CHAPTER V

Achieving Seismic Safety Through Land Use Planning

The Northridge earthquake showed how land use planning can be used to reduce earthquake damage. Land use planning—community general plans, zoning regulations, and environmental impact reviews—can reduce damage by identifying the seismic hazards caused by geologic conditions as well as vulnerable buildings and lifelines and by instituting measures to avoid or mitigate them. The Commission believes that land use planning policies and laws can and should be far more effective in reducing California's risk from earthquakes than they have been. Management of seismic risk should be a major factor in future land use planning policies and decisions.

Land use planning incorporates local and state government programs that guide private development and public infrastructure investments along a policy course reflecting community values. Taken together, the plans and implementing procedures provide a framework to guide development and redevelopment.

◄ Part of this Pacific Palisades home was destroyed by a landslide.

The safety element must define the extent of seismic hazards in the community and then establish policies and programs to mitigate risk.

Land use planning can be a strategic tool to recognize opportunities and constraints and to lessen and manage risk by balancing competing values; however, existing laws and guidelines governing these programs are not as effective as they should be. Local governments do not have the information and incentives they need to use land use planning tools effectively. The recommendations in this section, if implemented, would make land use planning a more effective tool in reducing and managing earthquake risk.

Land use planning is a shared responsibility of state and local governments. The state has established various mandates, described below, and is responsible for providing application guidelines and source information. Local governments are responsible for adapting the mandates to local conditions and implementing them on a day-to-day basis. Land use planning can affect seismic safety, especially over the long term, but local governments need better information to reduce earthquake risks.

General Plans and Safety Elements

The state's broadest local land use mandate requires cities and counties to prepare comprehensive, long-term general plans to serve as policy frameworks for local regulations, public and private investments, and intergovernmental coordination. Within these frameworks, local governments review and approve public and private projects according to local zoning, subdivision, and environmental review procedures. Local governments can impose conditions on private projects to minimize the risk of earthquake damage and use regulatory and financing powers to rehabilitate buildings and lifelines that are vulnerable to earthquakes.

Since the early 1970s, cities and counties have been required to address seismic safety as part of one of the seven required elements of their state-mandated general plans. The safety element must address

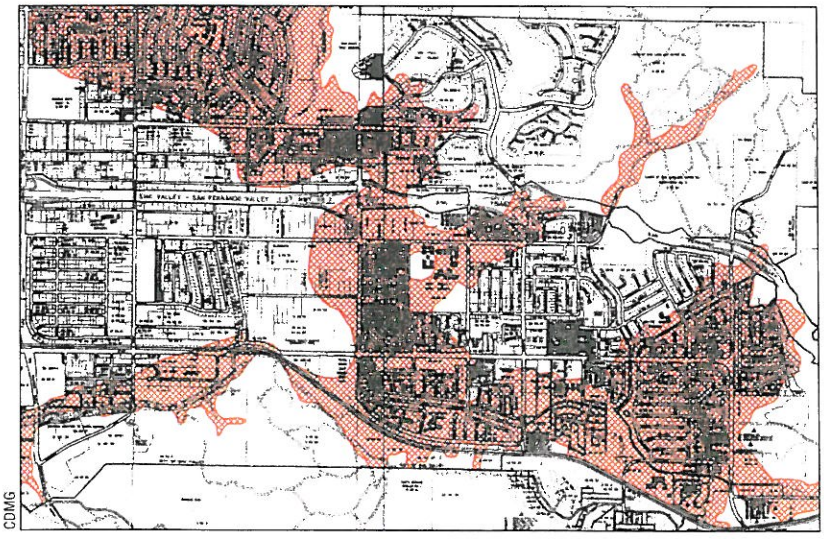
> any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction, and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of the Public Resources Code; and other geologic hazards known to the legislative body. . . . (Government Code Section 65302g)

Thus, the safety element must define the extent of seismic hazards in the community and then establish policies and programs to mitigate risk within hazardous areas and prevent or abate structural hazards in new and existing buildings. Since the general plan elements must be integrated and internally consistent, seismic safety policies are carried out through the land use, circulation, housing, and other elements of the plan. Policies outlined in the safety element must also be followed in zoning, subdivision, and public works decisions of local governments.

The background information used to develop the safety element must be thorough and current to serve as a useful basis for decision making. Because collecting original geotechnical information is expensive, most local governments rely heavily on geotechnical information published by the U.S. Geological Survey and the California Division of Mines and Geology (CDMG).

In addition to defining seismic hazards, the safety element should describe the kinds of dam-

Figure 74. Portion of a typical Seismic Hazards Mapping Act map. The orange area is the seismic hazard zone.



