Building Official's recommended administrative language for a mandatory strengthening program.

As URM risk-reduction efforts expand, there is a growing need for educating design professionals and building officials about strengthening provisions. The Commission hired Wiss, Janney, Elstner Associates to develop an educational document titled "Draft Commentary on the SEAOC/CALBO Recommended Strengthening Provisions." This has since been amended, adopted by SEAOC and published by ICBO.

Commentaries have traditionally been an effective resource for the self-training and reference by building officials and design professionals. The 1992 SEAOC *Commentary on Appendix Chapter 1 of the Uniform Code for Building Conservation* describes the code's philosophy and the basis for the technical aspects of the strengthening provisions.

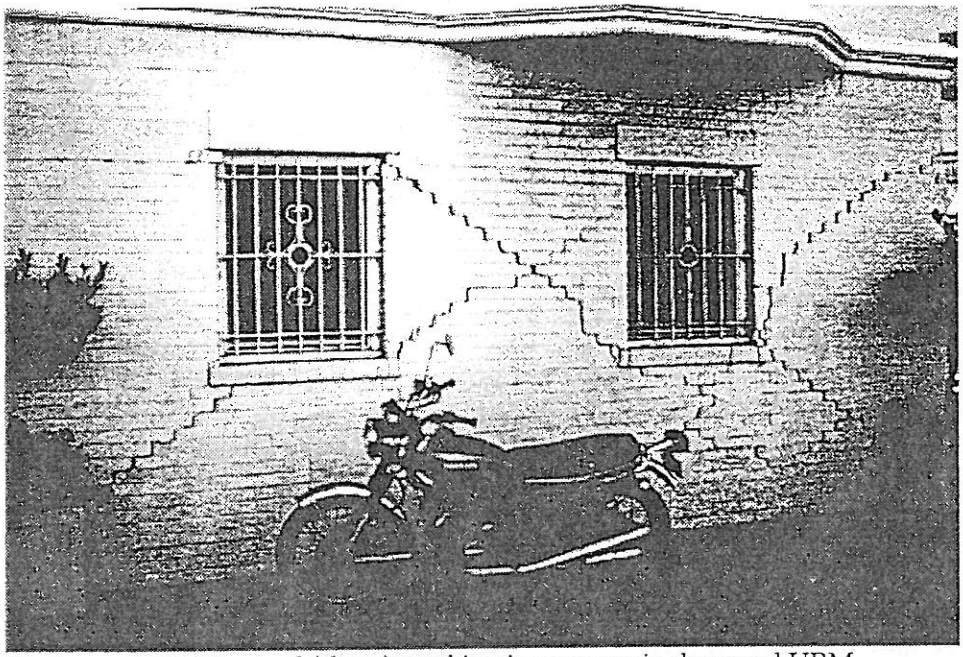
Wall Anchors
(excerpt from URM Bulletin Winter 1990)

Anchor suppliers and building officials in the Los Angeles basin reported that several design professionals have specified incorrect types of wall anchors for strengthening URMs. Wedge anchors should generally not be used in unreinforced masonry because the wedging action between the anchor and masonry is unreliable, especially for resisting earthquake loads. Anchors with sealed glass tubes of adhesive should not be used either because of the unavoidable loss of adhesive in wall voids.

Drilled and dry-packed grouted anchors and screen-type adhesive anchors are generally suitable for installation in unreinforced masonry. An ICBO-approved screen-type anchor can develop a keying action in the hole and can keep the adhesive in contact over the length of the dowel.

Nonbearing-wall Building Standards
(excerpt from 1990 URM Report, SSC 90-03)

Perhaps one out of five URM buildings has nonbearing-wall construction. These buildings tend to be multistoried and have walls that do



Photograph 12: Diagonal (shear) cracking is common in damaged URM buildings.

not support the weight of the building, hence the term "nonbearing."

Nonbearing-wall buildings have a much greater variety of construction than bearing-wall buildings. They can have concrete or steel frames and many variations of the physical relationships between frames and walls. Since few of these buildings had been strengthened in the past, local building officials have had to rely on earthquake engineering specialists to develop unique detailed requirements for each nonbearing-wall building. However, as the demands for seismic retrofit increase, the need for more uniform strengthening provisions will grow.

Strengthening provisions for this type of building have evolved much more slowly than bearing-wall provisions. The Los Angeles Division 88 ordinance, the Commission's Model Ordinance, and most other mitigation programs address only bearing-wall URM buildings. The programs in Long Beach, Palo Alto and Santa Rosa are notable exceptions; they have strengthening provisions for nonbearing-wall URM buildings, but none of these provisions are as comprehensive or detailed as those for bearing-wall buildings.

The City of Los Angeles has requested the Structural Engineers Association of Southern California to develop a set of comprehensive strengthening standards for nonbearing-wall URM buildings. This effort was delayed by the Northridge earthquake. A similar statewide effort has been launched by SEAOC in its Existing Buildings Committee.

Although some engineers consider nonbearing-wall buildings to be generally less life threatening than bearing-wall buildings, the URM Law requires local communities to include them in mitigation programs. The Commission's recommended approach for these nonbearing-wall buildings is to include them in the inventory process, notify the owners of the potential risks, and have the building officials instruct the owner's design professional to address risks in accordance with earthquake hazard guidelines such as those listed in the Commission's guidebook (pages 29 and 30).

Though there are no consensus standards for nonbearing-wall buildings, many such buildings have been successfully strengthened according to these and similar guidelines. However, owners with buildings of this sort should take special precautions and hire design professionals with specific experience in

strengthening these types of buildings. Building officials and owners should ensure a thorough independent review of the strengthening. Those owners that elect to strengthen their buildings voluntarily should be encouraged and where possible protected from future code changes.

Retrofit Standards

(excerpt from Turning Loss To Gain, SSC 95-01)

FEMA is making a major push to develop standards for retrofitting buildings, including varying performance objectives, by funding a five-year, $8,000,000 effort that is being directed by BSSC through the National Institute of Building Technology. The primary subcontractor for development of the provisions is ATC, a California-based nonprofit buildings research organization, and the majority of the engineers and researchers working on this project are from California.

The National Institute of Standards and Technology hired Rutherford and Chekene to study damage to URM buildings and to develop enhanced retrofit standards in 1995.

Historical Building Issues

(excerpt from 1990 URM Status Report, SSC 90-03)

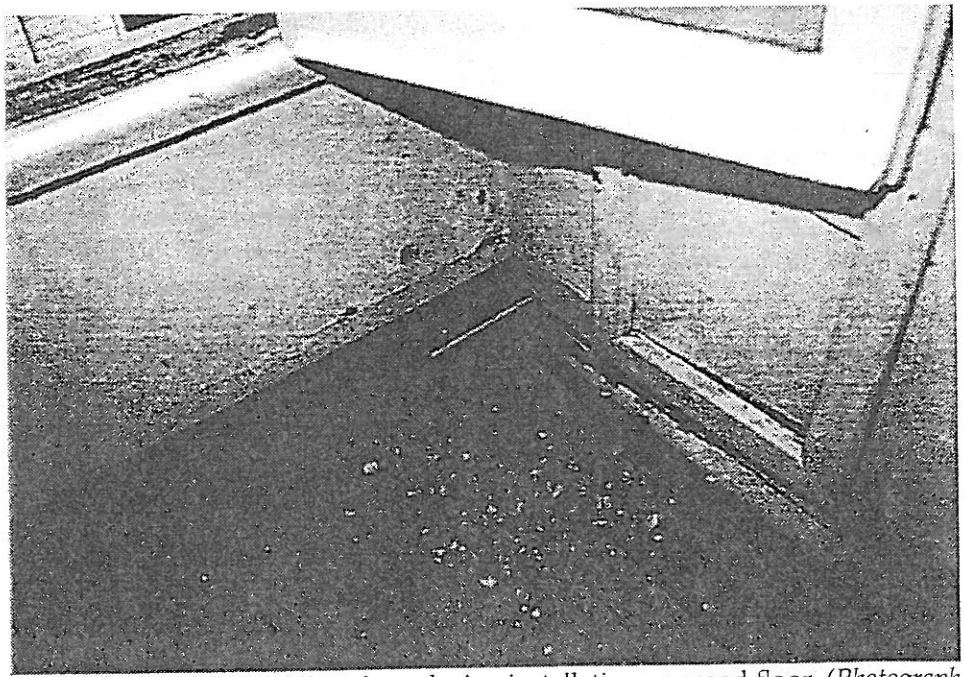
A great number of URM buildings are historical and so the issues of preservation and seismic safety have become intertwined. The Commission sees earthquake risk reduction efforts for historical URM buildings as a necessary and prudent form of preservation.

Historic Buildings

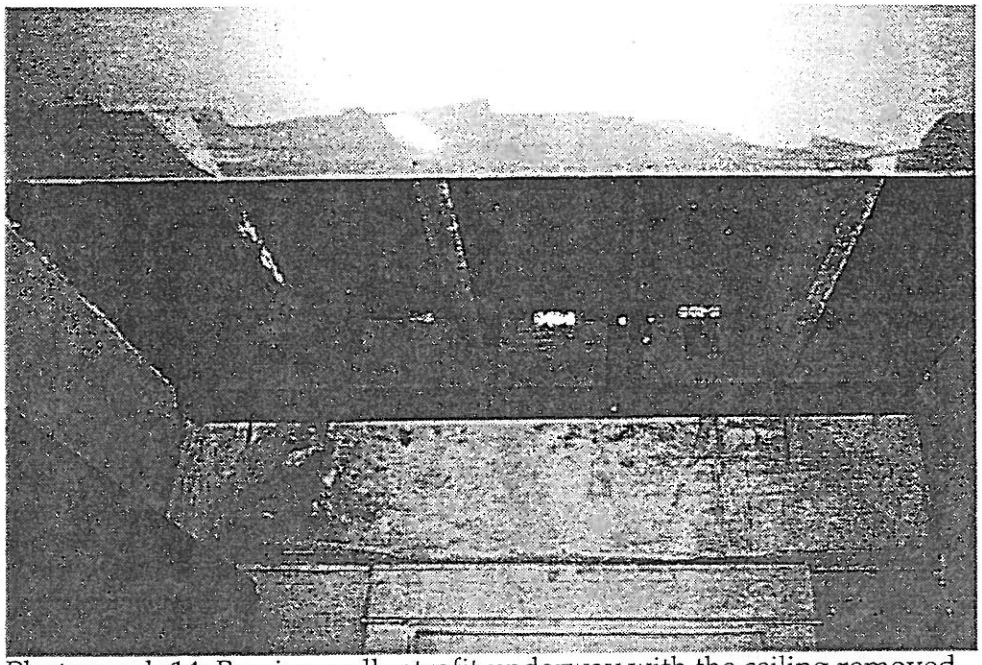
Because these buildings are already on historic resources lists, the URM Law allows them to be exempted from the inventory process. The law's wording has caused some confusion of local officials and owners.

Historical buildings are on existing historical building inventories that contain information about building age and the presence of unreinforced masonry wall construction. It would have been an unnecessary duplication of effort, so the URM Law did not require their inventory (see *Applicability of URM Law to Historical Buildings,* Cronin, January 22, 1991).

Historical URM buildings must, however, be included within URM hazard-reduction programs, as well as comply with the State Historical Building Code. This code is intended



Photograph 13: New wall anchors during installation on wood floor. *(Photograph credit: Los Angeles Department of Building and Safety)*



Photograph 14: Bearing wall retrofit underway with the ceiling removed.
(Photograph credit: Los Angeles Department of Building and Safety)

to preserve the aesthetics and fabric of historical buildings, and it allows the use of alternative building standards, broad judgment, and flexibility in applying seismic safety standards.

State law requires state and local agencies to use the State Historical Building Code when permitting work on qualified historical structures. Some local officials, however, are not aware of the mandatory requirements of the State Historical Building Code, and some find the state mandate difficult to implement.

Federal tax credits for historical buildings may assist owners to some extent, but this aid can often be offset by the greater construction cost and additional effort required to maintain the structures' historic fabric and appearance.

The strengthening provisions for non-historical URM buildings had their origins in the early rulings for the seismic safety of historical buildings. Back in the 1970s, the standard set for historical building strengthening was that they be retrofitted to resist ten percent of their weight. This eventually became part of the basis for the City of Los Angeles' Division 88 retrofit standards. Now that the URM provisions have come into wider use, some historical buildings are being strengthened to even lower standards because of the flexibility allowed in the State Historical Building Code. Unfortunately, surveys of damaged buildings after the Loma Prieta earthquake showed that partially retrofitted buildings often don't perform much better than unretrofitted buildings (ATC 31).

Historical URM buildings strengthened to such low standards are at risk. They may suffer irreparable earthquake damage. Nor does the Commission's Model Ordinance, which is allowed under the State Historical Building Code, provide assurance that URM buildings can be repaired after a damaging earthquake. The Commission recommends that historical URM buildings are at a minimum retrofitted to meet or exceed the hazard reduction objectives in the 1990 Draft Model Ordinance.

The goal of historical building seismic retrofits should be to ensure reparability after a damaging earthquake so that future generations can experience these buildings, but this goal will not always be possible or economically feasible to achieve.

Because of the flexibility allowed for historical buildings, the Commission recommends that seismic safety in historical buildings should be given high priority and verified with thorough, independent reviews.

The Commission hopes that preservationists and seismic safety interests can work together to find the resources to achieve appropriate levels of earthquake risk for historic buildings.

Historic Buildings in the Northridge Earthquake
(excerpt from Turning Loss to Gain, SSC 95-01)
Historic buildings are valuable community resources. These buildings create the identify of many communities. Besides the aesthetic contribution, these buildings often provide affordable housing and economically attractive retail and commercial space. Land use planning provides the policy framework to protect community resources and to address their seismic vulnerability.

