PART III: FRAMEWORK FOR REDEVELOPMENT AND EARTHQUAKE SAFETY

CHAPTER 6
INTEGRATING URBAN REDEVELOPMENT AND EARTHQUAKE SAFETY

INTRODUCTION

Natural disaster management is a pivotal issue in development theory and practice. Losses from disasters are a concern not only for the community in which they occur but also for the federal and local government interested in protecting lives, and public and private loans and investments. While the link between natural disasters and development has been demonstrated repeatedly, governments and planning agencies have not yet systematically integrated the consideration of natural hazards into redevelopment planning and implementation. These agencies often operate as though their activities and natural disasters were separate and unrelated issues. Even worse, disasters may be completely ignored in the planning and implementation of development and redevelopment activities in many local communities.

The concepts of supporting the integration of seismic safety in the redevelopment process is embedded on the fact that expending resources on redevelopment and disaster management are different investments in the same overall goal. Throughout the U.S., there are large numbers of urban neighborhoods affected by poverty, blight and abandonment. Concurrently, these cities are exposed to earthquake hazards. The fact that earthquake prone sites exhibit areas of substandard conditions increases the risk and exposure of large numbers of residents and capital projects in urban environments. When initiating redevelopment programs with an earthquake safety component the process transforms from a developing of resources into a safeguarding of community sustainability and growth and the protection of these resources and investments.

This chapter identifies a number of available disaster strategies that can be used to protect the lives and investments in local communities. A number of strategies have been chosen to represent the range of alternatives available for promoting earthquake safety in urban redevelopment programs. A taxonomy or classification system has been developed in order to offer organization to the integration of two complex programs: urban redevelopment and earthquake safety.

DISASTER MANAGEMENT STRATEGIES

Disaster management can be defined as *those activities which increase the ability to manage or cope with an extraordinary event or crisis of negative consequences.* Disaster management can be further divided into two elements based on time phases: pre-disaster activities and post-disaster activities. Pre-disaster activities are those actions which are enacted in anticipation of a disaster; post-disaster activities are those which are enacted as a result of a disaster.

Pre-disaster activities include programs commonly referred to as disaster prevention--activities taken to eradicate the phenomena itself or any negative social consequences of the phenomena; disaster mitigation--activities taken before a disaster to reduce (not eradicate) the negative results of the disaster after its occurrence; and disaster preparedness--activities taken to limit the results of the disaster through effective actions after a disaster occurs.

Post-disaster activities include programs commonly referred to as disaster relief--activities taken to reduce the immediate suffering from the disaster; disaster rehabilitation--activities taken to repair and rebuild the damage resulting from the disaster; and disaster recovery--activities taken to promote a state of normalcy after the disaster.

Prevention Strategies

o *Hazards Identification and Mapping*

These strategies are involved with collecting data, studying, and identifying the range of hazards, location, severity, and their occurrence probabilities in specific areas under consideration. A number of strategies can be used to accomplish these goals including historical research, geologic surveys, remote sensing, geographic information systems, and the preparation of hazards mapping. This information can allow for an understanding and prioritization of redevelopment in terms of the magnitude of risk to investment (physical, population, economic).

o *Vulnerability Assessment*

These strategies categorize the hazard exposure of human population/capital facilities; resources such as, housing, lifelines, production facilities, and critical and public assembly facilities; and economic activities and the normal functioning of the community. Vulnerability can be estimated for areas with the greatest development potential or already developed areas in hazardous zones.

o *Risk Assessment*

These strategies quantify the vulnerability of existing physical/social/economic environments together with the type, location, severity and probability of occurrence of the hazard(s) to produce an estimate of the probability of expected physical and economic loss for a given site. This information can be used to preclude the development of new buildings, populations, and economic activities in high risk sites.

o *Land-Use Planning*

These strategies include the identification of localized areas of high risk probability, location of hazardous buildings, identification of critical services, and the identification of population segments and economic activities at risk. This information can be used to prevent the location of new buildings, populations, and economic activities on high risk sites; and to develop appropriate mitigation strategies to reduce the risk to existing buildings, populations, and economic activities.

Mitigation Strategies

o *Regulations*

These strategies include the development, enactment, administration, and enforcement of policies, laws, and codes that result in the increased resistance of the physical environment to disasters. These regulations take into account the risk, economics, and critical nature of the various sectors of the physical environment. These regulations can provide for affordable and appropriate practices for increased resistance and protection for redevelopment investments, and the continued operation of critical facilities and activities.

o *Hazards Insurance*

These strategies reduce the disastrous consequences to a localized sector or area from a disaster by spreading the risk throughout a larger base. These programs would provide for the rapid reinstatement of buildings and activities that are damaged or destroyed allowing for protection of investment and a faster recovery to normalcy. Urban development programs funded with public financing should be adequately self-insured against future disasters. Expenditures for such protection should become a normal element of project planning and analysis.

- *Retrofit Programs*

These strategies would modify and strengthen existing environments (both physical and economic) in order to reduce the disastrous consequence a particular disaster could have on redevelopment. These programs would strengthen and protect existing environments that are in proximity to new development that would have a negative impact on new development in a disaster, such as adjoining hazardous buildings and materials.

Preparedness Strategies

- *Preparedness Planning*

These strategies would prepare and exercise coordinated plans for the actions of the various sectors effected by a disaster including emergency operations, search and rescue, food/water provision, relief and aid assistance, emergency shelter, medical services, transportation, debris removal, etc. in order to reduce the effects of a disaster on the local population.