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age that a community can expect during earthquakes. An understanding of the nature and extent of possible damage provides decision makers with knowledge of how earthquakes affect their communities and what needs to be done. However, the geotechnical information available for a given community for land use planning purposes is often limited or out of date. Effective plans need to reflect the likely presence of seismic hazards such as areas prone to earthquake-induced liquefaction, landslides, subsidence, flooding, and fault rupture. The Seismic Hazards Mapping Act (SHMA), enacted in 1990 (see sidebar), is expected to provide this type of information and to create a process in which developers evaluate the hazard and adopt appropriate mitigation measures. The timely completion of this program is critical to improving the effectiveness of land use plans in California.

Lack of geologic and geotechnical information is a particularly acute problem for local governments; state-of-the-art information in many cases is not available to decision makers and planning staffs or is not available in a form they can use in revising general plans, modifying zoning ordinances, or approving subdivision requests. Moreover, a building designer or utility engineer who lacks information on seismic hazards will not take measures to improve building and lifeline performance. Using the knowledge geologists can provide in land use and building decisions will lead to reduced seismic risk.

Although existing planning law does not require periodic revisions of safety elements to incorporate new seismic information, the SHMA does require published maps to be incorporated in general plans; however, it does not establish deadlines. When the maps and regulations prepared under the SHMA are published, local agencies will require geologic or geotechnical reports before approving projects located in seismic hazard zones mapped by the State Geologist. Reports must be prepared by registered civil engineers or certified engineering geologists and will contain site-specific evaluations of the seismic hazards affecting projects, identify portions of project sites containing seismic hazards, identify any known offsite seismic hazards that could affect the site in the event of earthquakes, and propose mitigation measures.

Another possible source of information regarding likely damage is a planning scenario. Under contract to the Governor's Office of Emergency Services (OES), CDMG has developed seven earthquake planning scenarios intended primarily for emergency response planning. These scenarios depict likely damage patterns in the San Francisco Bay Area and southern California and have been used extensively by emergency response planners, utility companies, and others.

Although these scenarios provide valuable information, they have several limitations for use in developing general plans:

- Each is based on the particular characteristics of a certain earthquake; therefore, its application is limited to planning for a particular event.
- They generally provide only a broad-brush regional perspective, so their usefulness for focused, jurisdiction-specific planning is limited.
- Scenarios have been developed to cover the major urban areas of the state that have experienced the most earthquake damage historically; they are not available for many other areas of California that are susceptible to earthquake damage.
- They focus almost exclusively on public and utility-owned facilities (for example, highways, airports, hospitals, water lines,

THE SEISMIC HAZARDS MAPPING ACT

The SHMA promises to greatly improve the extent and quality of geotechnical information available to local governments, building designers, and utilities. The act directs the State Geologist to prepare maps identifying areas throughout the state that are subject to seismically induced shaking, liquefaction, landslides, ground failure, and other seismic hazards. The California Division of Mines and Geology has begun work on this mapping program (Figure 74 is a portion of a SHMA map), but at the current level of funding, about $1 million per year, it will be decades before maps are complete for most urban areas. Meanwhile, the information available to many local governments to reduce earthquake risks in their communities is not as complete or useful as it should be.

The Federal Emergency Management Agency awarded a $9 million matching grant to fund preparation of 38 maps in Orange, Los Angeles, and Ventura counties over a 2.5-year period.

and electrical transmission lines) for emergency response planning, so they are of limited use in planning for problems associated with damage to private residential, commercial, and industrial facilities.

The Northridge Earthquake

Planners and engineers from eight jurisdictions that had structures damaged in the Northridge earthquake—Los Angeles County, Fillmore, Los Angeles, San Fernando, Santa Monica, Santa Clarita, Simi Valley, and Whittier—were interviewed to assess the status of local safety elements and their effectiveness. To get a similar perspective on the 1989 Loma Prieta earthquake, planners from Santa Cruz County, Los Gatos, Santa Cruz, and Watsonville were also interviewed. These interviews revealed some common themes:

- The officials generally believed their safety elements had been useful, either for their educational value to local planners and decision makers or because they provided leverage to require mitigation of specific seismic hazards.
- The officials believed that the safety elements needed to be improved.
- More recent safety elements contained better seismic information and more effective guidelines for land use decision making than older elements.
- Many local officials were surprised by damage patterns in their communities. Their safety elements had not adequately anticipated the effects of the earthquake because they had only cursory geological and geotechnical information and little or no information on building vulnerability.

Reducing and managing earthquake risk at the local government level can be enhanced by use of the information contained in well-done safety elements in a general plan. The policy direction provided by general plans can give local governments the framework needed to balance competing community concerns with resource limitations. Review of current land use planning practices and consideration of the lessons from the Northridge and other earthquakes indicates that up-to-date plans based on good seismic hazard and vulnerability data are not generally available. General-plan law is not used as effectively as it could be. The following recommendations will make these existing programs more effective.