The 1994 Northridge earthquake is only the most recent in a string of California earthquake that have severely damaged and destroyed historic structures. Although historic buildings are no more vulnerable than other buildings of similar vintage and design, the Coalinga, Whittier Narrows, Loma Prieta and Cape Mendocino earthquake all damaged older downtowns, which are still scarred and struggling to recover. Historic buildings constructed of URM walls are most susceptible to earthquake damage, although wood-frame, concrete, and steel-frame historic buildings have also been severely damaged.

The seismic retrofit of older buildings has proven effective in increasing the survival of historic buildings during earthquakes, but many owners of private buildings simply cannot afford the cost, which is often not justified by the building's revenue potential. Moreover, retrofit usually will not guarantee that a buildings will not be extensively damaged in an earthquake, so owners must also consider the possibility of high post-earthquake repair costs or the total loss of the building. Federal tax credits are available for rehabilitating historic buildings; however, few financial incentives for seismic retrofit reflect the value these buildings have to communities. The State Historic Building Code needs to be revised to reflect statues that make its use mandatory and to provide explicit guidelines for the seismic safety of historic buildings.

When an earthquake strikes, some owners of older and historic buildings find it more economical to have their buildings demolished at public expense than to pay for repairs. Under some circumstances, FEMA will reimburse local governments for demolishing damaged privately owned buildings but will not, as a general rule, pay for repairs. A few private owners may qualify to borrow from the Small Business Administration, but for most, economics favor demolition over repair. As a consequence, vulnerable historic buildings are lost after nearly every earthquake.

Although the Northridge earthquake's epicenter was in the San Fernando Valley, an area of fairly new development, the earthquake damaged many historic buildings, especially in Santa Monica, Fillmore, and East Hollywood. The Los Angeles conservancy estimates that well over 1,000 buildings, out of the 112,000 buildings evaluated for damage, were historic.

The Brown Derby in Hollywood, the Masonic Temple in Fillmore, and the First Christian Church in Santa Monica are notable historic structures demolished following the earthquake. As of May 1994, FEMA had approved demolition of 25 historic buildings and was reviewing proposed demolitions for another 25 to 30. Without doubt, other historic buildings not documents as part of the FEMA process were also damaged.

Several major problems make the challenge of safeguarding historic buildings from earthquakes difficult:

- The State Historical Buildings Code does not have standards that adequately address life safety or seismic damage to structures.
- Existing financial incentives are insufficient to encourage seismic retrofit of historic buildings.
- The expertise and technical guidance for dealing with historic buildings after an earthquake is often too late to help those who need it.
- For economic reasons, many historic buildings are retrofitted to levels that will

improve life safety during earthquakes but will not prevent the loss of the building.

Federal Government Efforts
(excerpt from 1990 URM Status Report, SSC 90-03)
The National Earthquake Hazards Reduction Program (NEHRP) is also embarking on efforts to encourage hazard reduction in existing buildings. However, they have not had much impact in California.

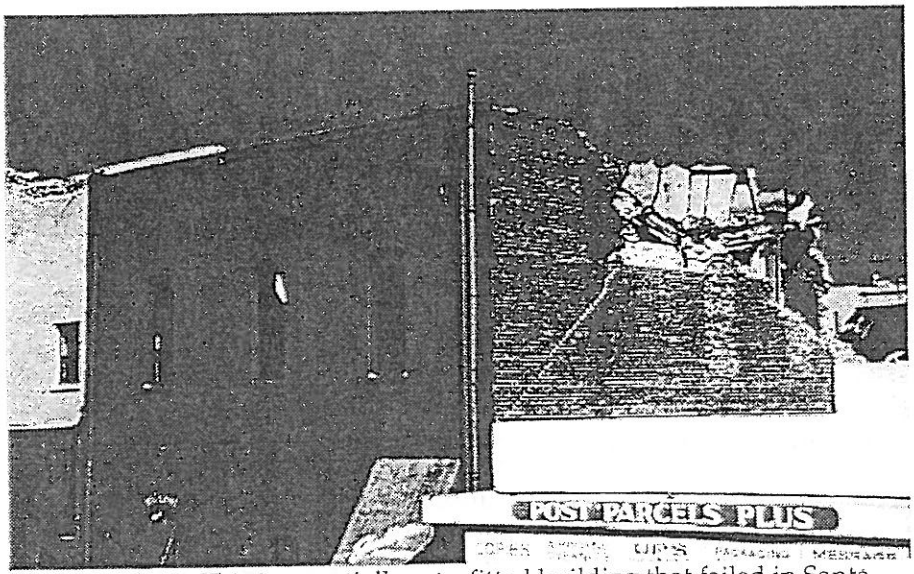
Several of NEHRP's "yellow books" may be helpful to both the state and local governments. In particular the following FEMA documents have been applicable to California's needs:

- *Typical Costs for Seismic Rehabilitation of Existing Buildings*
- *Estimating Losses from Future Earthquakes*
- *Establishing Programs and Priorities for the Seismic Rehabilitation of Buildings*
- *Proceedings and an Action Plan for Reducing Earthquake Hazards of Existing Buildings*

However, many of NEHRP's "yellow books" are geared for other areas of the United States. In several cases, NEHRP's efforts have specifically excluded application to California issues.

The country could realize greater benefits from NEHRP programs if federal support of and coordination with California state and local efforts were increased. NEHRP could justify closer ties by nurturing California efforts as pilot projects with the intentions of expanding similar projects nationwide. NEHRP should recognize that less than full attention to California problems is not in the best interests of the Federal Government in light of the nationwide risks.

Similarly, state and local programs should make a stronger effort to coordinate their priorities, plans and resources with NEHRP.



Photograph 15: This is a partially retrofitted building that failed in Santa Cruz during the 1989 Loma Prieta earthquake. A study by the Applied Technology Council (ATC 28) concluded that partially retrofitted URM buildings did not perform markedly better than unretrofitted URM buildings.

Observations of Recent Earthquakes

Northridge, 1994

(excerpt from Turning Loss to Gain, SSC 94-09)

Of the approximately 5,900 retrofitted buildings in Los Angeles (most of which were not in the San Fernando Valley region, which was the most heavily shaken), about 412 were damaged in the Northridge earthquake, about 50 so heavily that they had to be demolished. In Glendale, there were 267 retrofitted URM buildings, of which 17 were red-tagged. Burbank had 16 retrofitted URM buildings. of which only one was red-tagged. There was not one loss of life in any of the 1,400 strengthened residential URM buildings (containing 37,000 units) in the City of Los Angeles—most of which were fully occupied at the time of the earthquake—although a significant number of them were in areas of intense, albeit short-duration, shaking.

Damage and partial collapses in unstrengthened URM buildings—particularly in Fillmore and parts of Santa Monica—were noticeably more severe than in similar retrofitted buildings nearby and in other communities. Damaged URM buildings, such as the red tagged URM buildings on Lincoln Boulevard between Wilshire Boulevard and Arizona in Santa Monica, continue to present a serious hazard since they may collapse in a small magnitude earthquake or strong wind. These and other similar buildings could fall onto pedestrians or cars in adjacent parking lots or sidewalks or rear alleys. Of the 64 unstrengthened URM buildings in Fillmore, 10 were severely damaged and demolished. As of June 1995, five URM buildings have been retrofitted and six others have plans submitted and plan checks underway. Many other buildings remain damaged and vacant with an uncertain future. Clearly the Northridge earthquake reconfirmed that strengthened URM buildings perform better than unstrengthened URM buildings.

Whether or not the performance of retrofitted buildings for this size earthquake was acceptable remains an open question; but many engineers view the performance of retrofitted buildings in the Northridge earthquake positively. One engineer who helped to develop Division 88 went so far as to call it "an unqualified success" after review of damage following the earthquake (Schmid, 1994b). Another engineer states that "overall, the City of Los Angeles retrofit program [Division 88] must be judged a success in the Northridge earthquake" (Hamburger and McCormick, 1994b). Many others appear to agree and note that no lives were lost and damage to the total stock of retrofitted buildings was significantly lower than damage to similar unretrofitted buildings, such as in Fillmore.

However, some engineers have pointed out that while the percentage of significantly damaged retrofitted URM buildings is small across the entire sample, this is partly because there were few URM buildings in the San Fernando Valley area and north where shaking was greatest. In the isolated pockets where there were retrofitted URM buildings and where shaking was intense, such as West Hollywood and Santa Monica, damage to URMs was greater. The early-morning occurrence of the earthquake is also believed to be a significant factor; had the event occurred at noon on a work day, when pedestrians were on the street and at risk from collapsed parapets and upper-story wall failures, results and reactions would have been different.

A number of engineers and building officials attribute much of the significant damage to poor design and construction, not to the code itself. Some investigators reported that the damage in retrofitted URMs appeared to be in large part caused by design or plan check errors and lack of adequate quality control, citing numerous instances where unbonded veneer courses were incorrectly used in calculations of wall height-to-thickness ratios. There were also reports of buildings that appeared to have low mortar strength but were assigned much higher values by the original testing laboratory and reports of drawings that did not conform to the building being strengthened. In addition to stating that

Photograph 16: An inadequately reinforced masonry chimney toppled in the 1992 Big Bear earthquake and destroyed exit stairs.

quality control was a more severe problem than the Division 88 standards, the task force also recommended a number of specific code changes. The fact of the matter remains that URM buildings are brittle, vulnerable structures, and the degree to which seismic improvements can be made is limited by economic feasibility.

Many owners were unaware that a retrofitted building could still be damaged to the point of not being economically repairable. For example, the South Central Southern Missionary Baptist Church had spent $250,000 on earthquake reinforcement three years before the earthquake but, following the earthquake, the Reverend J. L. Gates stated, "There is no question we'll have to tear it down" (L.A. Times, 1994). Lula Washington, director of the Los Angeles Contemporary Dance Theatre, whose West Adams Boulevard headquarters was significantly damaged, observed, "When I saw this building, I almost collapsed myself. We reinforced for over $200,000 in 1992" (L.A. Times, 1994). The distinction between life-safety risk reduction and damage control is not well understood by many owners of retrofitted buildings.

In summary, retrofits of URM buildings significantly reduce, though they do not eliminate, the risk to life. However, many owners have obviously not been informed about the limitations of retrofitting. From an investment standpoint, since retrofitted URM buildings clearly may not be functional or economically repairable after moderate earthquakes, owners or potential owners considering retrofit must take the potential costs of repair into account, in addition to the immediate costs of the retrofit, when deciding whether to retrofit or replace.

In the Northridge earthquake, the mandatory retroactive strengthening efforts of several cities, led by Los Angeles, made a substantial difference. They dramatically reduced damage and life-threatening situations in URM buildings. Voluntary strengthening programs and other URM "risk mitigation programs" that simply involve the notification of owners that they own potentially hazardous buildings are clearly not effective for risk mitigation. Moreover, such programs essentially violate the Legislature's intent of state-mandated local programs by delaying proactive risk reduction measures and prolonging undue public exposure to life-threatening buildings.

Fillmore notified its URM owners but never adopted an official URM risk mitigation program. All owners were notified of the risk posed by their buildings long before the earthquake, and the city council debated the merits and costs of retrofitting. However, because the rents are too low in Fillmore to generate sufficient funds for major capital outlays in many of these buildings, Fillmore in 1993 reluctantly chose to forgo efforts to reduce seismic risk in their buildings. Mr Rov Harthorn, Santa Barbara's building official, evaluating

Fillmore's seismic risk, described the situation as follows:

> The city council faced a dilemma of choosing either an overly burdensome mandatory program with effective measures that economically would not materialize, or to enact a voluntary program that would lack sufficient.middle ground to consider such as longer term deadlines in the 10 to 20 year range, property resale trigger mechanisms, re-roof trigger mechanisms and other less burdensome trigger mechanisms designed to minimize fiscal impacts on the property owners. (Harthorn, 1992)

This same scenario has occurred in numerous., Oakland, Santa Cruz, Watsonville, Hollister, and Coalinga.

Existing state laws also encourage limited disclosure of general seismic safety information at the time of sale of all commercial buildings. State law also requires owners to place placards warning the public about earthquake risk at the main entrances to URM buildings. However, no government agency is responsible for enforcing these laws, so compliance is spotty at best. Even if governments required a formal . included a clarification of the benefits and limitations of retrofitting, most building owners are still not equipped to understand or manage their seismic risk in any comprehensive way.

Seismic risk has greatly reduced the market value of unstrengthened URM buildings, but rental rates are still controlled by local market rates. Therefore, private owners of URM buildings typically have difficulty securing loans for seismic retrofits and are unable to raise rents to establish a source of revenue to pay off retrofit costs without losing tenants. Some local government owners have established bond programs to finance retrofits of their own buildings, but very few local governments have created financial, land use, and zoning incentives for seismic retrofits of private buildings, although state laws have recently been changed to make it easier to create programs such as assessment districts.