- *Training and Public Awareness*

These strategies, although applicable to all elements of disaster management, promote the preparation and preparedness of all sectors of society for reducing the anticipated and actual effects of a disaster. The various sectors that should be trained and educated include government officials, the construction industry, the financial sector, commercial owners and operators, the health professions, and the general public.

TAXONOMY FOR REDEVELOPMENT AND SEISMIC SAFETY

A taxonomy for incorporating the core strategies of seismic safety within redevelopment process is issued in the remaining parts of this section. In this taxonomy, earthquake safety strategies are discussed within a limited number of interrelated redevelopment themes including: local government intervention, project formulation and design, information collection, land-use planning, urban design, financing and investment, delivery of infrastructure and urban services, and public and private sector partnerships.

LOCAL GOVERNMENT INTERVENTION

Local governments can play a decisive role in terms of earthquake safety. They have the power to regulate redevelopment through the zoning and building permit process that emanates from comprehensive land-use planning and building code promulgation. The municipality can adopt codes and standards to mitigate the risk to buildings and can limit densities in high risk areas.

Local governments are recognized as the first line of responsibility for emergency management in case of a disaster. The 1980s and 1990s are likely to be regarded as a fundamental turning point in urban redevelopment programs. Before the 1980s, the federal government was considered as the prime force in redevelopment. However, by the beginning of that decade, federal aid became more scarce due to the lack of success of previous large-scale urban redevelopment. By the 1990s local government was seen as the central mechanism for achieving economic redevelopment and implementing community programs.

In the aftermath of an earthquake the expenditures necessary to repair and/or replace the lost infrastructure in urban sites after an earthquake can frequently surpasses the capabilities of local authorities. Material losses of recent urban earthquakes are counted in the billions of dollars: more than US $6 billion in the Mexico City 1985 earthquake, US $13 billion in the Armenian earthquake of 1988 and approximately US $30 billion in the recent 1994 Los Angeles earthquake.

The destruction of municipal and/or privately-owned infrastructure during a disaster can seriously set back municipal and private capital investments. The rationale for incorporating disaster management strategies into the redevelopment process are contained in the fact that these long-term strategies will minimize the potential damage from earthquakes, and thus provide a means to local governments to protect large-scale urban investments over the long-term.

Key elements for local government intervention include:

a) Local governments which are positioned to adopt more flexible, innovative and creative administration of urban redevelopment programs can embrace effective earthquake safety measures including the development and enforcement of local laws, codes and regulations to increase the earthquake-resistance of their redevelopment programs. They can also embrace financing programs that allow the incorporation of earthquake safety as an integral component of local urban redevelopment programs.

b) The adoption of appropriate land-use practices can serve to protect the urban environments from this type of phenomena, especially in high risk areas.

c) The adoption of prudent building practices, application of proper building codes, and adequate construction supervision, can significantly improve the performance of the built environment in case of earthquake events.

d) Improved local managerial and technical skills can be supported to provide better opportunities for organizational and individual learning in the area of disaster management; these programs can be oriented to increase the supervision and enforcement capacities of local officials toward local policies, laws, regulations, and codes enacted by the municipalities to improve safety and resistance of the built environment.

e) The adoption of mechanisms for establishing contact between municipalities and the local population can allow local officials to obtain better information in order to formulate more realistic and effective disaster planning for urban programs and to promote development policies that take into account local hazard risks and vulnerabilities.

PREFEASIBILITY STUDIES

The design of redevelopment projects typically start with a project formulation stage. Prefeasibility and feasibility studies are required prior to the selection of the most optimal project solution. Project prefeasibility involves the preparation of a project profile which includes project objectives and principal characteristics, rough estimates of costs and benefits, and a preliminary identification of alternatives for design and implementation. In terms of earthquake risks, project prefeasibility requires a preliminary identification of the earthquake hazards affecting the redevelopment area and an identification of sources for additional data.

Key issues in project prefeasibility studies:

a) Define of project goals and objectives to reduce hazard mitigation and safety to protect the investment over the long-term.

b) Obtain readily available land-use, natural resource, and socio-economic information. Obtain readily available natural hazard information for the preliminary identification of earthquake-related hazards. Collect maps and geologic and topographic data.

c) Identify which hazard information is missing and which information will be needed during the different stages of project formulation and design. Consider financial and personnel resources needed for obtaining additional information in all areas.

d) Prepare basic planning information. Identify major problems that affects the redevelopment area. Identify key economic issues. Determine natural resources and social composition of the proposed area. Determine which earthquake-related hazards may affect the proposed project sites. Determine weight to be assigned to earthquake hazards in the overall redevelopment program.

e) Estimate the extent of the redevelopment area. When considering the formation of special districts, the determination of zones with similar earthquake vulnerabilities or a particular earthquake problem can be used to determine the program area. Typically other factors include costs, elimination of urban blight, expansion of tax bases, improvement of business and commercial activities, land availability, provision for growth, surrounding land-uses, transportation, political visibility, and jurisdiction acceptance.

f) Identify to what extent redevelopment programs can overcome or improve existing conditions in the project area. Determine funding alternatives to finance redevelopment programs. Determine an outline for redevelopment project strategies. Prepare project profile.

FEASIBILITY STUDIES

The feasibility analysis usually involves a preliminary evaluation of the technical and economic viability of a proposed project. It involves examining every aspect of the project and refining the estimate of its benefits. During this process, alternative approaches to various elements are compared: pre-investments, operating costs, environmental impacts, cost-benefit ratios and repayment probabilities are estimated; and optimal alternatives are recommended for further analysis and implementation. During this process a determination should be made as to the range and extent earthquake hazards could effect the project area. Different earthquake safety alternatives should be evaluated. This information should be incorporated into the process of project selection to ensure that cost-effective protection is adequately reviewed during the completion of project formulation.

