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A Strategic Plan for Earthquake Safety in Utah

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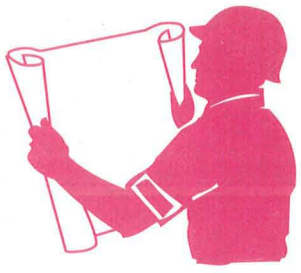
In the past two issues of the Fault Line Forum we highlighted strategies to increase earthquake awareness and education (v. 10, no. 4, p. 1-3) and improve emergency response and recovery (v. 11, no. 1-2, p. 1-3). In this issue, we focus on the strategies contained in the third key objective, to improve the seismic safety of buildings and infrastructure.

Anyone interested in obtaining a copy of *A Strategic Plan for Earthquake Safety in Utah* can contact Janine Jarva, Utah Geological Survey, 2363 South Foothill Drive, Salt Lake City, UT 84109-1497, (801) 467-7970, fax (801) 467-4070, e-mail address: nrdomain.nrugs.jjarva@email.state.ut.us, or Brenda Edwards, Utah Division of Comprehensive Emergency Management, 1110 State Office Building, Salt Lake City, UT 84114, (801) 538-3400, fax (801) 538-3770.

strategies . . . to improve the seismic safety of buildings and infrastructure.

STRATEGY: Improve plan review procedures on new construction to ensure that buildings are being designed in accordance with current seismic code requirements.



OUTPUT: Competent plan reviews are completed for new construction.

OUTCOME: Help ensure that new buildings are being designed safely by competent professionals to withstand seismic forces.

Background

Many municipalities have some form of plan review to ensure that buildings are being designed in accordance with the Uniform Building Code (UBC). However, a lot of buildings are built which do not meet current seismic code requirements, particularly in rural portions of Utah where plan checking is not performed.

Implementation

Mandate that important structures, such as schools, hospitals, or emergency response facilities, particularly those located in seismic zone 3, have a plan review by a competent professional before a building permit is issued.

Require plan reviews on all construction over a certain height and/or size in cities and towns located in nonrural counties, particularly Davis, Utah and Salt Lake.

Responsible Agencies

Structural Engineers Association of Utah
International Conference of Building Officials, Utah Chapter
Local governments

Resources Needed

Salary of competent in-house reviewer: $35,000 to $60,000 per year; or outside consultants: $500 to $2,000 per structure.

STRATEGY: Enforce the state amendment to the Uniform Building Code which requires building owners to install roof anchors and parapet bracing when reroofing their buildings.

OUTPUT: Copies of the amendment are distributed to building officials, architects, and engineers through the media and professional societies, and education programs are conducted.

OUTCOME: A gradual decrease in the seismic hazard posed by existing unreinforced masonry buildings.

Background

Unreinforced masonry structures built prior to 1976 pose a great risk to life safety during even moderate earthquakes. The weakest structural link is frequently the connection between the roof structure and supporting walls. A failure at this location can lead to collapse of the roof. Also, unreinforced parapets and appendages are particularly vulnerable to collapse if not properly anchored.

The logical time to perform this work at least expense is during reroofing when the roof structure is exposed, and new ties and braces can be easily installed. Ordinances similar to the amendment have worked successfully in Ogden and California cities.

The Uniform Building Code (UBC) Amendment was passed by the Utah UBC Commission in 1993, but has not been enforced, partially due to lack of knowledge of the amendment by building officials, or by building owners contracting reroofing without first obtaining a building permit, thereby bypassing the amendment requirement.

Implementation

Educate building officials, engineers, and architects of the amendment through the media, professional organizations, and the State Division of Occupational/Professional Licensing. Enforce the requirement to obtain a building permit before allowing people to reroof their buildings.

Responsible Agencies

Structural Engineers Association of Utah
American Institute of Architects, Utah Chapter
International Conference of Building Officials, Utah Chapter
Division of Occupational/Professional Licensing
Uniform Building Code Commission

Resources Needed

Minimal.

STRATEGY: Improve the post-earthquake operational status of essential service buildings.

OUTPUT: All essential government services buildings are identified. Buildings constructed before 1976 are retrofitted or relocated as needed, to meet standards that will allow them to remain operational after earthquakes.

OUTCOME: The ability to provide uninhibited disaster relief services.

Background

Lessons learned in recent damaging earthquakes demonstrate the need to continue essential government services during and after an earthquake. Many facilities constructed during periods when codes were not as comprehensive as current codes have sustained damages that restrict their use after an earthquake. Precautions must be taken to determine acceptable levels of facility performance to ensure post-earthquake availability of functions. Older essential services buildings that house emergency operations centers, law enforcement offices, and fire stations may not be able to remain functional after earthquakes. The potential loss of these functions poses an unacceptable risk because it would slow emergency response and result in unnecessary casualties and property damage.