Landers/Big Bear 1992

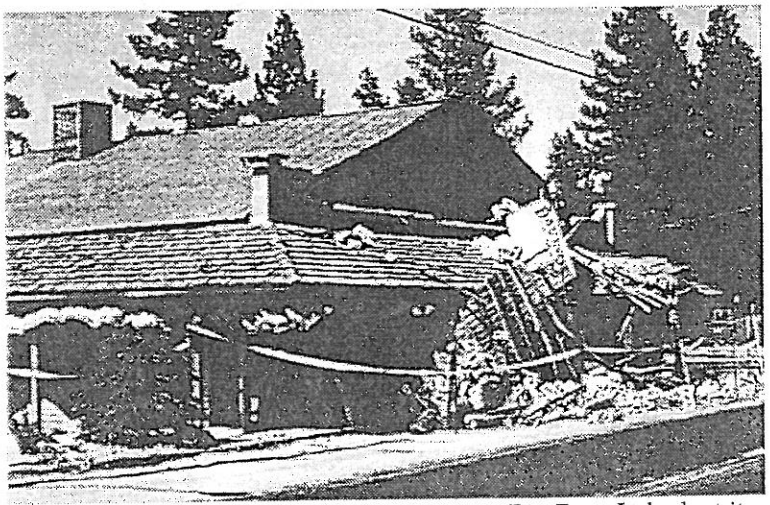
(Excerpt from Unpublished Seismic Safety Commission Reconnaissance Report)

There were relatively few URM buildings in the region of strongest shaking intensity of the Landers earthquakes of June 28, 1992. An unreinforced brick carpet retail store in Yucca Valley suffered extensive cracking and loose brick at its front gable wall. In Joshua Tree, a previously an unreinforced concrete masonry restaurant—previously damaged in April and slated for repair—was further damaged in the June shaking and since demolished.

San Bernardino County was in substantial compliance with the URM Law at the time of this earthquake with a notification-only program.

A popular unreinforced masonry restaurant in Big Bear Lake lost its front gable wall in a partial collapse (Photograph 17). Eight out of 41 URM buildings inventoried were demolished after the earthquake. Big Bear Lake was not in compliance with the URM Law at the time of the earthquake, but established a notification-only program after the earthquake.

No retrofitted buildings were observed in the regions of intense shaking. Extensive chimney damaged occurred in Big Bear Lake to both modern and older structures (Photograph 16).



Photograph 17: This popular restaurant in Big Bear Lake lost its gabled wall in the 1992 earthquake.

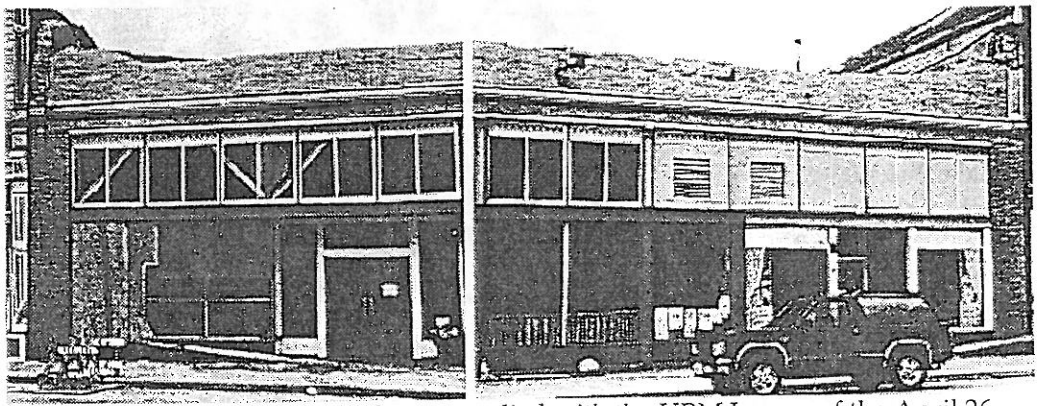
Photograph 18: Damage to the Ferndale Grocery Store caused by the California earthquake of April 18, 1906. *(Photograph credit: Report of the State Earthquake Investigation Commission, Volume 1, Plate 66)*

Cape Mendocino 1992

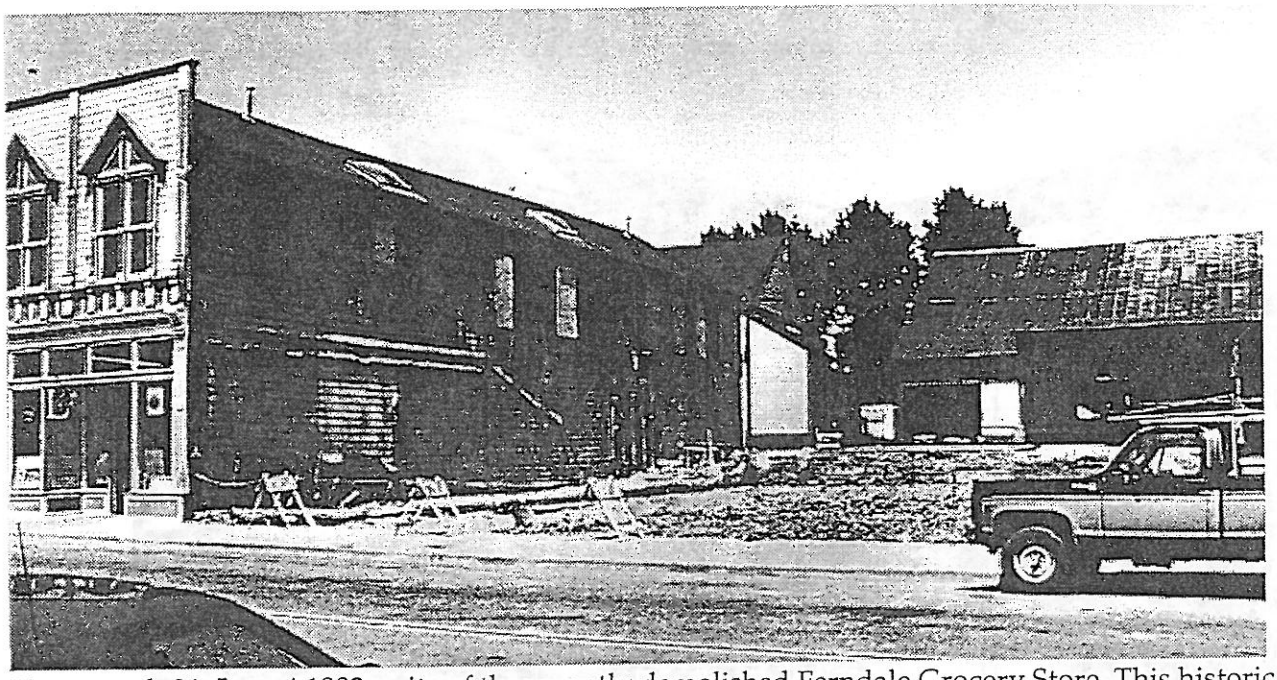
(Excerpt from the 1992 URM Status Report, SSC 92-01)

The April 25 and 26, 1992 earthquakes near Petrolia occurred in lightly populated rural and heavily forested settings. Wood frame construction is the prevalent type of building in the affected towns of Petrolia and Scotia, and the cities of Rio Dell and Ferndale.

In Ferndale, a town of 1500 people, the main grocery store lost its front and rear URM parapets, crushed two cars and sent paraders scampering to avoid the falling brick. Luckily no one was hurt seriously—not even a dog that was trapped in one of the cars. The URM grocery store lost much of its stock and has since been forced to relocate into another building. See Photographs 18 through 21.



Photos 19 and 20: Ferndale had not complied with the URM Law as of the April 26, 1992, Cape Mendocino earthquake. This damage to the same grocery store that was damaged in the 1906 earthquake could have been reduced if the owner had been informed of the risk and had strengthened the building.



Photograph 21: June 4 1992—site of the recently demolished Ferndale Grocery Store. This historic building was also damaged during the great 1906 earthquake. It was repaired to its original, unbraced state after 1906 only to face similar damage in 1992. This time, the damage was so extensive that the owner chose to demolish it. Only a vacant lot remains.

The remainder of Ferndale's downtown had wood frame construction, and, except for minor damage and broken storefront glass, fared quite well.

Ironically, Fortuna is one of the few jurisdictions affected by the earthquakes that is in compliance with the URM Law. However, its URM building had not been retrofitted yet. It too was damaged and subsequently demolished.

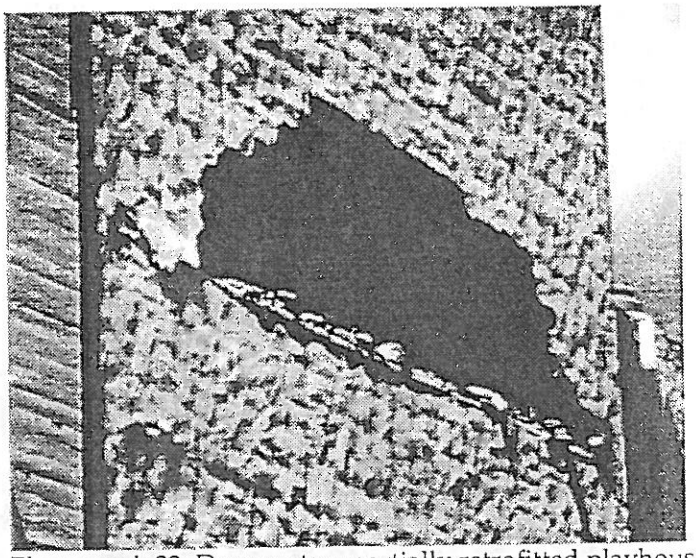
Ferndale and Humboldt County have not complied with the URM Law.

Joshua Tree 1992

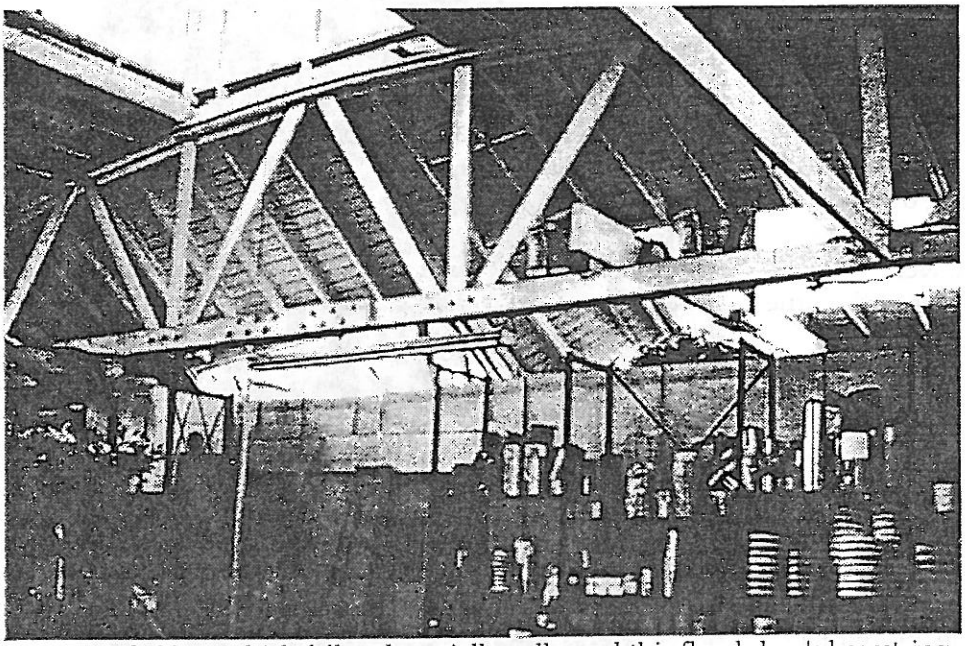
(Excerpt from the 1992 URM Status Report, SSC 92-01)

In Southern California, the Joshua Tree Earthquakes of April 15, 1992 unveiled several URM buildings that had not previously been identified in local government inventories.

It is quite easy to appreciate the risks of URM buildings after seeing gaping holes in failed walls and crushed cars. But it is unfortunate that owners and occupants—who were indeed surprised—had not been made aware of their risky situation and occupations back in 1990 in accordance with state law.



Photograph 22: Damage to a partially retrofitted playhouse in Pasadena after the Sierra Madre earthquake...



Photograph 23: ...which fell and partially collapsed this floral shop's bowstring roof.

Sierra Madre, 1991

(Excerpt from unpublished Seismic Safety Commission Reconnaissance Report)

The moderate Sierra Madre Earthquake of June 28, 1991, caused many unstrengthened URM buildings to suffer more damage than those recently strengthened. There were several excellent examples of reduced damage in retrofitted URM buildings when compared to unstrengthened buildings nearby.

However, one previously retrofitted playhouse with recently-installed concrete walls lost a portion of a hollow clay tile wall causing a partial collapse in the lower roof of an adjacent building (Photographs 22 and 23).

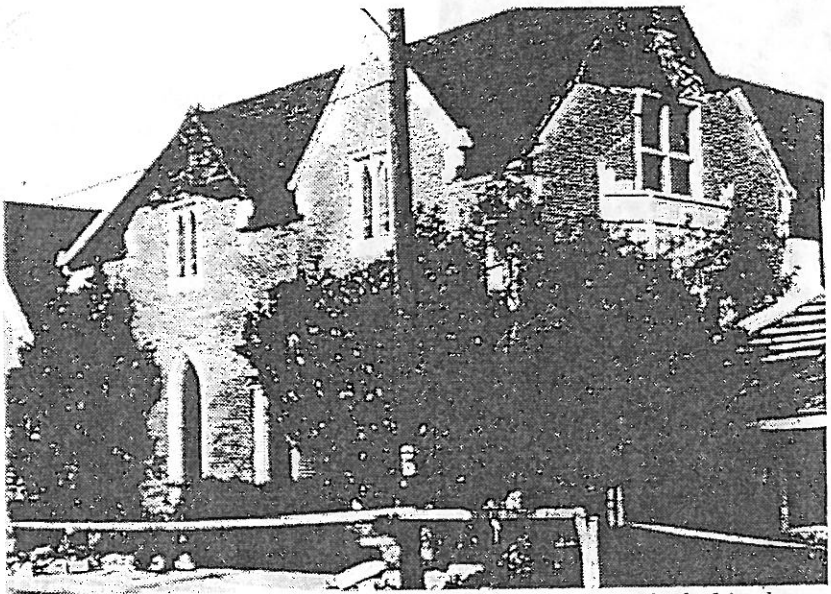
Upland, 1990

(Excerpt from Unpublished Seismic Safety Commission Reconnaissance Report)

Pomona was not in compliance at the time of the February 28, 1990 Upland earthquake which damaged many URM buildings. While its inventory of URM buildings was completed, it had not established a mitigation program at the time.