Key issues to be considered within project prefeasibility studies:

a) Obtain additional socio-economic, natural resources, and natural hazard information that is not available during preliminary phases of project formulation. Obtain institutional and legislation information that either affects or facilitates redevelopment activities. Include costs of collecting information during all phases of the project.

b) Review data in relation to existing land-uses, natural resources, projected urban growth, and economic trends. Identify constraints posed by earthquake hazards to the redevelopment area. Determine location, severity, and probability of earthquake occurrence within specific time-frames.

c) Identify immediate and long-term solutions for those hazards found within the redevelopment area. Develop a tentative set of objectives and priorities, giving especial consideration to earthquake hazards.

d) Identify adequate financing for earthquake safety measures. Ensure that structural and non-structural earthquake mitigation measures have been included and are practical and feasible solutions.

e) Review technical and economic viability of the project. In particular, prepare cost analysis studies addressing incidence and frequency of hazard risks in the redevelopment area and *impacts on physical structures, business, commercial, and historical areas; effects on employment and commercialization; and other key social-economic indicators. Estimate useful life of the proposed earthquake safety measures; estimate whether benefits are permanent or long-term as opposed to temporary or short-term. Estimate the amount of damage that would be prevented as a direct result of the earthquake safety measures. Provide an estimate of subsequent negative impacts to the area if measures were not implemented. Estimate effectiveness and cost of alternative earthquake safety measures.*

f) Determine viability of the project; determine most optimal solution; recommend redevelopment stratgies.

PROJECT DESIGN

Project design involves the final conceptualization of the project in anticipation of project implementation. At this stage is critical to incorporate and analyze new and existing information, and develop methodologies oriented toward the identification of the final solution.

The result of the urban design process is to create a functional and interactive relationship between buildings, streets, open spaces, blocks, neighborhoods, and districts. This interactive relationship can not exist if earthquake hazards are not considered properly and become a disruptive factor within the urban setting. At this stage, it is critical to determine adequate building locations, functions, and occupancies; geography of the urban region and characteristics of man-made elements; and the structural quality of buildings and infrastructure including, dams, roads, and bridges.

Key elements within project design:

a) Consider regional and site conditions. Estimate geological conditions, terrain, and land availability. Identify relationships between land-use, natural resources, urban growth, economic trends and earthquake hazards. Identify possible locations, severity and probability of occurrence of earthquake-related hazards and possible effects to the project area within specific time-frames (consult vulnerability analysis and earthquake risk studies). Identify other development projects that could exacerbate present risks from natural disasters. Establish areas of social, urban and economic growth. Correlate urban trends with areas of high earthquake risks. Examine carefully the compatibility of projects and land-uses. Determine which areas are particularly vulnerable to seismic-related risks.

b) Consider the appropriate earthquake safety measures to mitigate undesirable effects of earthquake hazards to the project area. Consider adjustments to existing and future land-uses. Determine incentives or limitations of earthquake risks to social, urban, and economic growth. Anticipate new codes, standards, and ordinances that should be adopted to comply with identified hazards.

c) Determine the economic, social and political cost of adopting new seismic safety measures. Identify how programs can be financed. Identify institutional programs that may support both urban redevelopment and earthquake safety programs (e.g., CDBG block grants, 404 Hazard Mitigation Grant Program, federal tax credits, guarantee loans, bonds, and local emergency plans).

d) Identify the legal framework that would support redevelopment programs and earthquake safety programs (e.g., local legislation for the creation of redevelopment agencies).

e) Analyze how the community will perceive the adoption of new earthquake safety regulations and evaluate (when analyzing each alternative) the opportunities for adoption. Evaluate how to reach community consensus and agreement. If appropriate, create awareness programs. Discuss with the community, the socio-economic impacts the redevelopment programs and/or individual projects will have. Determine expected number of lives lost, persons injured, damage to property and disruption of economic activities if earthquake safety measures are not enforced. Discuss alternatives.

f) Identify institutional actions that would reduce the risk of disasters to redevelopment projects. Identify earthquake safety measures and monitoring plans that would offer disaster protection to the project.

g) Determine final project option. Determine final appraisal of selected projects. Make sure enforcement mechanisms are in place for project implementation.

INFORMATION COLLECTION

To gather scientific and engineering earthquake information throughout the different stages of project formulation and development is essential for the identification of earthquake problems and solutions. This information includes soil structure, faulting, surface rupture, ground failure, ground water level, landsliding, liquefaction, ground motion, and tsunamis and seiche conditions. It is also essential to identify historical earthquake records, frequency of earthquake occurrences, and magnitudes and epicenter location of previous earthquakes. Key opportunities to integrate urban redevelopment and earthquake safety programs are identified by the level of information required during project preparation. Thus, it is essential that earthquake hazard information be collected at the very early stage of project formulation.

One important element when providing for the integration of earthquake safety and redevelopment is that earth-science and earthquake-related data are often present in map forms. Likewise, zoning, subdivision, and master planning information are usually mappable. Thus the integration of both set of information can be a direct and beneficial process.

Besides maps, information can be obtained in the form of studies and reports and should be presented in a language suitable to the use of engineers, architects, planners and decision-makers. Sources of information can include universities and research centers; scientific and technical reports, studies and journals, computerized data banks and services; professional, scientific, and technical society symposia; intra-governmental committees; national standards and specifications committees; and technical service programs.