Recommendations

The Commission recommends that:

- CDMG complete the SHMA program by 2005.

  The basic information that these maps provide is critical to the updating of general plans. Improving zoning and subdivision decisions will lessen future earthquake losses. The State Geologist must establish priorities to target the most populated areas with the greatest risk. All the state's urban areas should be mapped, and revised maps should be issued as better information is available.

- Legislation be enacted requiring review of the safety element of general plans every five years to incorporate new information; the information in maps prepared under the SHMA should be incorporated within one year of the date final maps are provided to local jurisdictions.

  Existing law does not require periodic revisions to incorporate new seismic information, and even though local jurisdictions are required to incorporate the information from maps prepared under the SHMA, there is no deadline. Since new geologic and geotechnical information is constantly being developed, a requirement that the seismic aspects of safety elements be reviewed and updated every five years will make sure that new seismic hazard information is incorporated.

- Legislation be enacted to make the existing optional CDMG review of safety elements mandatory for CDMG.

  The usefulness of safety elements can be improved if the information is up to date and properly described. Existing law

requires local governments to submit a draft copy of revised safety elements to CDMG, but doesn't require CDMG to review them. The staff of CDMG's Environmental Review Project has been reduced from six people to one over the last few years and is no longer able to provide timely and meaningful reviews of these documents. As a result some local plans are not as useful as they should be.

- Legislation be enacted to require that the safety elements 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.

  Besides the intensity of shaking, the vulnerability of the building stock is the greatest factor influencing the extent and location of damage and the greatest cause of losses. Very few general plans include inventories of vulnerable buildings and facilities or strategies to reduce the resulting risk. By not anticipating damage patterns, local governments lose the opportunity to manage their risks, plan their emergency response, and prepare for recovery. The general plans and long-term local government policies should provide the basis for community retrofit programs.

- Legislation be enacted to require CDMG to convene a high-level independent review board for the preparation and review of guidelines and maps prepared under the SHMA.

  The usefulness of maps will be improved through peer review by others who have experience in hazard mapping and those who will use the CDMG products.

- CDMG work with local governments to establish a systematic program to ensure that the information provided by the SHMA program can be easily incorporated into general plans and zoning, subdivision, and environmental quality decisions.

  Since the advice and assistance of a geologist or geotechnical engineer is not available to many smaller local jurisdictions, information provided under the SHMA must be in a form that can be readily understood by nontechnical decision makers.

- CDMG work with the Insurance Commissioner and representatives of the insurance industry to ensure that mapped hazard areas are not misinterpreted and used incorrectly in issuing insurance policies.

  A potential hazard in an area may be interpreted as a certainty. Conversely, insurers may not be adequately informed about mitigation measures incorporated in a project.

- CDMG and OES support the preparation of damage scenarios, including localized scenarios and scenarios for areas of the state not presently covered.

  Damage scenarios are both a powerful educational tool for decision makers and a valid way to develop mitigation and emergency plans. Damage scenarios also can be used for recovery planning. New computer programs under development by the National Institute of Building Sciences will allow for the rapid and inexpensive preparation of scenarios using building inventories and geologic maps. The damage patterns of the scenarios should be based on a range of seismic events (not a single type and magnitude of earthquake); they should have subregional foci (instead of a broad regional focus); and they should assess potential damage to residential, commercial, and industrial developments as well as public infrastructure.

Zoning, Subdivision, and Environmental Reviews

The day-to-day implementation of safety elements is done primarily through zoning, subdivision decisions, and environmental review procedures. Usually, these decisions and reviews pay

only cursory attention to earthquake hazards and assume that building plan checking procedures will address them. Unfortunately, routine plan checking and environmental reviews do not consistently address site-specific hazards.

Zoning

In zoning, a city or county divides its territory into various districts and specifies allowable land uses and development standards, such as minimum lot sizes and maximum building heights, for each district. Like a general plan, a zoning ordinance includes both a map showing the distribution of land uses and text setting out development regulations.

Although few zoning districts address seismic concerns exclusively, there are several ways in which seismic concerns are, or can be, reflected in zoning regulations:

- Areas with seismic or geological hazards such as unstable slopes or liquefaction potential can be zoned to allow only low-density uses such as grazing, agriculture, open space, or very-low-density residential use to discourage substantial development.
- "Overlays," or zones that require special review procedures or development standards, can be used to reflect seismic hazards in specific areas of the community.
- Zoning can be used to provide incentives such as density bonuses or parking requirement waivers to encourage seismic risk mitigation of buildings vulnerable to earthquakes.