Pomona, Upland and Ontario suffered losses of parapet brick and minor cracking in unreinforced masonry as well as storefront window breakage in older downtown buildings.

A damaged URM concrete frame building that was instrumented by the state's Strong Motion Instrumentation Program experienced accelerations on the order of 13 percent of gravity at the building's base. It has since been analyzed to determine if computer models can be developed that accurately characterize the



Photograph 24: URM veneer, while not technically included in the scope of the state's URM Law, can also pose life threatening hazards. This chruch's veneer peeled off and fell through the roof of an adjacent daycare facility during the Upland earthquake.

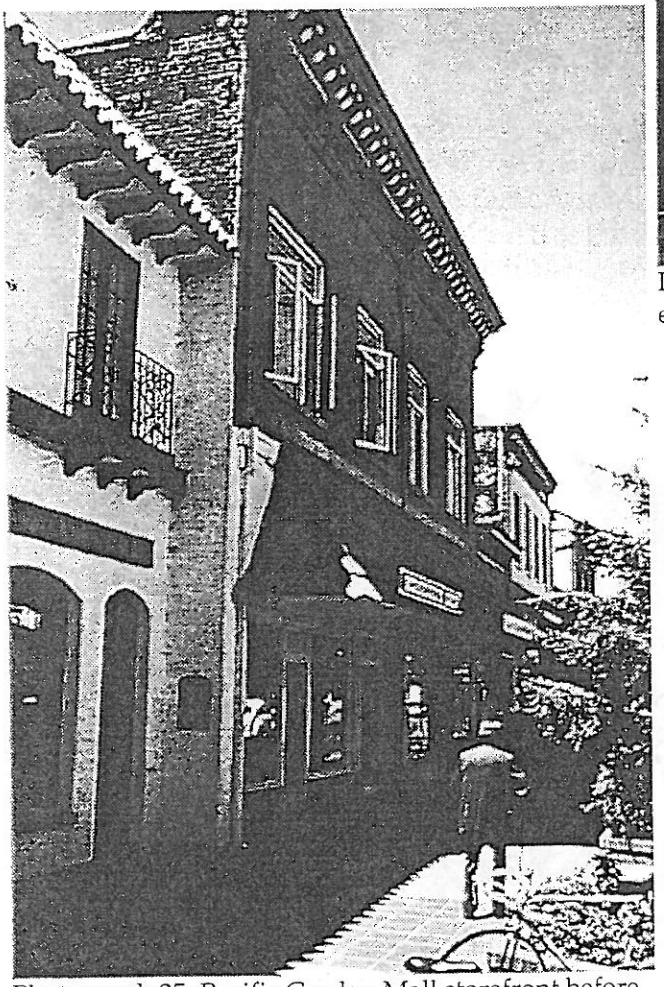
building's response to this earthquake (CSMIP, 1993). A retrofitted 1854 adobe building was also undamaged.

In LaVerne, a retrofitted URM wall in a warehouse collapsed stranding $2.2 million in auto parts inventory. The building owner and lessee had recently been notified that it was potentially hazardous. 70 people were apparently occupying the buildings at the time of collapse and all escaped with only minor injuries.

Loma Prieta, 1989

(excerpt from URM Bulletin Winter 1990)

Old downtown Santa Cruz will never be the same. Once its mall was a charming area of small shops in old-fashioned brick buildings, many catering to the tourist trade, but when I saw it—two days after the Loma Prieta earthquake, centered only ten miles away—the shops in its battered unreinforced masonry buildings were closed, perhaps never to reopen.



Photograph 25: Pacific Garden Mall storefront before the Loma Prieta earthquake...*(Photograph credit: Charles Eadie)*

Photograph 26: ...and after the 1989 Loma Prieta earthquake.

Twenty of Santa Cruz's damaged URMs, most in the vicinity of the Pacific Garden Mall, had to be demolished; many of the balance of the city's URMs were heavily damaged (Photographs 25 and 26).

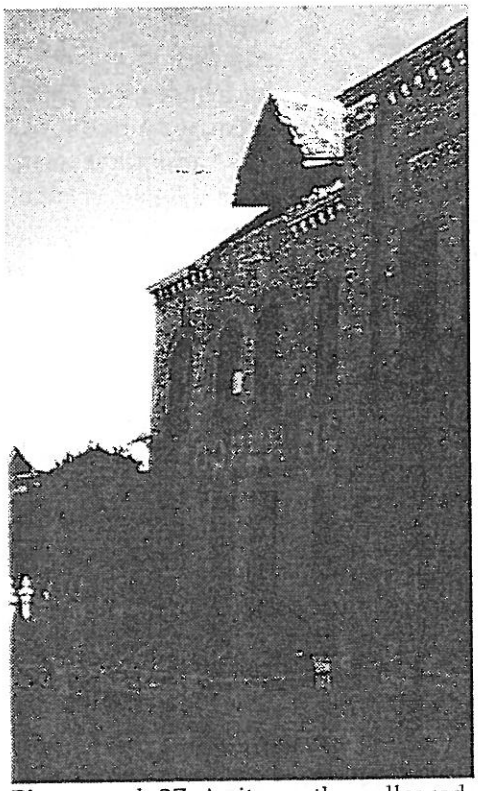
Hollister, about 35 miles from the earthquake's epicenter, fared better. Though its 17 URMs were all damaged in the quake, most are repairable. Nevertheless, the quake caused around $55 million in damage there—and it would have cost only about $3 million to strengthen Hollister's URMs.

As I toured the area affected by the earthquake, I saw much the same story elsewhere—URMs

had once again proved that they are dangerous, both to inhabitants and neighbors, in earthquakes.

Here are some observations:

- URMs are dangerous neighbors. Tops of URM walls and parapets failed, showering bricks on neighboring buildings or the sidewalk. A woman was killed in a department store in Santa Cruz when bricks from the URM next door came through the roof. Five people in San Francisco were also killed by falling brick.
- Infill URM walls fractured. In Oakland, the Emporium-Capwell store, a steel-frame building with infill walls of hollow tile, was heavily damaged. I saw a single-room-occupancy steel-frame-with-brick hotel in Oakland with heavy X-cracking that I believed could collapse in an aftershock; I was unable to locate a building inspector to close it, perhaps since Oakland's city hall, itself an URM, was closed.
- Veneers fell off URM buildings, threatening passersby. The Emporium-Capwell store in Oakland illustrated this, as did several buildings in downtown Los Gatos, Watsonville, Hollister, and Santa Cruz.
- The earthquake didn't care that a building was historic. The Cooper House in Santa Cruz looked pretty good in front, with only a few minor cracks; however, around the corner the walls had separated from the roof and partially collapsed. It had been partially retrofitted pursuant to the State Historical Building Code and has since been condemned and demolished.
- Old government anchors can't maintain an URM's structural integrity. I saw building after building with such anchors projecting from roof joists, over a pile of collapsed brick.
- Some wall failures showed hidden construction deficiencies. When the collar joint failed in a brick building in Hollister so that the outer wythe separated from the building, it exposed an inner wythe that had many joints without any visible mortar.
- The most heavily damaged URMs seemed to be those that were unstrengthened.
- Many unreinforced masonry chimneys failed.
- Modern and strengthened older buildings generally performed well in the earthquake; few appeared to have suffered more than minor structural damage.



Photograph 27: As it was then allowed by the State Historical Building code, this historical building was only *partially* retrofitted. The upper walls were not anchored to the gabled roof sections and thus collapsed during the 1989 Loma Prieta earthquake.

Media accounts stressed the spectacular collapse of the I-880 freeway, but the final score of dead and injured from this earthquake may show that hundreds of people were hurt and perhaps a dozen killed by failures of URMs. Moreover, the cumulative economic damage—the number of low-income people now homeless, the small businesses destroyed, the lost tax revenue—will rival that single collapse in long-term effect.

The Loma Prieta earthquake showed the need for local government to expedite efforts to identify hazardous unreinforced masonry buildings and adopt programs to mitigate the hazards. Mitigation program costs can be spread over a period of years, but repair or demolition costs in the area affected by

this earthquake have to be borne right now. Delaying URM hazard mitigation programs will mean still more lives will be lost in URMs in the future damaging earthquakes that are certain to strike California.

Performance of Nonretrofitted URM Buildings

(excerpt from Damage to URM Buildings in the Loma Prieta EQ, SSC 90-07)

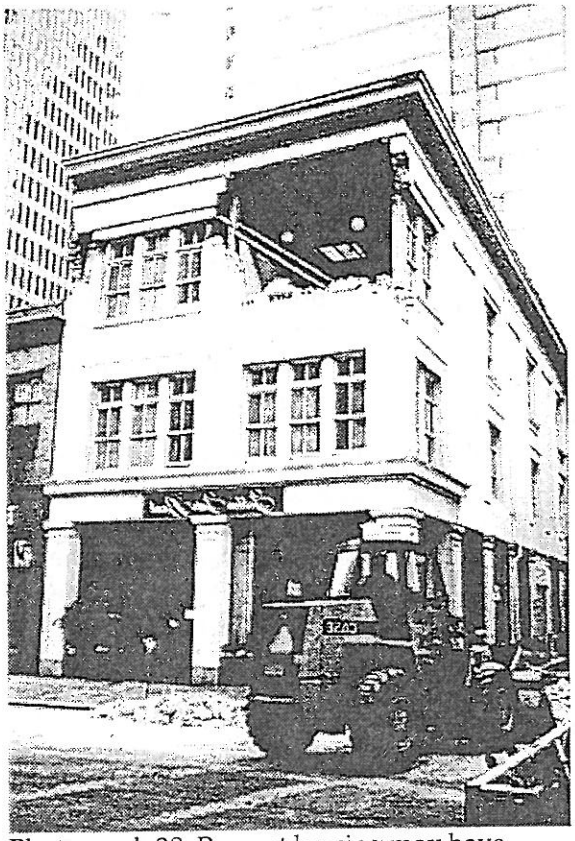
In the Loma Prieta earthquake, several common types of damage were observed which resulted from the following well-known URM building seismic deficiencies:

- *Parapet failure:* The most common type of damage observed in the earthquake, URM parapet failures, resulted in extensive debris, property damage, and one death.
- *Non-parapet falling hazards:* URM structures often have extensive decoration or ornamentation on street frontages. These appendages are not generally tied adequately to the structure and can pose a falling hazard to pedestrians. In other cases, the outer wythe of brick may become delaminated during an earthquake and litter the street below. In San Francisco, falling units or trim were observed in 101 of the 1,889 unstrengthened URM structures with records from survey form. Veneer damage or delamination was also quite common; 98 buildings had veneer damage.
- *Wall-diaphragm tie failure:* A tension tie between the walls and floors is a crucial element of all seismic retrofit ordinances, designed to prevent the wall from falling outward. Unfortunately, older buildings generally have no anchorage or relatively weak "government" anchors. In the Loma Prieta earthquake, many buildings had walls that fell away from the diaphragm due to inadequate or non-existent tension anchors. Nearly all of these failures occurred at the intersection of the roof and the upper story was. There were additional informal reports of buildings on the verge of wall failure—that is, the walls had effectively pulled away from the floors but had not yet completely failed. Seven deaths were related to this failure, five when the upper story wall fell on pedestrians, and two when the wall fell through the roof of an adjacent URM building, crushing workers inside.
- *Corner damage:* Damage to the corners of URM buildings has been observed in previous earthquakes. The failure mechanism is generally understood to be a lack of shear anchorage between the roof or floor diaphragm and the unreinforced masonry walls, allowing the diaphragm to slip relative to the longitudinal wall, punching out the wall oriented transversely to the diaphragm motion. The failure may be exacerbated by corner discontinuities and the inability of the longitudinal walls to carry the tensile forces generated when the transverse walls deflect outward and span not just vertically to the diaphragms but also horizontally to the longitudinal walls. A large number of buildings were observed to have corner damage from the Loma Prieta earthquake, usually at the intersection of two exterior walls and the roof diaphragm. Moreover, pounding damage from the adjacent structure was particularly widespread in Oakland and San Francisco because so many of the buildings do not have adequate seismic separation joints. Of the 1889 San Francisco buildings with records, 167 had corner distress above the first level, which could have been due to pounding or to the corner damage failure mode.
- *In-plane wall failure:* Several types of cracks may occur due to in-plane wall overstress. they include cracks at the corners of windows and other openings, stepped "X" cracking in the spandrels, vertical cracking at the edge of the spandrels, "X" cracking in walls or piers, and horizontal cracks at the top and/or bottom of piers. Of the 1889 buildings in San Francisco, 493 had one or more of these failure mechanisms.

Less commonly observed failure mechanism include:

- *Wall failure in bending between diaphragms:* If sufficient tension anchorage is present, the horizontal acceleration of the URM wall mass may cause the wall to span between floors. Because the unreinforced masonry is

weak in resisting the tensile forces produced in the wall, bucking or cracking may occur. Generally, the evidence of this type of failure is difficult to observe after an earthquake; in fact, it was hard to find examples of this failure mode in the Loma Prieta event, partially because the tension ties were not present or were too weak to prevent the walls from failing out-of-plane.



Photograph 28: Parapet bracing may have limited damage to this San Francisco building during the Loma Prieta earthquake.