Key elements in the identification and collection of natural hazard information:

a) Topographic maps (i.e., the standard USGS topographic map) can serve as a good base map to record both earth science and site planning information. These maps can be used to depict general soil structures, conflicts between land-use and earthquake safety, inventory surface water resources, hazardous areas, proposed cuts, calculations of slopes, and engineering or stabilizing land-measures.

b) Geologic maps can be used to show types, distributions, and physical characteristics of geologic units at or near the earth's surface. These maps can show susceptibility and potential consequences of geologic hazards, such as faults, earthquake-induced subsidence, and earthquake-induced rockfall and landslides. In addition, geologic reports and site investigations can be required *for all subdivisions on or adjacent to potentially hazardous areas when earthquake-related hazards are suspected to impose severe risks to proposed projects.*

c) Soil classification maps can be used to depict the distribution of different types of surface soils. Soil information includes bedrock units and superficial deposits, such as soils, colluvium, alluvium, and landslide debris.

d) Maximum earthquake intensity maps can show the location and severity of potential ground shaking for major fault systems. These maps can be used to determine the adequate location of new and existing critical structures on hazardous sites, cumulative damage potential for different building types, and interruptions to critical facilities and lifelines systems in case of major earthquakes. State and counties agencies can use these maps for preparing emergencies response programs.

e) Fault-rupture zone maps can be used to determine the location of surface fault rupture zones, proper location of the buildings with respect to faults, and seismic setbacks for proposed projects crossed by known or inferred active faults. These maps can be used in the preparation of statewide legislation, city and country regulations, and real-estate seller disclosures.

f) Liquefaction potential maps can show information on soils, groundwater, and geology. These maps can be used to assess the type of ground failure likely to occur and boundaries of liquefaction potential. Areas susceptible to liquefaction can be classified as moderate, low, and very low. Liquefaction potential maps can help decision-makers to determine the location of critical infrastructure and buildings.

g) Earthquake-induced landslide potential maps can be used to identify active landslide areas, slope stability, slope-failure potential, and triggering landslide mechanisms. They can be used for site-specific investigation identifying slope stability setbacks and development restrictions in areas of high landslide potential. Landslide potential can be classified as high, moderate, low, and very low.

h) Hydrologic maps can be used to depict the character of and interrelationships between surface and ground-water resources. They are useful for delineating and evaluating water supply, earthquake-related flood-prone areas, water quality, areas of potential subsidence, seepage areas and areas where erosion or sedimentation is a potential problem.

i) Maps may contain only basic data or they may be supplemented by engineering and planning interpretation. They may include discussions of earthquake recurrence, faulting events, and average recurrence interval for particular fault segments. Text accompanying base maps can include a list of historical earthquakes, and likelihood, location and severity of earthquake occurrence. Qualitative terms such as, high, moderate, low, and very low, very violent, very strong, strong and weak can be used to characterized earthquake likelihood of occurrence.

j) Geographic information systems (GIS) can be an important tool for planners and decision-makers attempting to integrate redevelopment and earthquake safety. GIS provides the basis for presenting and combining site planning and earthquake hazards information. For example, through a computerized system surface fault rupture, liquefaction potential, and landslide potential information can be combined or superimposed on maps containing information on political jurisdictions, land-uses, and urban systems.

k) Land-use studies can be used to determine project land-subdivision based on faulting, surface rupture, ground failure, erosion, landsliding, liquefaction, ground motion, and tsunamis and seiches conditions. Soil surveys can provide information on the limitations and capabilities of the soil *for a variety of urban and engineering uses. When used in conjunction with geologic, hydrologic, and engineering data it provides the basis for many studies on the natural limitation and potential of the land for particular uses. Based on this information, matrixes can be developed providing criteria for permissible land-use.*

l) Studies on ground shaking acceleration, losses, and predicted intensities can be used as a basis for inventorying unreinforced masonry buildings and for the strengthening or demolishing of unsafe ones. Probabilistic intensity and local site amplification maps can be used to estimate loss and replacement cost for various building types. Hazard event frequencies and potential risks of the project areas can be used to identify the area's problems and opportunities. Engineering studies include structural mechanics, engineering characteristics, risk analysis, monitoring of structures, damage inventories, structural vulnerability, soil mechanics, rock mechanics, seismic risk maps, structural performance, strength of materials, structural strength, response spectra. These studies are important for determining land-uses, the location of critical infrastructure, and building occupancies, configurations, and locations.

LAND-USE PLANNING

A primary goal of land-use regulations is the orderly development of land. To achieve this goal, improvements in land-use regulations to promote redevelopment programs should include disaster safety components for hazard mitigation.

Redevelopment programs can offer an opportunity to improve existing land-uses which are non-conforming with earthquake safety programs and to introduce more effective mitigation requirements. A comprehensive approach to land-use planning and earthquake safety can be developed using a framework of regulatory tools, namely, zoning ordinances, subdivision regulations, and master plans. Ordinances addressing earthquake hazards can minimize the impacts of earthquakes by reducing the amount of development in hazardous areas or creating incentives for the development of less vulnerable lands. Through subdivision regulations earthquake-related hazards can be averted during the formation of parcels, and site specific earthquake safety provisions can be required as a precondition for project approval. Master plans can set forth the policies which essentially prevent substandard development on hazardous sites.