Subdivision Review

Pursuant to the state Subdivision Map Act, local governments review proposed subdivisions and their related improvements and impose conditions necessary to conform with the local general plans and ordinances. The act generally requires that soils reports be submitted in conjunction with proposed subdivisions, but often these reports do not adequately deal with seismic hazards. The SHMA, by providing maps depicting areas with potential hazards and requiring site-specific analysis of the hazards, should eventually remedy deficiencies in current soils reports.

Environmental Review

Approvals of development projects, as well as adoption of most development plans and regulations, are subject to requirements of the California Environmental Quality Act (CEQA). This means that projects must be reviewed for their potential environmental effects and, depending on the results of the initial studies, may be examined more closely in environmental impact reports (EIRs) and modified as necessary to reduce negative environmental effects.

The CEQA and the state CEQA guidelines devote little attention to seismic hazards and earthquakes. Mere compliance with the building code is often considered adequate mitigation even when the code does not have requirements that address hazards. There is no requirement that the EIR assessment of seismic hazards be prepared or reviewed by a geologist or other qualified professional, so the information used in the review may be inaccurate or incomplete. Moreover, the guidelines do not require that mitigation measures be taken to reduce earthquake risk.

The Northridge Earthquake

None of the jurisdictions interviewed in connection with the Commission's Northridge study reported having adopted zoning provisions aimed exclusively at seismic hazards, though virtually all jurisdictions had adopted hillside ordinances that address seismic and geologic hazards in conjunction with aesthetic and open-space concerns. It appears that existing state zoning statutes are adequate to allow the use of zoning authority to address seismic safety once better information is available from the SHMA program and CEQA guidance is provided.

The areas suffering the most serious damage during the Northridge earthquake were more mature communities that had developed before the passage of CEQA. Thus, in these areas, CEQA has been applied more often to infill projects than to

projects involving major location decisions. The responses of the planners and engineers interviewed from the eight cities and counties affected by the earthquake, which presumably reflect practices statewide, indicate that seismic hazards are routinely considered in their environmental reviews. Although the emphasis on seismic hazards varies, seismic hazards are generally not considered major environmental issues in initial studies or EIRs. Typically, seismic hazards receive much less attention than such issues as traffic or wildlife habitat. Some communities reported that the primary seismic consideration in environmental reviews is whether the project is located within an Alquist-Priolo earthquake fault zone, even though most earthquake damage is caused by shaking and other types of ground failure outside the zones. Mitigation measures will not be effective unless they address these primary hazards.

Recommendations

The Commission recommends that:

- State CEQA guidelines be amended to require that EIRs address seismic hazards, and engineering geologists and civil engineers, practicing within their areas of competence, review the hazards and proposed mitigation measures.

  Interviews conducted by the Commission indicate that there is a general presumption that current laws and regulations—the Alquist-Priolo Earthquake Fault Zoning Act, the Uniform Building Code, and hillside ordinances—adequately address seismic hazards. EIRs seldom recommend special mitigation measures to address seismic risk such as those that would be recommended by geotechnical or soils reports.

- Legislation be enacted to amend the Subdivision Map Act to require that geologic and geotechnical reports addressing seismic hazards be required for all major (five lots or more) subdivisions unless information is already available or until superseded by SHMA maps and that reports be reviewed by local government staffs or consultants with appropriate credentials.

  Soils reports submitted in connection with subdivision proposals too often focus only on the immediate soil conditions and ignore more basic geotechnical concerns, including seismic hazards. Furthermore, there is no requirement that a geologist be involved in preparing or reviewing these reports, so the information presented may not be accurate or usable by the local jurisdiction's decision makers.

Typically, seismic hazards receive less attention than traffic or wildlife habitat.

Alquist-Priolo Earthquake Fault Zoning Act

Prompted by damage caused by surface faulting in the 1971 San Fernando earthquake, the state Legislature passed the Alquist-Priolo Special Studies Zone Act in 1972. In 1993 the act was renamed the Alquist-Priolo Earthquake Fault Zoning Act (the Alquist-Priolo Act). Its purpose is to prevent construction of buildings for human occupancy across active faults that may rupture. (Figure 75 is a portion of an Alquist-Priolo map.)

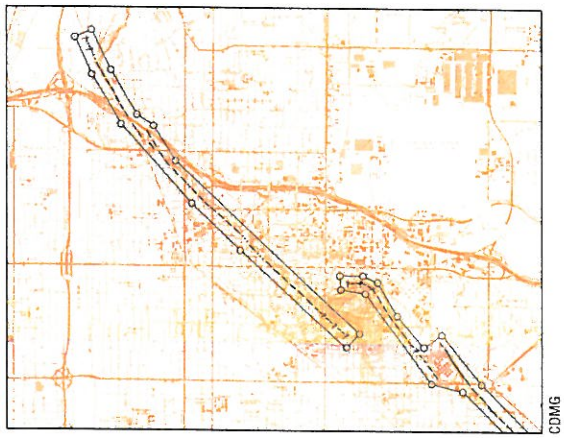

Figure 75. A portion of an Alquist-Priolo map, showing the special studies zones beside active faults.