- *Excessive diaphragm deflection:* In long, narrow building plan shapes, the diaphragm may be so flexible that mid span displacements can contribute to out-of-plane wall failures. Evidence of this type of failure was difficult to find in the Loma Prieta earthquake, possible due to wall-diaphragm tie failures.
- *Roof and/or floor collapse:* Very few roof or floor collapses were observed, although there were some examples in areas with strong ground shaking. Even where upper-story walls fell out-of-plane, interior partition walls were sufficient to prevent the roof from collapsing. Had the level of ground shaking been higher, however, more roof and/or floor failures would have been observed.
- *Soft story or other configuration-induced failure:* Vertical cracks were occasionally observed at the joint between two portions of a structure with differing heights. there were also some failures that resulted from soft first stories of from reentrant corners, but this mode of failure appeared to be less common than previous engineering experience would have predicted.

Performance of Strengthened URM Buildings

The inspection teams identified 281 buildings that showed evidence of pre-earthquake seismic strengthening (not including parapet bracing). From Rutherford and Chekene's (R&C) years of experience in the San Francisco earthquake engineering field, this seemed an unusually high number of buildings. Consequently, all 281 buildings were reexamined to check whether strengthening had, in fact, occurred, and if it had, what type had been employed. R&C's reexamination indicated that only 26 could clearly be identified as having been seismically retrofitted, presumably to the level of San Francisco Building Code Section 104(f). An additional 19 buildings showed evidence of retrofit systems that appeared less than complete or not conforming the section. The remainder of the 281 were probably mistakenly called "strengthened" by inspectors due to the presence of some visible ties of exterior walls; but these ties are often part of the original construction.

Of the 26 buildings presumably retrofitted the code standards, the damage percentage was 2.65 percent on a building basis. Further investigation uncovered an additional 23 buildings not on the city;s list of 2007 URM buildings. The damage percentage for these buildings was 0.74 percent. Combining these two sets of buildings into a group of 49, the damage was 1.73 percent. Including the 19 partially strengthened buildings, the aver damage was 1.68 percent, less than the 2.68

percent for the 1925 unstrengthened buildings. It is worth noting that preliminary results indicate that a higher than average percentage of the strengthened buildings are on soils with a high susceptibility of ground shaking. It should also be pointed out that drawing conclusions based on these very small damage levels may be inappropriate.

Performance of Strengthened URM Buildings Outside San Francisco

R&C's investigation of damage revealed a surprisingly low number of strengthened URM buildings outside San Francisco. The extent and level of retrofit varied significantly, and was generally of a less stringent level than that found in buildings strengthened to San Francisco's code of Los Angeles' Division 88 or Rule of General Application (RGA). Unfortunately, it has not been possible to review drawings and calculations or even to walk through the interior of these structures, so the observations of damage were quite limited.

In Campbell, two adjacent URM buildings (an office building and a warehouse) were previously strengthened to the 1973 UBC with internal crossbracing, floor/wall ties and out-of-plane wall strengthening. In the office building "X" cracking in the walls was observed, and it was given an ATC-13 damage rating of "light." In the warehouse a portion of the gable wall had fallen out, and damage was rated as "slight."

In Emeryville, four structures were known to have been strengthened prior to the earthquake. The local building department indicated that the past practice was to require retrofits to meet the Uniform Building Code in effect at the time of the work; however, any rational solution to provide some measure of security and to allow for a safe exit path from the building was generally approved. Damage to these structures was minimal, as was damage to the unstrengthened URM buildings in Emeryville.

In Hollister, two commercial buildings were said to have been previously strengthened. In one structure new plywood load bearing walls were put next to the existing URM walls to carry a new mezzanine. It is not known whether the stiffness incompatibility of these two materials was considered in the lateral force design or if the plywood walls were designed to take the out-of-plane URM wall forces. There was "light" damage to the structure, consisting of cracks at some openings, some pier cracks and some corner distress above the first level. In the other structure, the type of retrofit was unknown. the damage was also rated as "light," although the damage was probably more sever because city records indicate that the building was leaning, rafters were on the verge of separating from the structure, and a portion of the exterior wall fell through an adjacent roof.

In Los Gatos, only one structure had been previously strengthened. An historic pumphouse was converted to a meeting and fitness center for a homeowners' association. Using the 1985 UBC, the building was retrofitted by guniting the interior face of the URM walls. The structure suffered no damage.

In Mountain View, two structures were known to have been retrofitted; neither was damaged. The level of strengthening was unknown.

Palo Alto has had a hazard mitigation ordinance for some time and nine buildings have been strengthened. No URM buildings in Palo Alto suffered any damage.

In Santa Cruz, some strengthening to at least eight URM buildings had occurred previously although the level varied and strengthening was often incomplete. These partially strengthened buildings were damaged and vacated at rates similar to the unstrengthened buildings, but a much higher percentage of unstrengthened buildings were demolished. The weighted average damage to these strengthened structures 14 percent, also less than the 28 percent of the unstrengthened URM buildings.

In Watsonville, at least two commercial buildings had some strengthening. In one structure, new plywood diaphragms and wall anchorage ties had been added; nonetheless, damage was severe. In the other building, damage was minimal.

Loma Prieta URM Damage Conclusions

- Analysis of URM buildings in San Francisco does indicate that unstrengthened buildings performed worse than strengthened; the poorer the soil, the higher the damage; and the taller the average story height, the higher the damage. Assembly and industrial buildings performed worse than the residential, office and commercial buildings. Pre-1924 buildings did worse than newer buildings. Irregular and rectangular building plan configurations performed more poorly than buildings with square or notched configurations. finally, certain buildings types or prototypes performed better than others. It is worth noting, however, that the average damage for San Francisco's URM buildings was only 3.9 percent, and this relatively small ratio of average damage would be considered when viewing the apparent effects of different building characteristics in seismic performance.
- The number of strengthened URM buildings in the area affected by the Loma Prieta earthquake is quite small, presumably because mandatory strengthening requirements such as those in Los Angeles and Long Beach have not found, to date, much usage. However, strengthened URM buildings appear to have—reassuringly—performed better than those that are unstrengthened.
- Failure mechanisms predicted by theory and previous earthquake experience were also seen in the Loma Prieta earthquake; in fact, few, if any, new types of failures were seen. However, quantified data on the types of cracking patterns seen in URM walls was collected for a large number of structures. the most common pattern observed was the formation of cracks at the corners of windows and other openings. Many current codes and ordinances use the concept of "pier rocking" where, in certain situations, the failure mechanism is assumed to be a horizontal crack at the top and bottom of the piers. In our study of 1889 unstrengthened URM buildings in San Francisco, this was reported to occur in 199 buildings. Shear cracking of piers or walls was reported in 204; shear cracking of spandrels was reported in 124; and vertical cracking at the edges of spandrels was reported in 179 buildings. It is interesting to note that several cases were observed where vertical cracks formed in deep spandrels, but there were no obvious horizontal cracks on the top and bottom of the narrow piers.
- A wide variety of damage assessment and rating techniques were used by building departments in the jurisdictions studied for this report. Some departments were unaware of the ATC-20 publication *Procedures for Post-Earthquake Safety Evaluation of Buildings*, and used their own techniques. Most jurisdictions, however, used the ATC-20 documents, although they may have made some modifications. The applicability and effectiveness of the document was often related to the extent of damage and the number of personnel available for damage assessment. For a more comprehensive assessment, consult the Structural Engineers of Northern California document *SEAONC White Paper: Tagging of Buildings After the Loma Prieta Earthquake.*

Recommendations from the Loma Prieta Earthquake

Much remains to be learned about the effectiveness of different retrofit techniques, since so few strengthened buildings have been tested by a significant earthquake. While it is clear that buildings on poor soil experienced more damage, the impact this should have on codes is unresolved. Current URM strengthening ordinances generally do not have provisions that consider the effects of soil on design procedures.

- While observers were not experts, URM wall elevation data is not known, and rocking cracks may have closed, the number of times different types of cracking pattern were observed indicated to us that further study into the validity of the "pier rocking" concept may be warranted.
- We are aware of only one URM building equipped with strong motion sensing, the

old Gilroy firehouse. It actually indicated amplification of ground motion in the shear walls at the roof levels, a finding not necessarily consistent with assumptions in many current URM building strengthening ordinances. the Gilroy results, combined with our observation that there is generally more damage at upper story levels, suggests to us that more extensive implementation of strong motion instrumentation would be useful.

- We found the number of different assessment techniques used following the earthquake was surprising and not necessarily the most effective approach. We believe that better training of building department personnel and more consistent use of a more widely accepted assessment documents, such as ATC-20, would be useful for damage information collection and, more importantly, for occupant and public safety. Hopefully, problems encountered in the usage of ATC-20 can be explored and incorporated into a revised document.
- During our study of previously strengthened URM buildings, we found a wide variety of approaches and level of strengthening. While none appeared counterproductive, the effectiveness varied widely. We feel it is important that retrofit ordinances contain a clear statement of performance goals. Future research and monitoring of actual seismic performance should be used to validate the effectiveness of chosen ordinances to meet established goals.
- We strongly recommend educational programs for engineers engaged in URM building retrofit work and for building officials responsible for checking the work to help insure that latest design approaches are being utilized effectively.

(Excerpt from SB 547—A Political History, Tobin, 1990)
The Loma Prieta earthquake raised several issues for URM strengthening, including the importance of falling hazards on building exteriors, soil conditions, and wall spandrels. All of the URM-related deaths in the Loma Prieta earthquake occurred because of falling masonry at the exteriors of URM buildings. But the Commission's Model Ordinance does not reflect the importance of falling hazards in its building hazard rating classifications that establish which buildings should be strengthened first. The current hazard rating classifications are based on the number of occupants inside URM buildings, and the Model Ordinance recommends that buildings with more occupants should be strengthened first. Many would argue, however, that buildings posing the greater exterior falling hazards should be strengthened first. Taller buildings that pose the most falling hazards next to shorter buildings and busy sidewalks should perhaps be strengthened first. Future code change efforts will focus on this matter.

Some jurisdictions have considered setting higher strengthening priorities for URM buildings located on weaker soils. Currently the Commission's Model Ordinance has special provisions that indirectly account for the effects of soil, but it makes no distinction for weak soils. Further research is needed to refine our understanding about the effects of soils on URM buildings, but, in the meantime, it makes sense to reconsider strengthening priorities for buildings on weaker soils.

(Excerpt from 1990 URM Status Report SSC 90-___)
Several issues relating to URM buildings were highlighted in the Loma Prieta earthquake.

- *Threats to nonresidents*—All of the eight deaths and most of the scores of injuries that occurred as a result of falling masonry from URM buildings occurred outside or in adjacent buildings where falling masonry penetrated the roofs.
- *Damage Patterns*—Major damage to URM buildings occurred in over a dozen jurisdictions. In a partial survey completed last December, 868 URM buildings were found damaged and at least 45 had been demolished. Demolition of damaged buildings will continue for some time, since costs to repair the buildings range from $50 to $150 per square foot. Damage occurred to

both bearing- and nonbearing-wall buildings, although all of the deaths were caused by bearing-wall buildings. Major falling hazards occurred in tall nonbearing-wall buildings on weaker soils primarily in San Francisco and Oakland. There were very few nonbearing-wall buildings in cities closer to the epicenter.

- *Historical Buildings*—The Cooper House, a historical URM building in the Pacific Garden Mall in Santa Cruz, was partially strengthened prior to the earthquake using the State Historical Building Code. It suffered extensive damage and had to be demolished after the Loma Prieta earthquake. The Commission urges that historical preservationists, architects, and engineers heed this experience, and reexamine the earthquake performance objectives for historical buildings.

Armenia 1988

(excerpts from 1989 URM Status Report)

A disastrous earthquake of magnitude 6.8 struck Soviet Armenia on December 7, 1988, proving the point that California has known for decades: Unreinforced masonry buildings are hazardous in earthquakes. In the Armenian earthquake, failure of unreinforced masonry buildings caused thousands of deaths and injuries. And the Armenian disaster has only just started—orphans, amputees, psychological trauma, lack of permanent housing, the loss of factories and jobs, and the disruption to that nation's economy will leave a lasting mark. It will take years to recover and decades to forget.

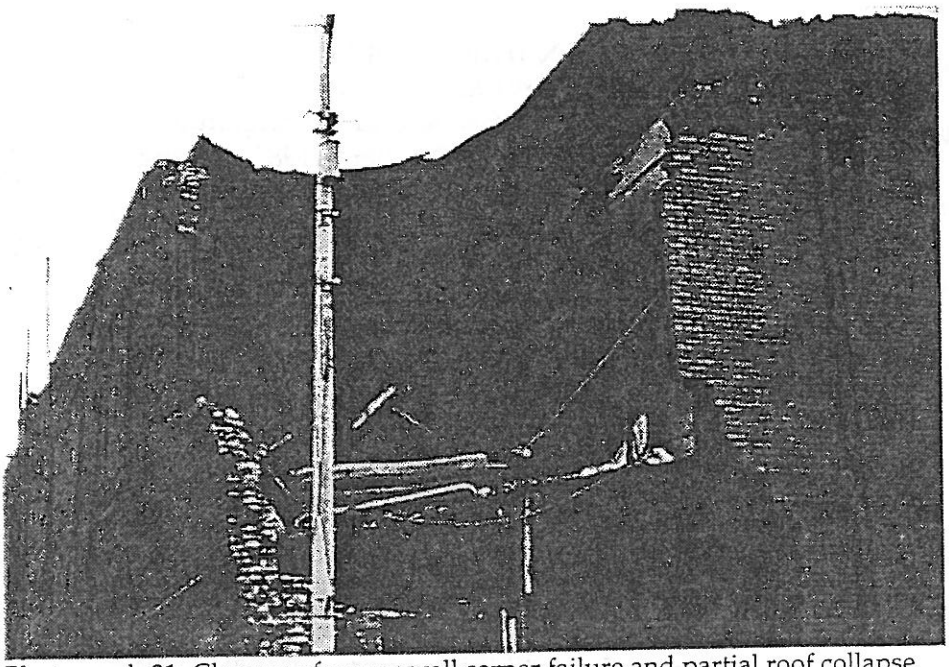
Whittier Narrows 1987

(excerpt from 1989 URM Status Report)

On October 1 a few-second 5.9 magnitude earthquake and on October 4, 1987 a strong aftershock struck an area stretching from Ventura county to central Orange county and from Long Beach to Ontario, damaging approximately 10,000 buildings. Damage losses from buildings and contents, report in 37 cities and in the unincorporated portions of Los Angeles and Orange counties, exceeded $358 million (in 1987 dollars).