Key elements in land-use planning:

a) Utilize land-use studies, earth science information, and earthquake-related hazards to identify future uses and demand for land. Consider projections of population growth and distribution, economic activities, social and cultural needs, and transportation requirements. Utilize maps and studies on land-uses, engineering, and geological information. Utilize land-use surveys to determine the criteria for the functional organization of districts and subareas, transportation, critical facilities, infrastructure, and environmental resources. Utilize land-supply analysis to identify under-utilization of certain areas, land available for new construction, future growth, development capacity, and alternatives for new land-uses and intensities.

b) Determine particular conflicts in terms of land-use and earthquake-related hazards. Explore limitations in land-use that may be triggered by earthquake-related hazards. Determine if any earthquake hazards pose a long-term risk to the project area. Explore land-use alternatives in the context of earthquake-related hazards. Utilize land-use maps to depict the functional organization of the land and natural capability of each land unit to accommodate potential uses. Use tables to summarize the development potential of under-utilized land. Evaluate the risks for specific individual sites.

c) As possible, restrict development in areas characterized by faulting, surface rupture, ground failure, unstable slopes, landsliding, liquefaction, tsunamis, and seiches that could result in serious damage to particular types of structures. As much as possible avoid construction in high risk sites, especially for high occupancy buildings, critical facilities, and lifeline systems. Develop matrices correlating earthquake-related hazards potential and land-uses to impose restrictions in zones susceptible to earthquake hazards.

d) Enact ordinances limiting construction in highly vulnerable sites. Within a seismic safety context, establish the size for each lot, the number of families per acre, and the height of dwelling units. Consider comprehensive planning, zoning ordinances and subdivision regulations that can set appropriate land-uses for new construction. Correct non-conforming uses within the regulatory system. When the avoidance of high risk areas is not feasible, enact stringent earthquake safety measures for existing and proposed development.

e) When highly vulnerable sites can not be avoided, identify programs discouraging or encouraging certain types of land-uses. Use bonuses to increase the willingness to adopt earthquake land-uses in agreement with earthquake safety measures. Use density bonuses to control the amount of development that would take place in the redevelopment area. Use incentive bonuses and density transfers to allow an increase in density in less vulnerable sites in exchange for a decrease in densities in areas of high risk.

f) Within areas affected by earthquake-related hazards, determine maximum usable areas. Determine seismic setbacks for proposed projects crossed by known or inferred active faults. Identify setback lines for hazardous areas and parcel boundaries. Use adequate densities and/or open spaces in areas of high earthquake risk. When appropriate use clustering as a way to avoid seismic risk areas. Use cluster development or planned unit development to concentrate buildings and infrastructure in less vulnerable areas of a particular site.

g) Promote construction in less vulnerable sites by using transfer of development rights. Use this approach for historic buildings when repairs and retrofit programs are not cost-effective but can be a desirable option in terms of historical significance and usages. Use transfer of development rights for historic districts where no demolition or intensification is permitted; allow new densities within the same zoning district or adjacent districts where intensification of development is supported.

h) Enact codes, zoning ordinances, and subdivision regulations enforcing land-uses compatible with earthquake risks. When necessary, develop structural mitigation standards, such as creation of buffer areas. Develop adequate enforcement mechanisms. As needed, require engineering, geologic, and seismologic reports for specific hazardous areas as a precondition for project approval.

URBAN DESIGN

In most disaster literature limited attention is devoted to the importance of redevelopment programs in the aftermath of a disaster. The major focus of earthquake research and development and adoption of regulations has been on individual buildings. However, buildings do not operate in isolation within the urban system. Buildings, infrastructure, open spaces are all part of a strongly interrelated system composed of many interdependent activities, services, and facilities. The single failure of one of its components can affect the overall system. During the 1989 Loma Prieta Earthquake not one high-rise building in the affected area failed catastrophically; the main problems experienced were primarily limited to the general lifeline systems (e.g., collapses of the upper deck of the San Francisco-Oakland Bay Bridge and the Cypress Street double-deck highway), and to the large amount of debris from building damage, which caused great disruption to normal urban functions.

Typically redevelopment is exclusively associated with the elimination of urban problems; however the process can be used to improve urban systems after a disaster. Appropriate buildings setbacks, densities, open spaces, location and design of critical infrastructure and lifeline systems can be introduced within urban redevelopment programs to reduce to reasonable levels the risks associated with earthquake hazards in urban settings.

Key elements within urban design:

a) Determine the levels of risks imposed by earthquake-related hazards on new construction and existing facilities. Identify vulnerable human settlements, production facilities, critical facilities, and lifeline systems. Identify those human activities and man-made structures that could exacerbate earthquake-related hazards (i.e., construction in hillsides and eroded slopes, and destruction of natural buffers).

b) Adopt building codes, standards and regulations compatible with earthquake safety programs for new and existing construction. Identify methods for re-structuring existing environments to accommodate urban designs and seismic concerns. Promote earthquake resistent design concepts, and appropriate building layouts, dimensions, topology, configuration, and design methodologies.

c) Determine if disallowing human activities in earthquake high risk areas is a viable measure. If it is, prohibit new construction in high risk areas and designate existing occupancies as non-conforming. Contemplate the relocation of communities, lifelines, critical facilities, and historical structures. Estimate demolition programs and costs. Contemplate the acquiring of or exchange of hazardous properties. Develop criteria for the relocation of new settlements, lifelines, and critical facilities. Examine programs that may support these activities (i.e., 404 Hazard Mitigation Grant Program and CDBG block grants).

d) If the forbiddance of human activities in earthquake high risk areas is not a viable measure, establish programs that discourage and limit certain human activities in those areas. Determine if new construction will be allowed. Establish programs reducing land-use intensities or buildings occupancies. Prohibit setting of high occupancy and critical structures (i.e., schools, theaters, churches, stadiums) and critical facilities (e.g., hospital, fire station and emergency centers) in high risk areas. Adopt earthquake codes, material specifications, and performance standards, for buildings that are built or will be built in high risks areas. Adopt sound architectural designs to provide greater strength to buildings and structures. Identify programs to encourage urban growth towards areas of less risk.