The Alquist-Priolo Act requires the State Geologist to delineate earthquake fault zones, generally one quarter of a mile wide, along California's active fault traces. Once the State Geologist officially designates an earthquake fault zone, the affected jurisdictions must make this information public, and real estate agents must disclose to potential buyers that the property is located in a designated fault zone. According to CDMG, 12 earthquakes of magnitude 6.0 or greater in California since the passage of the Alquist-Priolo Act had associated primary or secondary surface displacement, and nine of those earth-

quakes resulted in surface displacement within earthquake fault zones already delineated by CDMG.

The city or county must also adopt procedures for reviewing and approving permits for new buildings to be located within the zones. The Alquist-Priolo Act applies to new or expanded structures for human occupancy, defined as structures that will be occupied more than 2,000 person-hours per year except single-family wood-frame dwellings and wood-frame dwellings of up to two stories when part of developments of three units or fewer. Before a city or county can approve a project within a designated fault zone, the applicant must, with some exceptions, submit a registered geologist's report describing the possibility of surface rupture. Typically, local governments incorporate the Alquist-Priolo Act information, policies, and criteria into their general plan safety elements and adopt regulations and guidelines for implementing them at the project review level.

Thrust faults, like the one that caused the Northridge earthquake, often rupture over a broad area with discontinuous and erratic displacement patterns that lead to confusion in interpretation

The effectiveness of the Alquist-Priolo Act has been strenuously debated. The most frequent criticism of the act is that it designates as active only faults with evidence of recent surface rupture. Other types of evidence along a fault—microseismicity, recognizable geodetic change, or youthful geologic and geomorphic patterns indicating recent tectonic activity—cannot be used for designating a fault as active even if it shows evidence of activity.

Another criticism of the Alquist-Priolo Act is that some types of recent surface rupture are not mapped. Only clearly defined geological surface ruptures are delineated as earthquake fault zones. This is because fault descriptions must be clear since the act prohibits locating structures for human occupancy over fault traces, and setback requirements demand the clear delineation of the fault trace on the ground surface. Complex surface displacement patterns can make it difficult to delineate a useful fault trace; for example, thrust faults often rupture over a broad area with discontinuous and erratic displacement patterns that could lead to confusion in interpretation.

A third problem is that because the act was written to apply to structures for human occupancy subject to local government permit authority, it does not protect lifelines, industrial facilities, or state-owned buildings.

A new definition of "active fault" is needed. Many people mistakenly believe that faults not designated as active under the act will not cause earthquakes and nearby shaking and that they are safe from earthquakes if they live outside designated earthquake fault zones. However, many other faults, even though they lack clearly defined or recent surface ruptures, are capable of causing damaging earthquakes—the Northridge, Whittier Narrows, and Coalinga earthquakes all occurred where there was no Alquist-Priolo Act designation. Mitigation measures might be addressed as part of the SHMA procedures.

At present, the Alquist-Priolo Act does not cover many utilities, public-agency buildings, and small-occupancy buildings and facilities. Extending the act to cover projects of this nature will make it more effective in reducing risk.

The Northridge Earthquake

The Northridge earthquake did not occur on a mapped fault and caused no primary surface faulting within any Alquist-Priolo Act earthquake fault zone, although there was some evidence of secondary surface deformation. However, general information on the earthquake, plus 20 years of experience with the Alquist-Priolo Act, suggests the need for changes to improve the use of existing knowledge.

The Alquist-Priolo Act would be more useful in reducing earthquake damage and speeding recovery if the definition of "earthquake fault zone" were expanded and if it were more broadly applied.

Recommendations

The Commission recommends that:

- Legislation be enacted to allow designation of active fault zones based on all viable geologic, geodetic, and tectonic evidence and provide for alternative mitigation measures

to be defined by the Mining and Geology Board as appropriate to complex areas where the location of potential fault ruptures is uncertain.

- Legislation be enacted to apply the Alquist-Priolo Act to all publicly owned facilities, critical facilities, and lifelines, including public utility pipelines and facilities in which hazardous materials are used or stored, and to provide for alternative mitigation measures appropriate to lifelines.

Inundation Mapping

California has over 1,300 dams that impound substantial volumes of water. The failure of any of the 800 largest of these dams could cause deaths and injuries, displace people, spread hazardous materials over a wide area, and do extensive damage to property, electrical generation facilities, transmission lines, and water supplies. A failure damaging lifelines could affect life-support systems in communities far outside flooded areas.