As in similar moderate earthquakes, the building type most frequently damaged in the Whittier Narrows earthquakes was unreinforced masonry. Many URM buildings in the cities of Alhambra, Los Angeles, Pasadena, and particularly Whittier suffered partial collapse of exterior walls and parapets, and a few sustained complete collapse of walls and roofs. Of 2431 buildings inspected in a post-earthquake survey of URM buildings in the city of Los Angeles, which was not as severely shaken as Whittier, 1633 exhibited no damage, 676 had minor damage, and 122 had to be totally or partially vacated. This evidence clearly underscores the importance of URM building hazard mitigation, and the need for local governments to pursue implementation of the URM Law.

Photograph 29: Falling brick is a significant threat to life and property adjacent to URM buildings (1987 Whittier earthquake).



Photograph 31: Closeup of upper wall corner failure and partial roof collapse.

Strengthened URMs are almost three times more likely to escape earthquake damage according to a survey of strengthened and unstrengthened bearing-wall URMs conducted by the city of Los Angeles after the 1987 Whittier earthquake. For every strengthened URM building that was damaged enough to be at least partially vacated, 2.7 unstrengthened buildings were.

Damage to URMs included:

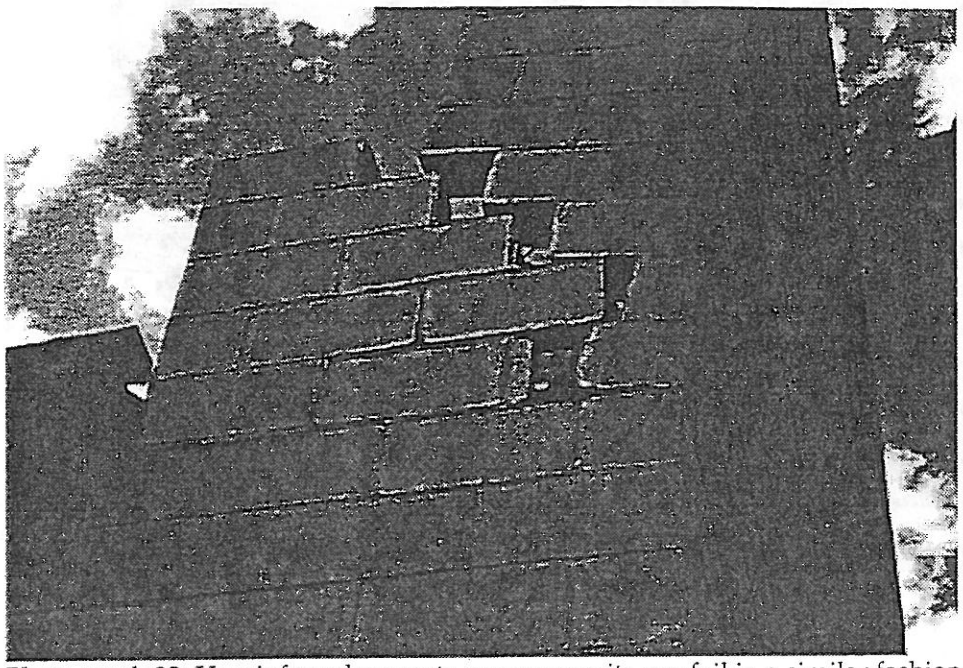
- *Wall movement.* The effects of out-of-plane wall movement caused partial collapse, wythe separation, or wall cracking at lintels and tops of slender wall piers. This type of damage was observed in some buildings strengthened prior to the earthquake but tended to occur in areas of poor mortar quality and at upper levels, where walls have low overburden and possible experienced higher inertial forces. Where wall collapses occurred, secondary vertical load supports such as crossways or columns kept many floors from collapsing
- *Wall separation from floors and roof.* This problem was not observed in fully strengthened buildings and was not common in buildings strengthened with only new wall anchors.

Observations confirmed that original government anchors should not be relied on to provide tension anchorage for walls in unstrengthened buildings. Government anchors generally failed at the end embedded in the wall.

- *In-plane wall cracking.* X Cracks in piers and horizontal rocking shear cracks at the tops and bottoms of piers were observed. Cracking in wall spandrels occurred above jambs of openings.

Photograph 30: Failure of URM buildings often starts at the upper corners and progresses toward the middle of the building (1987 Whittier earthquake).

As required by the law, the Seismic Safety Commission published a *Guidebook to Identify and Mitigate Seismic Hazards in Buildings* to assist local jurisdictions in carrying out the law's provisions, and has held workshops to familiarize local building officials with the actions needed.



Photograph 32: Unreinforced concrete masonry units can fail in a similar fashion to brick (1983 Coalinga earthquake).

Conclusions

- Though the Whittier earthquake caused no life loss from URMs, it produced only a few seconds of strong ground motion. Larger earthquakes will cause more damage in strengthened URMs, but we can learn from the Whittier and incorporate findings into future standards.
- Out-of-plane wall movement, especially in top stories and walls with poor mortar quality, was observed in strengthened buildings. The UCBC strengthening provisions have been revised to reflect these observations.
- Installing only wall anchors to strengthen buildings partially reduces certain types of damage by leaves the buildings vulnerable to others and to collapse. Partial strengthening using only wall anchors should be considered as only a temporary and short-term method of mitigating risks.

Coalinga 1983

(excerpt from Report on the Coalinga Earthquake of May 2, 1983)

Two points should be made regarding damage to structures that housed Coalinga businesses. First, engineers and other investigators found it difficult to make accurate assessments of the amount of damage caused by ground shaking because local authorities restricted access to the downtown business district. Moreover, debris clearance and the removal of heavily damaged buildings began so soon after the earthquake that, in some cases, it was difficult for investigators to differentiate the effects of the earthquake from those caused by the heavy equipment brought in lager; several investigators (e.g., School and Stratta, 1984; Kariotis, 1984) note that much information on the earthquake performance of buildings was lost thereby. Second, the city's decision to demolish buildings in the area of heaviest damage downtown made the issue of the extent of damage to commercial structures more or less moot, at least from the business owners' standpoint. No consideration was given to saving buildings that had sustained only 60 percent damage, for example; damaged unreinforced masonry buildings located downtown automatically became part of the demolition plan.

Although complete building collapse was confined to the downtown area, business-related losses were considerable throughout the community. Reportedly, 212 businesses sustained damage to building or stock that interrupted their operation, although the majority reopened within weeks. 114 businesses were completely destroyed, and 71 had major

Photograph 33: Partitions can often create voids in partially colapsed buildings (1983 Coalinga earthquake).

damage (Frend, Ewing, and Isaacson, 1984). Prior to the earthquake, there had been 52 businesses in the downtown area, including 27 businesses on the Plaza. All were shut down at least temporarily.

Although complete building collapse was confined to the downtown area, business-related losses were considerable throughout the community. Reportedly, 212 businesses sustained damage to building or stock that interrupted their operation, although the majority reopened within weeks. 114 businesses were completely destroyed, and 71 had major damage (Frend, Ewing, and Isaacson, 1984). Prior to the earthquake, there had been 52 businesses in the downtown area, including 27 businesses on the Plaza. All were shut down at least temporarily.

Damage to commercial property was particularly grave in this earthquake because the business district, with about 40 percent of Coalinga's retail space and a majority of its businesses, contained so many older, unreinforced masonry buildings. The damage to such vulnerable buildings, while it certainly was not surprising to engineers and others familiar with the design of seismically resistant structures, is nevertheless one of the most striking lessons of the Coalinga earthquake, and it should be noted by California communities.

There were 40 one- or two-story unreinforced masonry buildings in the twelve-square-block downtown area. Shah, Et al. (1984) surveyed all the 13 buildings in the commercial district, assessing the degree of structural damage by building type. (Only the outsides of buildings were evaluated. Concrete-block buildings, cast-in-place concrete structures, and wood-frame buildings generally performed well. Newer buildings and "engineered" buildings in the downtown area and other parts of the community had little or no structural damage.

On the other hand, three-quarters of the old unreinforced masonry buildings were extensively damaged, were total losses, or collapsed. Seven buildings collapsed outright in the earthquake, but two of these were knocked down by bricks falling from neighboring buildings. In many cases, the front walls of unreinforced masonry buildings, particularly second-story walls, collapsed onto the side walks, endangering pedestrians and people trying to leave the buildings (Reitherman et al., 1984).

Individual unreinforced masonry buildings failed for a variety of reasons. In general, damage was related to inadequate or nonexistent anchorage between walls and roofs, between walls and floors, and between the walls themselves (Kariotis, 1984).

Fire Damage

fire hazard is a major concern in earthquakes, as was demonstrated in the 1906 San Francisco and 1923 Tokyo earthquakes. Despite widespread

Photograph 34: This storefront fell onto the sidewalk and street in Coalinga.

media reports of a major problem with fire after the Coalinga main shock, fire actually caused very little damage. The city controls its own natural gas distribution system, and the city's entire gas supply was shut off immediately following the main shock to reduce the fire hazard.

There was one major fire, in the Coalinga Inn, a two-story brick building downtown that had been severely damaged. A flame, probably from the water heater, apparently ignited the inn's liquor inventory when bottles smashed on the floor. The fire was difficult to extinguish, and eventually destroyed the building. The adjacent jewelry store was demolished to prevent the spread of the fire.

Damage Pattern Implications

The following are brief summaries of the general lessons learned from the earthquake-related damage in Coalinga:

Old, Unreinforced masonry buildings are hazardous

The 1983 Coalinga earthquake graphically illustrated the significant life and safety hazards these buildings post. Persons in the downtown area were more than twice as likely to be injured as those who were elsewhere during the earthquake. Ground shaking caused several buildings to collapse, and the volume of brick that fell into the streets caused observers to wonder why the earthquake casualty count was not much higher.

The extent and kind of damage to unreinforced brick buildings in Coalinga was typical of damage observed in other 20th-century earthquakes. Reitherman, in a comparative study of building damage in Coalinga and other major earthquakes, has concluded that the great majority of such buildings present a life threat when subjected to ground shaking. Several other observers (e.g. Hopper et al., 1983; Shah et al., 1984) point out that what happened to buildings in Coalinga could happen in many other California communities with similar buildings.

The Seismic Safety Commission estimates that there are approximately 30,000 hazardous buildings in California. The majority are in metropolitan areas where high population densities place large numbers of people at risk from building collapse and falling brick. The City of Los Angeles has identified approximately 9300 dangerous buildings and has instituted a program to retrofit or remove them. According to the Commission survey, San Francisco and Oakland 2200 and 1600 hazardous

buildings respectively. Generally the hazardous buildings in cities are higher occupancy, taller, and more massive structures than those in Coalinga. In addition, a number of smaller California towns have buildings similar to those that collapsed or were severely damaged in Coalinga.

Despite the fact that unreinforced masonry buildings are quite prevalent in many cities and towns and their hazards are well known, only four California cities have enacted ordinances to abate the hazard they present. Some communities have successfully attempted to develop local abatement programs; others are only beginning to consider hazard reduction measures. Land use and building safety issues are the province of local governments, and there has been considerable local resistance to instituting needed building safety programs. All California communities have an interest in overcoming such resistance and making reasonable progress with risk mitigation. If the anchorage requirements and measures for parapet reduction required by building hazard reduction programs had been in effect in Coalinga, both physical damage and threats to life safety would have been greatly reduced (Kariotis, 1984; Reitherman et al., 1984).

Lessons Learned

The lessons to be learned from these earthquakes are clear:

- URM buildings pose a present and reoccurring threat to life, property, and livelihood. Their risks should be identified and evaluated, disclosed to the public, and mitigated in a timely manner.
- Retrofits of URM buildings can and do reduce damage from moderate earthquakes, and in many cases, retrofits allow owners to avoid demolition.
- Other building types can pose unacceptable seismic risk, although generally less life-threatening than URM buildings, particularly when coupled with the threat of fire. Two exceptions are the older concrete frame buildings and "soft story" buildings which, upon collapse, can threaten hundreds of lives.
- Older residential buildings with unbraced cripple walls and URM chimneys pose a substantial economic risk to the state.
- Older facilities of most types of construction pose significant risks of losing building functions after moderate and major earthquakes. Most dwellers and businesses in California are obviously not prepared for earthquake losses and lengthy business interruptions.
- Buildings, such as public schools, that are built with high quality construction, code enforcement and earthquake resistance in mind, performed markedly better than other buildings in these recent earthquakes.

Seismologists surmise that California has recently entered into a new era of heightened seismic activity. All the more reason to face up to the risks of URM buildings.

Legislative Efforts

1989 Summary of Legislative Efforts

(excerpt from 1989 URM Status Report)

Two new laws passed by the State Legislature provided incentives and financial assistance that assist in implementing the URM Law:

- Assemblyman Costa's bill AB 810 made technical corrections to existing law, which provides load funds through the sale of local revenue bonds (Chapter 90-756).
- Senator Alquist's SB 424 created a state construction loan guarantee program to make loans for seismic retrofits more attractive to private lenders (Chapter 90-1203).

One bill could have gone a long way to assist in implementing the URM Law:

- Senator Mello's SB 1088 would have allowed special local tax assessment districts to be formed that could help finance seismic retrofit (vetoed).