e) Determine which areas will be left as natural ground and open spaces; and establish programs for acquiring hazardous areas (e.g., impact fees and planned unit development). Determine adequate location of buildings with respect to faults and other earthquake hazards. Design lifeline systems to avoid high risk areas. Examine the proximity of new and existing critical structures to hazardous sites and structures. Use seismic setbacks for areas of proposed development that are crossed by known or inferred active faults. Use setbacks to create adequate separation between development and steep slopes and landslide hazard areas. Use slope stability setbacks for areas where unrepaired active landslides and dormant or old landslide deposits have been identified. Use erosion prone area setbacks to restrict development in vulnerable terrains.

f) Identify programs discouraging or encouraging certain types of design practices in agreement with earthquake safety measures. Use incentive bonuses and transfer of development rights. Height limitations can be exceeded in exchange for better adjacency between buildings, adequate building configurations, appropriate setbacks, and the adoption of earthquake safety measures surpassing those enforced by current codes and standards. Within historical districts, specific densities *may be increased to offset costs generated by seismic retrofit in certain less vulnerable areas within the project area.*

h) Determine adequate locations of buildings within the urban setting. Regulate the distance from buildings to sidewalks in areas of intense pedestrian circulation. Estimate drift movements to promote appropriate exterior cladding. Establish street patterns and pedestrian systems directed at avoiding loss of lives and injuries from collapsing debris and parapets during an earthquake.

i) Consider ordinances recommending adequate building shapes, configurations, building heights, densities, and setbacks. Consider potential pounding between adjacent structures. Determine appropriate separations between buildings. Consider interrelations between buildings in congested urban centers located in areas of high seismic risk. Consider the entire urban blocks as a unit in terms of urban design. Establish setbacks designed to reduce building pounding effects during earthquakes. Enforce appropriate separation of adjoining buildings located in close proximity. Major attention should be given where high-rise, medium-rise, and low-rise structures are located in close proximity.

j) Determine adequate earthquake designs for reentrant corners, soft stories, variations in strength and stiffness, and variations in support stiffness. Particular attention should be paid to designs involving the use of taller columns in the first floor; the use of heavy exterior cladding systems above open first floors; the use of a smaller number of vertical supports at the first floor; discontinuous shear walls, in which shear walls are omitted at the first floor; variations in strength and stiffness throughout the building; changes in facades; corner storefront building which may have two adjacent open sides, and two adjacent heavy party walls; and variations in support stiffness.

k) Adopt historical rehabilitation and retrofitting programs. Enact state URM laws mandating the rehabilitation and retrofitting of older structures. Establish detailed programs and analyze which earthquake safety measures should be adopted to add safety to substandard structures. Place moratoriums on buildings and condemn and demolish unsafe structures. Enact non-conforming provisions directed at offsetting the added cost associated with retrofitting older structures in inner-cities. Prepare programs for building compliance with earlier codes than those presently enforced; determine which buildings can be exempted, among others, from current zoning or land-use regulations, electrical codes, plumbing codes, fire safety requirements. Use notification programs to inform owners of the conditions of unreinforced masonry buildings. Post public signs identifying hazardous structures. Disclose hazardous buildings to real estate buyers. Make public records of potentially hazardous buildings. Initiate public campaigns to increase awareness of earthquake hazard phenomena. Establish natural hazard preparedness and mitigation programs. Prepare schedules for building upgrading and retrofit. Determine costs and financial viability of retrofit programs.

l) Develop alternatives for legislation and adequate taxation or desincentives to control the growth of housing in high risk zones and limit construction densities in high risk areas. Enact necessary codes, zoning ordinances, and subdivision regulations enforcing earthquake safety programs. Ensure that codes, ordinances and regulations controlling development are reviewed within the framework of earthquake safety, and that as such, they provide protection consistent with the degree of risk. Issue building permits for new housing construction in areas of high earthquake hazard risks only when constructed in compliance with state-of-the-art disaster-resistance ordinances. Develop ordinances enforcing the use of posted warnings in hazardous buildings. Establish disclosure acts in which owners of unreinforced masonry buildings must notify potential buyers of the building's seismically hazardous conditions. Develop model ordinances that can be adopted by a range of jurisdictions.

FINANCING AND INVESTMENT

Current concepts of urban redevelopment shift investment responsibilities from national to local governments. This approach acknowledges that lower levels of government are better positioned to share responsibilities with the private sector for the redevelopment of the urban environment.

Local governments are faced with continuous community pressures to upgrade urban conditions in neighborhoods affected by substandard constructions and decayed infrastructure. When a disaster strikes local governments are forced to divert their funds to respond to the massive demands of the community to return to normalcy. While they may be equipped to carry out functions under normal circumstances, local governments can find it difficult to respond to major disasters and support urban redevelopment programs.

Increasingly, local governments are using certain types of financing mechanisms to respond to the demand for public services. One approach is that governments should gradually remove themselves from direct provision and become, instead, expediters and facilitators within urban service markets. Actions include, taxing powers, capital fees, impact fees, municipal bonds and the formation of special districts. A long-term commitment by local governments to adequate urban redevelopment requires that capital projects are well selected, beneficiary charges are employed to pay for such projects, and that local governments have adequate local resources to support these activities.

There are two options for financing earthquake safety and urban redevelopment programs:

- as merely a continuation or extension of programs that are viable in a market context under any circumstance; or
- as special cases of post disaster activity.