Following the near-collapse of the Van Norman Dam in the 1971 San Fernando earthquake, the Emergency Services Act was amended to require the owner of any dam whose failure could result in death or injury to prepare and submit to OES an inundation map showing areas of potential flooding. The act also requires cities and counties to adopt emergency procedures for the evacuation and security of people within these potential inundation areas.

The owners of some dams now subject to the mapping requirement were not originally required to prepare inundation maps because in 1972, when the law was passed, there was no downstream population at risk. Present law does not specify at what point an inundation map must be prepared as downstream areas begin to develop.

The 1972 legislation gave dam owners six months from the effective date of the law to complete the required inundation maps but, as of May 1994—over 20 years after the deadline had passed—OES reports that the owners of 200 to 300 dams have yet to comply.

There is no requirement that inundation maps be updated or revised to reflect changes in downstream drainage channels or erection of barriers such as freeways that could dramatically change the flow patterns of floodwaters. This means that both evacuation planning and land use planning leading to development decisions may be based on outdated or erroneous hazard scenarios.

Since the statute calling for mapping inundation areas is in the Emergency Services Act and is intended to guide evacuation planning, inundation maps now play almost no role in land use planning and decision making.

At present there is little incentive for state and local agencies to consider the inundation threat in approving new development. CDMG is authorized, but not required, to include inundation areas on maps prepared under the SHMA, and safety elements of local general plans must consider seismically induced dam failures along with other hazards. Although inundation resulting from dam failures would logically be a subject of consideration in environmental reviews under CEQA, it is not mentioned in the state CEQA guidelines.

Some federal agencies have already completed inundation maps for their dams, but not all. Emergency response and land use plans need complete information on areas of potential inundation.

Although the failure of levees was not an issue in the Northridge earthquake, it is apparent that many levees, especially in the Sacramento-San Joaquin River Delta, are critical to the safety of existing water supplies and development. Inundation maps are not required for these areas even though many levees are vulnerable to failure from earthquake shaking.
Inundation maps depicting areas at risk from flooding caused by the failure of levees would be used to guide emergency evacuation, land use planning, water supply restoration, and development decisions.

The Northridge Earthquake

Following the Northridge earthquake, the Division of Safety of Dams, part of the Department of Water Resources, inspected 108 dams within a 47-mile radius of the earthquake's epicenter and found 13 with some cracking or movement; none was judged to be a safety hazard.

The Pacoima Dam, located in the San Gabriel Mountains about 11 miles from the epicenter, was the most significantly damaged. It experienced peak ground accelerations in excess of 0.7g. The water level was 131 feet below the crest at the time of the earthquake. Though the Pacoima Dam is rarely near capacity (3,700 acre-feet) and the probability of the simultaneous occurrence of peak capacity and a damaging earthquake is remote, the potential flood could affect over 280,000 people downstream.

As of May 1994—over 20 years after the deadline—OES reports that the owners of 200 to 300 dams have yet to complete required inundation maps.

Recommendations

The Commission recommends that:

- Legislation be enacted to impose sanctions on dam owners who fail to prepare and submit inundation maps by December 31, 1996.
- Legislation be enacted to require that inundation maps be reviewed and revised whenever downstream development could significantly change hydrologic patterns and to require that inundation maps be reviewed every ten years and revised when necessary to reflect new data and to incorporate new inundation mapping technology.
- Legislation be enacted to amend land use laws to require state and local agencies to make specific findings regarding the acceptability of inundation hazards before approving development of critical facilities (for example, hospitals, schools, emergency response facilities, hazardous material storage, and sewer treatment plants) within potential inundation areas.
- The Governor petition federal agencies responsible for dams in California to provide inundation maps for their facilities to the state and local agencies.
- Legislation be enacted to require owners to prepare inundation maps for low-lying areas protected from flooding by levees.

Hazardous Materials

Building industry regulations, such as the Uniform Building Code, the Uniform Plumbing Code, and the Uniform Fire Code, which are adopted and enforced by cities and counties, address structural issues relating to the use and storage of hazardous materials. The use, storage, and handling of hazardous materials are also subject to city or county zoning regulations; therefore, the scope and stringency of regulations varies from community to community. Where discretionary approvals are required (for example, general-plan amendment, rezoning, and use permits), projects are also subject to environmental review under CEQA.

Businesses that handle hazardous materials, even in fairly small amounts, must submit annual inventories of the materials they use and must prepare a business plan that includes plans for responding to a release or threatened release of hazardous materials. Local agencies must also prepare their emergency response plans concerning hazardous materials on the basis of this information. Businesses that handle acutely hazardous materials must prepare risk management and prevention programs that comprehensively evaluate risks and identify engineering controls and prevention measures.