Landmark Seismic Safety Legislation Passed in 1990

(excerpt from URM Law Bulletin Winter 1991)

AB 3313 (Woodruff) Requires the Building Standards Commission and the Office of the State Architect to develop and adopt uniform guidelines for the seismic retrofit of state government buildings by January 1, 1993 and adopt seismic retrofit building standards by January 1, 1996.

AB 3897 (Willie Brown) Expands the Alquist-Priolo Seismic Hazards Mapping Program of the California Division of Mines and Geology to include maps for areas prone to strong ground shaking, liquefaction, and landsliding, in addition to current map information for fault rupture zones and inundation from dams. The program is funded by increases in building permit fees and premiums from the mandatory residential earthquake insurance program (see below).

SB 2902 (Hill) Establishes a low-deductible residential earthquake insurance program that provides up to $15,000 of coverage for earthquake damage with annual homeowner premiums of $12 to $60.

Proposition 127, SCA33 (Rogers), AB 43 (Floyd) Prohibits the reassessment of property value and the raising of property taxes for the seismic retrofit portion of the added property value when a building has had a seismic retrofit.

1990 Summary of Legislative Efforts

(excerpt from 1990 URM Report, SSC 90-03)

In 1989, 17 bills were signed into law. The Governor vetoed just one of the seismic safety financial assistance bills in September.

Two bills that improved URM financing were signed into law. SB 424 (Alquist, Chapter 1203) provides for a construction loan guarantee to encourage private lenders to make affordable construction loans for seismic retrofit of residential URM buildings. AB 810 (Costa, Chapter 756) improves the state law that allows local governments to establish local revenue bond programs to fund seismic retrofits.

The Legislature convened a special session in November 1989 after the Loma Prieta Earthquake to address earthquake disaster aid and recovery needs. Twenty-four bills were passed including a 1/4-cent sales tax to finance disaster aid. Another 80 bills were introduced and held over for consideration in January 1990.

The Commission followed over 160 earthquake-related bills in the second half of the 1989 legislative session. Below is a summary of bills that could have affected URM hazard reduction efforts:

- *AB 1279 (Hauser)*—Provides local governments with more effective means to enforce seismic retrofit programs and deal with uncooperative building owners. (Chapter 90-192)

- *AB 1497 (Hauser)*—Expands the construction loan loss guarantee program to commercial buildings. (Vetoed)
- *AB 3209 (Costa)*—Amends local earthquake revenue bond programs so that existing debt on buildings can be refinanced with bond money. (Chapter 89-756)
- *AB 3556, AB 17X (Cortese)*—Encourages redevelopment agencies to set aside a portion of redevelopment funds for seismic retrofit. (Chapter 90-933)
- *AB 3966 (Floyd) and SCA 33 (Rogers)*—Exempts more types of hazardous buildings from property tax increases after undergoing seismic retrofit. (Proposition 127, passed, Chapter 91-8)
- *SB 2428, SB 27X (Mello)*—Would allow the establishment of assessment districts to finance seismic retrofit of buildings. Chapter (90-29X)

1991 Summary of Legislative Efforts

(excerpt from 1991 URM Status Report, SSC 91-04)

In 1991 there was a dramatic reduction of earthquake-related legislation as compared to the flurry of activity after the 1989 Loma Prieta Earthquake. This legislation still avoids the central issues of seismic risk reduction such as the high costs and the need for incentives. Some of the key bills that became law in 1991 are summarized below:

- *AB 204 (Cortese)*—Establishes the Uniform Code for Building Conservation Appendix Chapter 1 as a minimum seismic retrofit standard for bearing wall URM buildings. Local agencies began enforcing this new model code effective July 1, 1993, and they may amend it using the same procedures they currently can use to amend the Uniform Building Code. (1991 Statutes Chapter 173)
- *AB 1001 (W. Brown)*—Allows cities and counties to use municipal bonds to finance the seismic retrofit of privately-owned unreinforced masonry buildings.
- *AB 1963 (Areias)*—Requires owners to post placards warning the public of seismic risk inside and near unstrengthened URM buildings.
- *AB 2358 (Frazee)*—Allows local governments to adopt seismic retrofit standards that provide less safety than the Uniform Code for Building Conservation for pre-existing ordinances or if certain buildings have architectural or historical significance, or are part of a Main Street Program.
- *SB 597 (Alquist)*—Requires the Office of the State Architect to develop seismic retrofit guidelines for other types of hazardous buildings by July 1, 1996.

Three bills were vetoed by Governor Wilson:

- *AB 416 (Floyd)*—Would have allowed building owners to make incremental life safety and seismic improvements without requiring the entire building to meet all current building code requirements, provided an unsafe condition is not created.

  The veto message stated that the state's current exemptions from handicap access requirements for hardship cases provide more than adequate flexibility, and that AB 416 was not necessary.
- *AB 272 (Hansen)*—Would have allowed local governments to use local ordinances in place of Appendix Chapter 1 of the Uniform Code for Building Conservation if the local government had adopted their ordinance prior to January 1, 1993. Local governments could have ruled parts of that code inapplicable if they found that local socio-economic conditions warranted lower seismic safety standards.

  The veto message stated concern over changing a well-established precedent by allowing local governments to lower building standards for socio-economic reasons.
- *AB 1964 (Areias)*—Would have established a goal for the state of California to retrofit or vacate all state owned or leased unreinforced masonry buildings by the year 2005.

  The veto message said that the state is now inventorying its buildings but doesn't yet

know how many URM buildings it owns. Currently the state cannot estimate the capital needed to meet this bill's goal.

Research Needs

(excerpts from 1990 URM Status Report)

In recent efforts to revise the Commission's Model Ordinance, a number of research needs have been identified:

- Refine earthquake performance objectives for existing buildings.
- Study the issues relating to Zone 3 earthquake risk reduction.
- Explore new and alternative risk reduction technologies; seek out and encourage the development of methods that could result in higher safety and lower costs.
- Study the policy issues surrounding the placing of warning placards on potentially hazardous buildings and determine if placards are an effective risk disclosure measure. Study the effectiveness of local government programs that have required placards on URM buildings.
- Develop seismic retrofit techniques and standards for nonbearing-wall URM buildings:
  - Study, test, and identify acceptable slenderness ratios for nonbearing URM walls.
  - Study the out-of-plane stability of nonbearing URM walls in conjunction with in-plane response.
  - Identify response parameters, evaluation techniques, and retrofit methods for infill walls aligned with concrete or steel frames, and nonbearing walls offset from frames.
  - Develop analytical models for nonbearing-wall buildings.
- Refine retrofit techniques and standards for bearing-wall URM buildings:
  - Refine the relationships between masonry strength tests and actual in-plane URM wall strength. Develop alternatives or supplementary testing methods.
  - Evaluate URM wall rocking and shear response of wall piers and its effect on URM wall stability.
  - Study the sensitivity of URM wall performance to collar joint mortar quality, and explore methods of improving inter-wythe connections in URM walls.
  - Study the effects of overburden on walls, especially as it influences out-of-plane URM wall shear capacity.
  - Develop comprehensive guidelines for the repair and retrofit of earthquake-damaged URM buildings.
  - Study the effects of foundation rocking on the performance of URM buildings.
  - Study the recent strong motion recordings of URM buildings and recommend refinements to analysis and design procedures.
  - Develop short-term testing programs of existing buildings slated for demolition.
  - Study the performance of strengthened and unstrengthened URM buildings in the Loma Prieta and Upland earthquakes and recommend enhancements to risk reduction provisions.
  - Study the effects of soil-structure interaction and the dynamic characteristics of soil, and recommend methods of incorporating soil effects in hazard reduction provisions.
  - Study the role of URM wall spandrels in building performance, including steel, concrete, and arch lintels, and recommend methods of evaluating and reducing hazards in pier/lintel URM wall systems.
  - Develop comprehensive limits for the application of the ABK Method, now called the "Special Procedures" for URM buildings.
  - Determine the sensitivity of retrofit cost to varying force levels and detailed requirements.

- Develop a comprehensive cost-benefit model for determining consistent risk reduction measures.
- Study the effects of pounding between adjacent buildings and determine effective methods of evaluating and reducing risks in existing buildings.
- Study the applicability of brick URM strengthening provisions to other masonry types such as adobe, concrete masonry units, hollow clay tile, cobblestones, and cut stone.
- Study and recommend consistent variations of risk reduction methods for different seismic hazard zones.
- Develop a cost-benefit analysis that can be used by local governments to compare the costs of seismic retrofit with the anticipated benefits.

The Commission recommends that the National Science Foundation, FEMA and CUREe consider these research needs in their program plans.

Recommendations

Review of 1989's Recommendations

(excerpts from 1990 URM Status Report, SSC 90-03)

The recommendations made in last year's annual report and their current status is described below:

- *1989 Recommendation:* Explore the feasibility of additional incentives at federal, state, and local government levels to encourage timely action by local governments and building owners to mitigate earthquake hazards in URM buildings.

  1990 Status: A number of bills were introduced pending in the state Legislature. Refer to the "Legislative Efforts" section in this report for a summary.

- *1989 Recommendation:* Complete and distribute the URM Owners' Handbook, which will inform owners about available resources, the management of earthquake hazard mitigation for their buildings, and the implications of strengthening to less-than-current-code standards.

  1990 Status: Completion of the handbook was delayed by the Loma Prieta Earthquake and eventually abandoned.

- *1989 Recommendation:* Encourage the Building Standards Commission, the Structural Engineers Association of California, and the California Association of Building Officials to complete their efforts to develop uniform strengthening standards.

  1990 Status: The Commission adopted a revised Draft Model Ordinance in February 1990, and related code revision efforts are described in the "Technical Issues" section of this report (see Appendix D for the 1995 version of the model ordinance).

- *1989 Recommendation:* Encourage the organizations above and the Federal Government to assist in developing strengthening standards for nonbearing-wall URM buildings, and eventually for other potentially hazardous buildings as well.

  1990 Status: The Structural Engineers Association of California, the California Building Officials, the American Institute of Architects, the Building Seismic Safety Council, the National Science foundation, and the Federal Emergency Management Agency are all involved in multi year efforts to develop seismic retrofit standards.

- *1989 Recommendation:* Identify and explore the specific reasons why certain local governments may be unable to comply with the URM Law by the January 1, 1990 deadline. Evaluate the data on mitigation programs submitted by local jurisdictions to determine the effectiveness of these programs and the URM Law and to recommend appropriate action to the Legislature.

  1990 Status: This report describes various reasons why some local governments have been unable to comply with the URM Law in the "Local Government Issues" section.

Review of 1991's Recommendations

(excerpt from 1991 URM Status Report, SSC 91-04)

- *Recommendation:* Request cities and counties to provide more complete URM building occupancy information where available. The URM Law requires the collection and reporting of building occupancy information, but unfortunately many cities did not collect it during their inventories of URM buildings.

  1992 Status: Many local governments have produced subsequent reports (see Appendix B).

- *Recommendation:* Ask cities and counties with URM hospitals to report their risk mitigation program information to the Office of Statewide Health Planning and Development which must enforce local government standards that are more stringent than current state regulations.

  1992 Status: The Commission's 1992 survey of local governments asked local

governments with URM hospitals in their inventories to fill out an additional information form which will be relayed to the Office of Statewide Health Planning and Development. Four local governments indicated that they have a total of 29 URM hospital buildings in their inventories.

- *Recommendation:* Introduce legislation to address the seismic retrofit of potentially hazardous state-owned buildings in conjunction with the Commission's recommended policy on acceptable levels of earthquake risk. Work with the Legislature and Governor to adopt a final earthquake risk policy.

  1992 Status: The Commission sponsored AB 1964 (Areias) which would have established a goal of mitigating the risks in the state government's URM buildings by the year 2000. This proposal was considerably less ambitious than that proposed by the Commission's policy on acceptable levels of earthquake risk which recommended addressing earthquake risks in all major state government buildings by the year 2000. Governor Wilson vetoed this bill because the state doesn't know the scope of its risks or the amount of money needed to mitigate them.

  The Commission's Policy on Acceptable Levels of Earthquake Risk in State Buildings was referred to the Office of the Legislative Analyst which declined to complete its assessment of the policy because of budget and staff reductions.

- *Recommendation:* Encourage the development of seismic retrofit standards for nonbearing-wall URM buildings as well as other potentially hazardous buildings.

  1992 Status: The Strong Motion Instrumentation Program has recovered several strong motion records from 1990 and 1991 moderate earthquakes in the Los Angeles area. The Program has also completed a major research project to apply the knowledge gained from those records to ongoing retrofit code development efforts.

- *Recommendation:* Continue to monitor the status of local government compliance with the URM Law.

  1992 Status: The Commission has continued to collect information on local government progress. The most recent updates are reflected in this report and Appendix A.

- *Recommendation:* Hold one or more seminars on technical issues relating to the seismic retrofit of URM buildings to improve the education of building officials, inspectors, and contractors.

  1992 Status: The Commission co-sponsored one URM seminar with the California Building Codes Institute in San Jose. The California Building Officials has also held several similar seminars in other parts of the state.

- *Recommendation:* Complete a booklet and seminar on financial assistance alternatives for seismic retrofitting in conjunction with the Bay Area Regional Earthquake Preparedness Project and others.

  1992 Status: This handbook, titled "Seismic Retrofit Incentive Programs," on financial incentives for the seismic retrofit of URM buildings is now available. It was developed by the Association of Bay Area Governments with funds from the Commission, the Federal Emergency Management Agency and the Bay Area Regional Earthquake Preparedness Project.

- *Recommendation:* Complete and disseminate the URM Owners Handbook to local governments for their use.