Key issues within local government financing and investment:

a) Assistance to disaster victims can be available from section 404 Hazard Mitigation Grant Program. These funds can be used for the relocation, acquisition of high risk areas, seismic strengthening, repairs, and restoration of damaged facilities after a disaster. Funding from this program can be authorized for local governments which have suffered a substantial loss of taxes and other revenues as a result of a major disaster.

b) Tax credit programs can enable taxpayers to credit some percentage of allowable expenditures against their tax liability. Federal tax credits can be used for the rehabilitation of older structures and in urban redevelopment programs which take place following a natural disaster.

c) Federal grants can be used to generate activities which may be desirable, such as the voluntary seismic strengthening of substandard buildings and infrastructure. These grants can be directed at local governments, private institutions, and individuals.

d) Federal direct loans can be provided through federal monies for a specific period of time with a reasonable expectation of repayment. These loans may or may not require the payment of interest; however a well focused lending disaster program should follow a market approach, that is, loans extended for disaster reconstruction should follow a similar structure to loans granted under normal conditions. SBA loans are provided to owners of seismically hazardous buildings. These federal loans are the first type of assistance offered to households and business after a disaster as part of long-term urban recovery programs. All loans used from public monies should require adequate disaster resistance when investments are to be made in hazardous areas. Federal loans can be used for the rehabilitation and seismic retrofit of older unreinforced buildings.

e) Guaranty programs can be used in urban redevelopment programs after a disaster. They can become a key element in integrating disaster and redevelopment programs. These programs can become an important mechanism for introducing earthquake hazard policy to guarantee that the assistance funds are spent on sound investments, and to create national policies in support of long-term development. Guaranty programs should require appropriate disaster planning elements and construction standards as an integral part of the redevelopment process in order to provide for long-term protection of the investments. Within guaranty programs, policy, and program planning and design can incorporate disaster management policies that promote the protection of investments.

f) Private loans can be granted under the community reinvestment Act of 1977. Private lenders can be required or induced to make funds available for earthquake safety programs. Such inducements may or may not be combined with government loan guarantee programs.

g) HUD programs directed toward the prevention or elimination of slums and blighted areas are a valuable resource in financing seismic safety programs. These types of loans can also become a key element in the implementation of post natural disaster urban redevelopment programs. CDBG can be used for substantial rehabilitation and retrofitting programs for low- and moderate-income communities, public buildings, and critical facilities; it can also be used after a disaster to fund redevelopment activities containing special seismic safety elements. Section 8 certificate programs can be used for post-disaster assistance; beneficiaries can be encouraged to adopt seismic safety standards in areas prone to earthquakes; and rent subsidies can be provided for those owner's who adopt certain safety standards. HOME programs can be allocated at the discretion of local governments for the adoption of earthquake safety mitigation measures, as long as local governments determine that such activities are priority issues within their communities. Through the 108 Program, communities are entitled to receive guaranteed loans that can be used to finance the removal of debris, repair, rehabilitation or demolition of buildings on public land, and the installation of public improvements. Through UDAG programs, local governments can support earthquake safety activities for downtown commercial projects in urban areas affected by extensive poverty and unemployment.

h) Property taxes can promote the adoption of earthquake safety standards. Higher taxes can lead to lower development densities or to the complete avoidance of a particular site. Lower property taxes can reduce the pressures (by decreasing the tax burden) to convert this land into more intensive uses.

i) Property transfer taxes are associated with the sale of real estate. Cities have the power to raise or lower such taxes and provide an important source of funding for the seismic upgrading of unreinforced masonry building and historic buildings. Property transfer tax rebates can be used by the owners to pay for seismic retrofit.

j) Tax abatement and tax rebates can be awarded at the discretion of local governments to encourage redevelopment in economically depressed or blighted areas. They can be awarded to property owners who seismically strengthen their buildings.

k) Sales taxes can be imposed to cover capital projects following a disaster. Within urban redevelopment programs, sales taxes can finance the construction of public infrastructure.

l) Entry charges can be waived to promote seismic safety programs. A building permit fee can be waived to expedite urban reconstruction programs and to promote seismic upgrading interventions in urban settings. Planning permit fees can be waived for owners who choose to adopt a full retrofit programs. Permit fees can be reduced for owners performing retrofit work.

m) *Exactions, proffers and impact fees can be used to provide upfront financing for the expansion of public facilities with seismic safety elements, additional seismic requirements for infrastructure in high risk areas, and retrofit of critical facilities. When rendered in the form of land, dedicated lands can be used as open spaces and parks to prevent development and be used during emergency activities in the aftermath of a disaster. Impact fees can allow the relaxation of certain zoning restrictions, occupancy limitations, parking regulations, and other zoning regulations for owners undertaking seismic strengthening measures. Impact fees can also be linked to new development; developers can help pay part of seismic mitigation activities in older section of the city as new development takes places in the periphery of center cities.*

n) *Municipal bonds can allow public entities to borrow and lend money to private investors for financing seismic safety programs. They can be used to finance most earthquake safety programs. Municipal bonds can also be used to cover major costs of retrofitting programs for commercial and residential; to bring buildings up to a level required by codes, standards, and regulations triggered by seismic retrofit programs; and supply long-term financing at market rates for those owners unable to find commercial loans to comply with retrofitting ordinances.*

o) *The formation of special districts can generate upfront financing for infrastructure and major project related expenses. They can allow local authorities to finance major seismic safety and long-term earthquake recovery programs. Following the formation of the district, the increase in property tax revenues generated within the district is available to the municipality to retire debt or pay for costs incurred under the redevelopment plan. Financing of special districts usually takes place mainly through the adoption of tax increments, Mello-Roos, special assessment, and Marks-Foran financing mechanisms. These financing programs may tap property taxes, sales taxes, municipal bonds, and development and assessment fees. Incentive programs can encompass loans guarantees, loans assistance, land assembly and write downs. Special districts are entitled to receive financial aid and grants from federal state and other local sources.*

DELIVERY OF INFRASTRUCTURE AND URBAN SERVICES

The delivery of well-placed suitable land for urban redevelopment, and the affordable expansion of water systems, sewage and solid waste collection services constitute a major challenge for local governments.