The Northridge Earthquake

There were over 100 reported incidents involving hazardous materials related to the Northridge earthquake—pipeline breaks, tank failures, falling containers, and transportation accidents. Although these incidents were manageable, it is evident that life-threatening incidents from releases of hazardous materials caused by earthquakes are likely and can be expected to be much more extensive than those experienced in the Northridge earthquake and other recent moderate events.

Among the most significant incidents were:

- Three separate fires, suspected to have been ignited by gas leaks or chemical reactions, totally or partially destroyed nine science laboratories at the California State University, Northridge.
- The earthquake derailed a Southern Pacific Railroad train. One of the six derailed cars containing sulfuric acid leaked approximately 8,000 gallons. Approximately 400 gallons of diesel fuel leaked from the overturned locomotive. Two cars containing ethylene glycol and petroleum were also derailed but did not leak.
- A high-pressure natural-gas line on Balboa Boulevard in Granada Hills ruptured, leading to a fire that burned overhead utility lines and five nearby homes. There were similar natural-gas fires in streets in Fillmore and Santa Monica.
- Several pipelines that carry petroleum products from production fields to Los Angeles Harbor were damaged and leaked.
- The Four Corners Pipeline No. 1 leaked at a failed weld in Santa Clarita, releasing over 4,000 barrels of crude oil, temporarily blocking access to a hospital before flowing into the Santa Clara River.

The Northridge earthquake demonstrated how little we know about the hazardous materials used, produced, transported through, and stored in our communities and the risks they pose during earthquakes. Improving the knowledge base and decision making regarding hazardous materials will require the cooperation of the State Fire Marshal, the California Highway Patrol, and the Public Utilities Commission. The information in safety elements should be used when decisions are made regarding acutely hazardous materials.

The threat of larger earthquakes and large numbers of hazardous-materials incidents makes it necessary to establish policies to guide future development and redevelopment to reduce the combined hazard. Land use planning laws should be amended to require the consideration of seismic hazards and building vulnerability in cases in which significant quantities of acutely hazardous materials are stored.

Recommendations

The Commission recommends that:

- State general plan guidelines be revised to require safety elements to include maps that depict where acutely hazardous materials are stored, used, and transported and their relationship to seismic hazards and that circulation elements address the existing and proposed location of pipelines transporting hazardous materials.
- Legislation be enacted to amend the Alquist-Priolo Act and the SHMA so they apply to all facilities that produce or store reportable quantities of acutely hazardous materials.

Life-threatening incidents from hazardous-material releases caused by earthquakes are likely.

Historic Buildings

Historic buildings are a valuable community and cultural resource. These buildings create the identity 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 Northridge earthquake is only the most recent in a string of California earthquakes 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 earthquakes all damaged older downtowns, which are still scarred and struggling to recover. Historic buildings constructed of unreinforced masonry (URM) 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 building 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 statutes 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.

The Northridge 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. (Figure 76 shows damage to a historic building.)

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 demolition for another 25 to 30. Without doubt, other historic buildings not documented as part of the FEMA process were also damaged or demolished.

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

- The State Historic Building 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.

Recommendations

The Commission recommends that:

- The State Historical Building Safety Board revise the State Historic Building Code to include minimum life safety standards and guidance on measures to control damage.

  Seismic retrofitting of historic buildings can lessen building damage and possibly avert the need for demolition, thus protecting historic heritage as well as saving lives.

- The California Office of Planning and Research, in consultation with the Office of Historic Preservation, publish guidelines for adding optional historical resources elements to local general plans to address the seismic retrofit of historic buildings.

  Many communities have buildings or 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.

Redevelopment

There are 375 redevelopment agencies in California administering approximately 665 redevelopment project areas. Many of these areas encompass older downtowns, which are particularly susceptible to earthquake damage because most of their buildings were built before the mid-1970s, when modern building codes became effective. They often include concentrations of historic buildings that lend character and charm to communities.

Redevelopment law grants broad powers to redevelopment agencies, making them capable of addressing earthquake-related problems. The most frequently used tool for mitigating seismic hazards is tax-increment funding to subsidize seismic retrofits or upgrades of buildings, bridges, and public facilities to withstand the effects of earthquakes. Redevelopment funding has been particularly helpful in upgrading unreinforced masonry buildings.

Redevelopment powers can be used for a wide variety of purposes during post-earthquake recovery, including financing repairs of damaged structures, alleviating hazardous conditions (including demolition of hazardous structures), and providing relocation and temporary housing assistance to property owners and residents. Recognizing how development powers can help in responding to disasters, the state Legislature enacted the Community Redevelopment Financial Assistance and Disaster Project Law (the "Disaster Law") in 1964. The Disaster Law allows a city or county that does not have a redevelopment agency to use simplified and expedited procedures to create one and to adopt a redevelopment plan for a disaster area. It also allows existing agencies to create, amend, or merge projects according to the same procedures. Normal procedural requirements waived by the Disaster Law include detailed documentation to support the adoption of a plan, environmental review under CEQA, community participation, and consultation with other taxing entities before adopting a plan.