Implementation

Using a uniform assessment procedure, the cataloging of location, hazard type, and structure vulnerability should be undertaken. Retrofit or relocation possibilities are then analyzed. Cost/benefit information is compiled and analyzed. Mitigation is then undertaken on a priority basis.

Responsible Agencies:

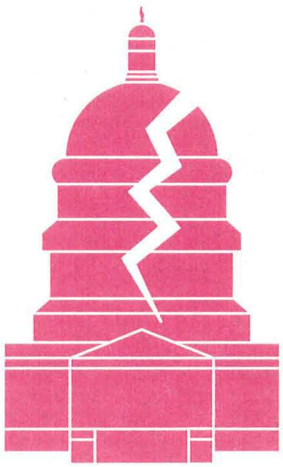
Local governments
Utah Division of Facilities Construction and Management

Resources Needed

A rapid visual screening assessment costs approximately $1,500 per building.

Funding to rehabilitate the facilities on a priority basis depends on results of assessment.

STRATEGY: Reduce structural hazards of government-owned buildings.



OUTPUT: Government-owned buildings structurally modified to better withstand earthquakes.

OUTCOME: A safer environment to conduct government business.

Background

State and local governments own a great number of buildings. Some have unreinforced masonry walls or are made of nonductile concrete or other materials likely to collapse during an earthquake. In past earthquakes, these facilities have suffered higher losses than other construction-type facilities. The public, government employees, and government functions—including many emergency services—are at risk because of these buildings. The state owns approximately 4,500 buildings of which approximately 2,300 would be considered essential in the event of a catastrophic event.

Implementation

Complete a program to ensure that major state government buildings can withstand an earthquake to the extent that collapse is precluded, occupants can exit safely, and functions can be resumed or relocated promptly consistent with the need for these services after earthquakes. Essential buildings would need to be identified and prioritized in terms of the necessity for their use to supply essential services after a catastrophic event. ATC-21, the rapid visual screening of buildings for potential seismic hazards could then be used to identify buildings by design and vulnerability parameters. Based on these parameters, buildings should then be prioritized by order of essential need and vulnerability to a seismic event. Detailed evaluations and cost estimates should then be generated for the retrofitting or replacement of each of the facilities, including a timetable for completion of the work.

Responsible Agencies

Utah Division of Facilities Construction and Management

Local governments

Resources Needed

Rapid visual screening to identify and catalogue government buildings structurally at risk in a seismic event averages $1,500 per building. Funding to conduct geologic investigation of the building site averages $2,000 per site. The total cost to evaluate 2300 essential state-owned buidings would be $3,450,000 for the buildings themselves and $4,600,000 for the geologic site evaluations, or approximately $8,050,000.

Cost for detailed evaluation of at-risk government buildings averages $5,000 per building when done on individual buildings. Evaluations conducted on groups of buildings can be considerably less costly.

Costs to upgrade government-owned buildings ranges from $8.75 to $18.00 per ft^2. Cost to carry out needed seismic upgrade of buildings will depend on results of assessment.

STRATEGY: Mitigate nonstructural hazards in government-owned and leased buildings.

OUTPUT: Assess hazards in government-owned buildings and upgrade as necessary.

OUTCOME: A safer and operational working environment for government agencies following an earthquake.

Background

Falling hazards to occupants and visitors can be posed by nonstructural building elements such as parapets, cornices, ceiling and lighting systems, window and building cladding systems, air conditioning, and plumbing and electrical equipment. These hazards are significant to the continuity of building functions following earthquakes.

The seismic safety of nonstructural elements in all new construction is largely regulated by building codes. Before 1976, however, most building codes failed to explicitly regulate the seismic safety of nonstructural elements. As a result, nonstructural elements in older buildings are often unbraced or unattached to the structure and can fall or move excessively during earthquakes.

Implementation

Perform an evaluation of government-owned and leased buildings with regard to falling hazards in existing nonstructural building elements. The evaluation would identify and prioritize these elements with regard to level of danger presented. A cost estimate for correcting each hazard would be part of the evaluation. Upon completion of the evaluation, appropriate action can be undertaken.

Responsible Agencies

Utah Division of Facilities Construction and Management

Agencies and institutions that are responsible for facilities

Local governments

Resources Needed

If evaluation of nonstructural hazards is performed during investigation of structural hazards (see Strategy 3.4) in the same building, additional cost would be approximately $100 per building.

Cost to carry out seismic upgrade will depend on results of evaluation.

STRATEGY: Improve safety of older public school buildings.

OUTPUT: Identify and reduce structural and non-structural seismic hazards in all pre-1976 public school facilities.

OUTCOME: Safer facilities for students and teachers, as well as buildings useable in an emergency.