As development takes place, the potential impact from natural disasters on these services increase. Natural disasters strike at the weakest links in the infrastructure delivery system. Because basic infrastructure is composed of numerous subsystems and components integrated together as a whole system, any damage to a weak component can cause serious disruption or complete failure to the entire system. In contrast to an individual building's effect on the total urban fabric, any destruction of a critical component of an infrastructure system can have disastrous short and long-term effects on the total urban system.

These strategies would promote and support an increase in the provision of infrastructure and urban services to provide suitable land as an effective and successful means of encouraging increased housing development and economic growth. Actions would include the acquisition of property and providing on- and off- site infrastructure and services to promote increased development.

Key issues in the delivery of public services:

a) *Local government management reforms should be encouraged during project design to improve their capacity for planning and applying reasonable criteria to redevelopment programs for the provision of basic services. These programs include emergency plans and procedures that anticipate predictable sets of disaster scenarios and consequences.*

b) During the planning and development of infrastructure, detailed vulnerability impact and risk assessments must be undertaken. Engineering studies should be required for critical systems in order to identify weaknesses in the systems that could result in collapse or prolonged closure of infrastructure delivery after a disaster.

c) Earthquake safety programs for infrastructure and urban services should be encouraged in areas of risk. These programs should include the preparation of plans for disaster response; and seismic standards for the design, construction and retrofitting of infrastructure and basic services.

d) Community awareness should be promoted on the importance of protecting infrastructure and basic urban service systems. Such actions should include prioritized actions for reducing hazardous risks to critical systems.

PUBLIC/PRIVATE SECTOR PARTNERSHIPS

Public and private sector institutions share common concerns in terms of earthquake hazard vulnerability. These concerns include developing and understanding which urban services might be destroyed or disrupted, economic impacts of losing such services, economic impacts on the investment sector, and resource identification and allocation.

In virtually every city, the capacity of the private sector, whether through formal institutions such as banks, construction companies, and land developers, or through informal enterprises and individual labor, exceeds the public sector's ability to provide housing. When allowed to function freely, the private sector creates many forms of shelter, affordable by a wide range of income groups without expenditure of scarce public funds.

In the last decade, there is a growing tendency to develop public/private partnerships. As urban populations reach unprecedented levels and resources are more scarce to satisfy community needs, municipalities have searched for non-traditional social and economic resources within their communities, to expand the local resource base in support of redevelopment programs.

The expanding role of local municipal governments in economic development requires them to facilitate provision of infrastructure and urban services to deal with the present levels of urban concentration and with the physical and social activities generated by the urban economy. Thus, the efficient and effective provision of urban services and physical infrastructure are among the most important functions that federal and local governments perform in the urban redevelopment process.

At present, public/private development is the watchword for those involved in community development. Local governments are increasingly entering into agreements with the private and informal sectors of the economy to address community programs. For instance, municipal governments are installing basic infrastructure as private developers undertake housing projects for low-income families. Also, local governments are increasingly becoming a stabilizing influence in development programs by providing upfront subsidies and guarantees to involve lenders.

Public/private partnerships will continue to grow in importance in the coming years; they can be a force in developing disaster programs, and can reduce the economic burden on municipalities when responding to local disasters.

Key issues within public and private sector partnerships:

a) The initiation of public/private sector disaster insurance programs for private sector development through a range of financial incentives.

b) The initiation of programs for making available and expediting disaster -related loans for building disaster resistance housing, rehabilitating housing for disaster resistance, and reconstructing after a disaster through a range of financial incentives.

c) The introduction of market-based, home improvement credit programs for low-income households that promote and encourage disaster rehabilitation and upgrading.

d) Within redevelopment activities municipal partnerships with the private sector can be formed to promote incentives such as loans, guarantees, grants, or tax reductions for those institutions and individuals that comply with disaster initiatives in high risk areas. Incentives can be provided, for example, for the use of disaster-resistant building codes and more disaster-resistant building materials.

e) Local governments can seek the collaboration of community planners, architects, and engineers, professional associations, and banking/financial institutions to collaborate in the formulation of master plans and training activity programs. The advantage can be mutual; municipalities can take advantage of the practitioners in the field while professionals can have an input in the decision making process of local urban redevelopment.

f) Municipalities can strengthen their relationships with community-based organizations, neighborhood associations, grassroots organizations, cooperatives, and financial institutions that can provide credit for retrofitting or construction of disaster-resistance units in neighborhoods and participation in disaster -related community development projects. Partnerships between municipal governments and the private sector can address the following roles for municipal governments:

g) Encourage overall government response planning that incorporates and coordinates the roles and responsibilities of private service delivery mechanisms.

h) Promote the future replacement of inefficient and out-dated technologies with newer more effective technologies by private companies who deliver urban services during repair and reconstruction after a disaster.

i) Provide loans to private sector organizations or jointly-held financial institutions that agree to make specific types of housing loans, such as for those that comply with disaster resistant earthquake safety measures in terms of earthquake safety.

j) Promote programs of public/private participation to solicit views from interest groups and concerned citizens at the community level.