Tobin

Figure 76. The historic First Christian Church in Santa Monica was seriously damaged in the earthquake.

The Northridge Earthquake

Four of the eight affected communities interviewed had already used redevelopment powers to address problems resulting from the Northridge earthquake, and three of the eight had either taken or intended to take advantage of the Disaster Law.

An issue raised during interviews with communities affected by the Northridge earthquake was the spending caps required of all redevelopment projects. Agencies were concerned that adding disaster recovery needs to the expenditures for projects already planned could cause them to exceed their spending limits.

Unless redevelopment plans explicitly include earthquake-related project descriptions (for example, seismic retrofits), agencies that have established relatively low spending caps may be reluctant to spend their scarce resources on such efforts.

Recommendations

The Commission recommends that:

- Legislation be enacted to allow redevelopment agencies to increase spending caps easily after a natural disaster to accommodate disaster-recovery activities, including repairs to meet appropriate standards.

- Legislation be enacted to add to the definition of "blight," when designating a redevelopment project area, those structures deemed by the local jurisdiction to pose an unacceptable risk of collapse in earthquakes.

  Strengthening these vulnerable structures will improve the area's ability to recover, physically and economically, from earthquakes. Including seismically vulnerable buildings in the definition of blight will make redevelopment powers a more effective tool.

Planning for Recovery

In the aftermath of an earthquake, there is intense pressure to rebuild the damaged parts of the community as they were before the earthquake and to do it as rapidly as possible. Human nature favors a return to the way things were. Businesses want to restore operations, and residents are understandably eager to repair or rebuild their homes so they can return. At the same time it is important to remember that earthquake damage and the rebuilding process provide the opportunity to mitigate future disaster damage as well as to realize other community objectives and change land use patterns and regulations.

Because of the strong desire to return to normal after earthquakes, the owners of damaged properties tend to repair or reconstruct their buildings to their pre-earthquake condition; often they have neither the interest nor the ability to pay for seismic upgrades that would avoid repeating losses in future earthquakes. A common attitude is that they have already had their earthquake. This tendency is reinforced by state and federal post-earthquake disaster aid policies that do not clearly require upgrades and by a lack of repair standards.

The Northridge Earthquake

The general plans of eight jurisdictions affected by the earthquake were reviewed. Only two of them had safety elements that addressed post-earthquake recovery and reconstruction.

Recommendations

The Commission recommends that:

- The CBSC amend the CBC to include triggers to require that alterations, repair, retrofit, and reconstruction activities incorporate seismic upgrades to mitigate future earthquake damage. The code should allow setting aside mandated upgrades not related to life safety that may be triggered when elective remodeling projects are undertaken.

  At present neither government programs—loans, tax incentives, and grants for earthquake repairs—nor payments made under private insurance policies require seismic retrofits unless there are trigger mechanisms in the building code. The triggers should have some flexibility in interpretation, and standards for repairs and retrofits should include cost-effective measures.

- Legislation be enacted to require local general plans and emergency plans to address post-earthquake recovery and rebuilding.

  Until fairly recently, planning for post-earthquake recovery and rebuilding had received little attention, principally because the state's guidelines for emergency response planning do not require it to be a part of local emergency plans.

Training

Knowledgeable local government decision makers and professional staff are key to the proper integration of earthquake risk-mitigation measures into land use planning. Representatives of the eight jurisdictions interviewed after the Northridge earthquake stressed the educational value of preparing safety elements and the knowledge gaps that occur when those involved move on to other endeavors.

The Northridge Earthquake

Interviews with land use planners in jurisdictions affected by the Northridge, Loma Prieta, and Whittier Narrows earthquakes point to the critical need for those professionals involved in plan-

ning to be properly trained in seismic principles and to keep up to date. For example, safety elements are often prepared by staff specialists or consultants, and staff planners who must carry out the policies are not deeply involved.

Those who become knowledgeable during the writing and adoption of safety elements may move on to other positions and jurisdictions, and their replacements may have only a cursory knowledge of their contents. Knowing the issues, understanding seismic hazards and building vulnerability, and being aware of potential mitigating actions are essential to taking advantage of risk-reduction opportunities and properly balancing seismic safety with other community concerns.

Recommendation

The Commission recommends that:

- The American Planning Association, the League of California Cities, and the County Supervisors Association of California institute formal training on earthquake principles for their members.