Background

A large number of public school buildings were designed prior to the 1976 Uniform Building Code seismic requirements. Additionally, some recent portable classrooms may not be adequately anchored to their foundation. Many schools have free-standing bookshelves, file cabinets, and other heavy shelved items that are not secured and may cause harm. A major earthquake may cause significant property damage and injury to students and teachers. Additionally, these damaged structures will not be available for disaster relief efforts.

Implementation

Identify all schools and their associated hazard, structural, and non-structural problems. Initiate plan to mitigate, rebuild, or relocate the public school structures, and create a priority list to determine which buildings are the most hazardous. Study minimal cost methods of partially retrofitting schools, such as providing connections between wall and roof structures.

Responsible Agencies

Utah Office of Education
Individual school districts

Resources Needed

Funding for seismic studies provided in school district taxing policies. Studies by Salt Lake School District averaged $1,000 per building. These studies were done on a group basis. A projected range would be from $500 to $5,000 per building, and would depend on the complexity of the structure and the degree of detail required in the study. Over one-third of these assessments have already been done. Total cost for assessments of all school buildings would be on the order of $720,000.

Funding and technical expertise for seismic upgrades also funded by school district taxing. Costs for upgrades in Salt Lake averaged $833,333 per school, but costs will vary as indicated in the assessments. If the statewide average upgrade costs $500,000 per school, the total cost would be about $300 million.

STRATEGY: Improve safety and operational ability of older hospital buildings.

OUTPUT: Assess earthquake vulnerability of all hospitals and upgrade the structures to better survive an earthquake.

OUTCOME: Safe structures that will provide a more secure environment for patients and staff and improved ability to survive an earthquake and provide disaster relief.

Background

Many Utah hospitals were designed prior to the 1976 Uniform Building Code seismic requirements. A major earthquake may cause significant property damage and injury to patients and health-care providers. Of equal concern, these damaged structures will not be available for disaster relief efforts after an earthquake.

Implementation

Hospitals should remain operational after an earthquake. A risk and vulnerability analysis of the structures should be performed. Upgrade the structural and non-structural components as required.

Responsible Agencies

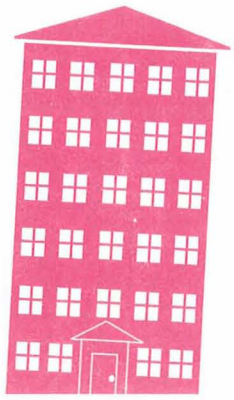
Uniform Building Code Commission
Utah Division of Comprehensive Emergency Management
Privately owned and county hospital organizations

Resources Needed

Cost of seismic studies could range anywhere from $1,000 to $10,000 per structure depending on building size, complexity, and degree of detail desired in the study. Many Wasatch Front hospitals have already been evaluated.

Cost for seismic upgrades depend upon vulnerability but can be generalized between $8.75 to $25.00 or more per ft^2.

STRATEGY: Improve safety of older high-occupancy buildings (250 persons or more) to be structurally competent enough to withstand moderate to large earthquakes.



OUTPUT: Assess seismic vulnerability of all older high-occupancy structures and retrofit or disclose building condition upon resale.

OUTCOME: Prevent collapse in the event of an earthquake, thus reducing life loss, property loss, potential secondary effects, and reconstruction costs.

Background

High-occupancy buildings designed prior to the 1976 Uniform Building Code seismic requirements are of special concern because of the potentially significant loss of life and injury. Efforts should be made to insure against structural collapse and non-structural failure.

Implementation

Identify all high-occupancy buildings in the state. Assess each structure to determine vulnerability and propose mitigation techniques and costs. Require disclosure of hazards and building condition upon resale. Find funding sources and incentives to help building owners mitigate the hazards. A publication by the Applied Technology Council (ATC-33) provides seismic rehabilitation guidelines for existing buildings.

Responsible Agencies

Utah Division of Comprehensive Emergency Management
Uniform Building Code Commission
Local governments

Resources Needed

Cost of vulnerability studies are approximately $1,000 to $4,000 per building.

Cost for seismic upgrades for public facilities is $5 to $25 or more per ft^2.

Technical expertise and guidelines for seismic upgrades.

Local government agencies enact and enforce new regulations.

STRATEGY: Improve the seismic safety of older homes.

OUTPUT: Create and distribute maps of seismic-hazard areas and upgrade information packets, procedural manuals, standards, and requirements to all affected home owners, all real-estate agents, building contractors, and lending institutions. Establish funding sources and incentives to encourage seismic-safety retrofitting.

OUTCOME: Improved safety and lower repair costs in the event of an earthquake.

Background

There are many unreinforced masonry houses along the Wasatch Front which are susceptible to seismic damage. Many older frame houses were built without adequate anchorage to their foundations. Water heaters and other non-structural elements are usually not anchored to resist earthquakes.