  1992 Status: This project was not completed due to the lack of staff at the Commission.

A Review of 1992's Recommendations

(excerpt from 1992 URM Status Report, SSC 92-01)

- *Recommendation:* Continue to monitor the status of local government compliance with the URM Law.

  Current Status: Most local government building officials have continued to voluntarily cooperate in summarizing the status of their local governments URM risk

reduction efforts. The most recent updates are summarized in Appendix A. The Commission keeps a correspondence file on each jurisdiction that is available for public review.

- *Recommendation:* Introduce legislation to encourage local governments in seismic zone 3 to inventory their URM buildings.

  Current Status: Legislation was unsuccessfully sought by the Commission in 1992. In May, 1995, the Commission unanimously passed a motion urging the legislature to mandate the strengthening of all URM buildings statewide including state-owned URM buildings and buildings in Seismic Zone 3.

- *Recommendation:* Introduce legislation to require the disclosure of risks to the public upon the sale of URM buildings statewide.

  Current Status: 1992 legislation requires prospective buyers of commercial URM property to receive a copy of the Commission's *Commercial Property Owner's Guide to Earthquake Safety* which contains a recommended earthquake weakness disclosure report.

- *Recommendation:* Introduce legislation to amend the state's special assessment district laws so that local governments can tailor financial incentives for the more flexible mitigation of seismic risk in existing facilities.

  Current Status: No known action to revise special assessment laws has been considered by the legislature.

- *Recommendation:* Continue to pursue pending legislation to establish uniform guidelines for the evaluation and seismic retrofit of hazardous buildings other than URM buildings.

  Current Status: The Division of the State Architect has responded to mandates imposed by SB 597 and AB 3313 by hiring a Seismic Review board to develop draft interim seismic retrofit guidelines which are currently undergoing further development and public review.

- *Recommendation:* Encourage the development of seismic retrofit standards for nonbearing-wall URM buildings.

  Current Status: Retrofit guidelines for nonbearing-wall URM buildings will be included in DSA's interim retrofit guidelines, as well as national guidelines slated for a 1997 completion by the Applied Technology Council (ATC 33). The Commission also addresses nonbearing-wall retrofit issues and existing research in its *Provisional Commentary for Seismic Retrofit* (Product 1.1) and its *Review of Seismic Research Results on Existing Buildings* (Product 3.1) as part of its Seismic Retrofit Practices Improvement Program.

- *Recommendation:* Encourage the development of guidelines for buildings used for storing acutely hazardous materials.

  Current Status: Guidelines for the seismic evaluation and retrofit of hazardous material facilities have been developed in part by the Los Angeles County Fire Chiefs Association. Risk management and prevention programs within such facilities are underway. The State Fire Marshal has adopted Article 80 of the Uniform Fire Code to regulate the storage of hazardous materials.

- *Recommendation:* Complete the edits and disseminate the URM Owners Handbook to local governments for their use.

  Current Status: This project has not been completed due to its low priority and the lack of staff at the Commission.

- *Recommendation:* Encourage state agencies to disclose the seismic risks of existing state government buildings to the public.

  Current Status: While recent budget control language required UC and CSU to disclose seismic hazards in state government buildings, the Commission is not aware of steps taken by these and other agencies to comply with this language.

- *Recommendation:* Prepare and disseminate seismic risk guidebooks for commercial building owners and prospective buyers.

Current Status: The *Commercial Property Owner's Guide* to Earthquake Safety is now available from the Commission and the California Association of Realtors.

Recommendations for 1995

- The Legislature revisit the state's 1986 Unreinforced Masonry (URM) Law and consider appropriate actions to address the inequities and the public's continuing exposure to risk that have resulted from the failure of a significant number of local governments to comply with the intent of the law, so that approximately half of the state's URM buildings remain unstrengthened.
- Legislation be enacted to require owners of potentially hazardous buildings to disclose seismic risk to potential buyers at the time of sale, to lenders, and to tenants on entering into or renewing leases, or when they relocate within a building. The disclosure should include pertinent information about the risks of damage, ways to reduce risk and the benefits, costs and limitations of seismic retrofits.
- Legislation be enacted to allow the warning placards required by existing law to be removed from potentially hazardous buildings that have been retrofitted in substantial compliance with the Uniform Code for Building Conservation, Appendix Chapter 1, provided that the disclosure in the preceding recommendation take place.
- Legislation be enacted to require owners and business operators to include warning placards at the entrances to hazardous buildings of all types as well as seismic risk management and response plans as part of their overall emergency plans for safety in the workplace.
- Legislation be enacted to authorize funds for a Center for Earthquake Risk Reduction with a sustained funding source to help achieve desired earthquake performance for new and existing buildings.
- Legislation be enacted to require that the safety element of general plans address seismic vulnerability of existing building stock, or inventory, and contain risk-mitigation strategies. Description of the building stock should be included in enough detail to support the risk-mitigation strategy.
- Urge the legislature to mandate strengthening of all unreinforced masonry buildings including state-owned buildings statewide in accordance with the state's model building code, the Uniform Code for Building Conservation, Appendix Chapter 1.
- The Seismic Safety Commission should continue to monitor the status of local government compliance with the URM law.

For historic buildings, the Seismic Safety Commission recommends that:

- The State Historical Building Safety Board revise the State Historical Building Code to include minimum life-safety standards and guidance on measures to control damage.
- Seismic retrofitting of historic buildings can lessen buildings damage and possibly avert the need for demolition, thus protecting historic heritage as well as saving lives.
- The Office of Planning and Research, in consultation with the Office of Historic Preservation, should public guidelines for adding optional historical resources elements to local general plans to address the seismic retrofit of historic buildings.

  Many communities have buildings or preservation areas with economic as well as historical importance. Land use plans provide a policy framework for local government to adopt and implement policies to protect valuable historical assets and improve seismic safety. Guidance can help in the development of plans to safeguard these buildings from earthquakes.

Summary and Conclusions

(excerpt from 1992 URM Status Report, SSC 92-01)

Nearly all local governments in Seismic Zone 4 have taken steps to comply with the URM Law. Over ninety-four percent of the URM buildings in Zone 4 are now located in cities and counties with risk-reduction programs, yet one out of three of these programs is relatively ineffective in reducing earthquake risks in URM buildings.

The Commission believes that:

- *Mandatory strengthening programs* are effective in significantly reducing URM risks.
- *Voluntary strengthening programs* will probably have some effectiveness in cities with strong economic conditions and incentive programs. However, those cities will probably be faced with at least a few uncooperative owners that will not retrofit their buildings.
- *Other programs*, such as simply notifying the owners, will usually not be effective in reducing earthquake risks in a timely manner.

Increased public awareness as well as financial and insurance pressures will come to bear upon most URM building owners over the next decade to address the seismic risks in their buildings.

The state government is at a critical stage for the URM risk reduction effort. Despite a significant budget deficit, the state is faced with the costs of retrofitting its own buildings and bridges as are most local governments. Building owners and local governments are looking to the state for both a firm commitment and assistance.

Most cities, counties, and building owners have expressed a willingness to take more effective steps to reduce their risks if affordable financing is made available. This will take an equally firm commitment from private lending institutions statewide.

The success of the URM Law will be influenced by future earthquakes, the perception of risk, and how they, in turn, influence the public's willingness to allocate money for risk reduction.

The Commission looks forward to the time when we will know that we have enacted all practical measures to reduce earthquake risks in unreinforced masonry buildings.

Appendix A—1995 Survey of City and County Mitigation Efforts

Jurisdiction				Survey Results (numbers of URMs)											
Inventory Complete	Number of Historic URMs	Number of Non-Historic URMs	Mitigation Program Established	Replied to 1995 Survey	UCBC Compliance	Compliance with Jurisdiction's Program	Partial Compliance/ Uncer Construction	Retrofit Permit Issued	Plans Submitted / Plancheck Underway	Reduced Occupancy	Demolished	Slated for Demolition	Warning Placards Posted	No Mitigation Progress	Owners Notified
Adelanto 12 URM															
Yes	0	12	No	Yes	1					1	10				
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Agoura Hills 1 historic URM															
Yes	1	0	Yes	Yes		1									
Mitigation Program Type: City completed strengthening of the historic.															
Technical Mitigation Standards: State Historic Building Code															
Progress and Remarks:															
Alameda 73 URM															
Yes	0	73	Yes	Yes	2	22	19							30	73
Mitigation Program Type: Parapet, wall anchorage, and wall slenderness limits only.															
Technical Mitigation Standards: 1985 Seismic Safety Commission (SSC) Model Ordinance partially referenced.															
Progress and Remarks:															
Alameda County 18 URM															
Yes	0	18	Yes	No											18
Mitigation Program Type: Notices to owners															
Technical Mitigation Standards:															
Progress and Remarks:															
Albany 37 URM															
Yes	0	37	No	Yes	7	10		2	1		3	1			37
Mitigation Program Type: Draft presented to City Council 3/95															
Technical Mitigation Standards: UCBC Appendix Chapter 1 adopted 1/95.															
Progress and Remarks: Mandatory strengthening program expected to be adopted 7/95.															

Jurisdiction				Survey Results (numbers of URMs)											
Inventory Complete	Number of Historic URMs	Number of Non-Historic URMs	Mitigation Program Established	Replied to 1995 Survey	UCBC Compliance	Compliance with Jurisdiction's Program	Partial Compliance/ Uncer Construction	Retrofit Permit Issued	Plans Submitted/ Plancheck Underway	Reduced Occupancy	Demolished	Slated for Demolition	Warning Placards Posted	No Mitigation Progress	Owners Notified
Alhambra 164 Non-historic URM 6 Historic URM															
Yes	6	164	Yes	Yes	141	141	14		1		3			15	170
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1985 Edition of Chapter 96 of the Los Angeles County Code.															
Progress and Remarks:															
Anaheim 16 URM															
Yes	0	16	Yes	Yes		7	2	1		1	1	1		5	5
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1987 Edition of the SSC Model Ordinance															
Progress and Remarks: In 1988, the city believed that they only had 1 URM which was demolished, subsequent inventories identified more buildings.															
Antioch 25 URM															
No	0	25	No	Yes											
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks: Requested a copy of the model ordinance in 1995.															
Apple Valley 14 URM															
Yes	0	14	Yes	No											
Mitigation Program Type: Notices to owners, retrofits triggered upon alterations or additions.															
Technical Mitigation Standards: 1987 Edition of the UCBC Appendix Chapter 1															
Progress and Remarks:															
Arcadia 25 URM															
Yes	0	25	Yes	Yes	25	25					3			1	25
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1987 Edition of the SSC Model Ordinance															
Progress and Remarks:															
Arcata 2															
Yes	0	2	No	Yes	2										
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Arroyo Grande 25 URM															
Yes	0	25	Yes	No											
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1987 Edition of the UCBC Appendix Chapter 1															
Progress and Remarks: Reduced permit fees, extended time limits, and Non-conforming building use permitted.															

Jurisdiction				Survey Results (numbers of URMs)											
Inventory Complete	Number of Historic URMs	Number of Non-Historic URMs	Mitigation Program Established	Replied to 1995 Survey	UCBC Compliance	Compliance with Jurisdiction's Program	Partial Compliance/ Uncer Construction	Retrofit Permit Issued	Plans Submitted/ Plancheck Underway	Reduced Occupancy	Demolished	Slated for Demolition	Warning Placards Posted	No Mitigation Progress	Owners Notified
Artesia 4 URM															
Yes	0	4	Yes	No											
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1985 Edition of Chapter 96 of the Los Angeles County Code															
Progress and Remarks:															
Arvin 19 URM															
Yes	0	19	No	No											
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Atascadero 28 URM															
Yes	0	28	Yes	No			2							2	
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: SSC Model Ordinance															
Progress and Remarks:															
Atherton 1 URM															
No	0	1	No	No											
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Avalon 19 URM															
Yes	0	19	Yes	No		2		2	3					12	
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1985 Edition Chapter 96 of the Los Angeles County Code															
Progress and Remarks:															
Avenal 8 URM															
No	0	8	No	No											
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Azusa 24 URM															
Yes	0	24	Yes	No											
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1982 Edition of Division 88 Los Angeles City Code															
Progress and Remarks:															

Jurisdiction				Survey Results (numbers of URMs)											
Inventory Complete	Number of Historic URMs	Number of Non-Historic URMs	Mitigation Program Established	Replied to 1995 Survey	UCBC Compliance	Compliance with Jurisdiction's Program	Partial Compliance/ Uncer Construction	Retrofit Permit Issued	Plans Submitted/ Plancheck Underway	Reduced Occupancy	Demolished	Slated for Demolition	Warning Placards Posted	No Mitigation Progress	Owners Notified
Bakersfield 191 URM															
Yes	0	191	Yes	Yes	3	13	9		3	3	13			147	191
Mitigation Program Type: Voluntary strengthening															
Technical Mitigation Standards: 1991 Edition of the UCBC Appendix Chapter 1															
Progress and Remarks:															
Baldwin Park 5 URM															
Yes	0	5	Yes	Yes		4						1			
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1982 Edition of Division 88 Los Angeles City Code															
Progress and Remarks: 1955 program of parapet bracing and wall anchors															
Banning 49 URM															
Yes	0	49	Yes	No											
Mitigation Program Type: Notices to owners															
Technical Mitigation Standards: None															
Progress and Remarks:															
Barstow 93 URM															
Yes	0	93	No	No											
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Beaumont 37 URM															
Yes	0	37	Yes	No											
Mitigation Program Type: Mandatory strengthening															
Technical Mitigation Standards: 1988 Edition of Division 88 Los Angeles City Code															
Progress and Remarks:															
Bell 52 URM															
Yes	0	52	Yes	No			1		3					48	
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															
Bell Gardens															
Yes	0	0	N/A	Yes											
Mitigation Program Type:															
Technical Mitigation Standards:															
Progress and Remarks:															