Implementation

The first step is to create and distribute an information packet describing hazards, general procedures, standards, funding sources, and incentives to the homeowners. Technical and procedural documents are to be made and dispensed upon request. Funding and incentive packages should be created by public and private industries such as insurance and mortgage companies. One publication, available through the Utah Division of Comprehensive Emergency Management, describes methods for seismically upgrading older, unreinforced masonry homes.

Responsible Agencies

Utah Division of Comprehensive Emergency Management
Utah Division of State History
Uniform Building Code Commission
Real-estate, insurance, and mortgage groups

Resources Needed

Cost to develop a household earthquake upgrade information packet and technical and procedural documentation (booklets available through State agencies and from the Federal Emergency Management Agency) approximately $40,000.

Financial incentives to encourage homeowners to make seismic retrofits.

STRATEGY: Improve safety of mobile homes.

OUTPUT: Seismically brace all new mobile homes; retrofit inadequately braced existing mobile homes at time of resale. Create and implement incentive packages to encourage mobile home owners to retrofit existing installations.

OUTCOME: Increased safety for occupants, reduced amounts of utility rupture and associated hazards and repair costs.

Background

Mobile homes are extremely vulnerable to

earthquake damage. Since mobile homes are virtually never connected to a foundation, they tend to fall off their supports during an earthquake, often severing their typically rigid gas and water connections. This can lead to fire and rupture of water lines.

Implementation

Identify locations where bracing and retrofitting is appropriate. Legislation is needed to require new mobile homes to be seismically braced and existing mobile homes be retrofitted at time of resale. Provide tax or insurance incentives to those who mitigate.

Responsible Agencies

Utah Division of Motor Vehicles
Local government

Resources Needed

Cost of seismic bracing on new installations will be part of the installation price paid by homeowners but is unknown at this time.

Provide financial incentives to retrofit existing installations. California requirements and industry standards for wind anchorage can accomplish retrofit requirements if enforced.

Local governmental agencies enact and enforce new regulations.

STRATEGY: Prevent loss of historic buildings.

OUTPUT: Vulnerability assessments and mitigation completed on buildings on the National Historic Register.

OUTCOME: The preservation of historic buildings and their associated heritage in the event of an earthquake.

Background

Utah's designated historic buildings are an irreplaceable cultural resource. Many of these structures are likely to be damaged beyond repair by an earthquake. The problem is compounded by the lack of funding to reinforce these buildings in a way that preserves their historic and architectural qualities. After an earthquake, damaged historic buildings should not be demolished without thorough review.

Implementation

Identify and then reduce seismic hazards in all "National Register" historic buildings. Provide mitigation solutions and aid in the creation and acquisition of funds needed to make the necessary upgrades.

Responsible Agencies

Utah State Historical Society for privately owned buildings
Utah Division of Facilities Construction and Management for state buildings

Resources Needed

Funds needed for assessments on approximately 1,000 sites. Assessment and retrofit costs for historic structures are much higher than for other buildings.

Money and technical expertise for seismic upgrades depends on results of assessments.

STRATEGY: Improve lifeline survivability in the event of an earthquake.

OUTPUT: Assess and mitigate earthquake hazards on all lifelines.

OUTCOME: Functional or easily/rapidly repairable lifelines after a earthquake.

Background

Critical elements of the infrastructure of many utilities and other lifelines are vulnerable to damage during earthquakes. Within the electric power network, porcelain insulators and certain pole-mounted transformers may have a high probability of failure. Telecommunications switching equipment, as well as transceiver towers and conduits may be displaced or moved out of alignment. Liquid and gaseous fuel pipelines and petrochemical tanks may be displaced or ruptured.

Implementation

State, county, and local public works departments in conjunction with utilities should survey, inventory, and assess the condition of their respective lifelines. Upon completion of the assessment, plans for mitigation and or replacement should be developed and implemented. Emergency response plans should be developed, and seismic considerations incorporated into the design of new lifelines.

Responsible Agencies

Utah Public Service Commission
Uniform Building Code Commission
Federal Energy Regulatory Commission
Municipal and private utilities and pipeline operators

Resources Needed

Regulatory rate consideration from Utah Public Service Commission, Federal Energy Regulatory Commission or local government.

Cost for assessing lifeline vulnerability not available at this time.

Cost for lifeline upgrades depends upon results of assessments.

STRATEGY: Improve earthquake performance of water and waste-water systems.

OUTPUT: Establish appropriate and practical uniform safety and emergency response plans for all water and waste-water systems.

OUTCOME: Improved safety, performance, and reliability of water and waste-water systems.

Background

Culinary and waste-water systems include aqueducts, pumping stations, transmission pipelines, water and waste-water treatment facilities, distribution and collection pipe networks, and distribution storage tanks and reservoirs, all of which are vulnerable to earthquakes. Water and waste-water systems can be rendered inoperable because of damage to tanks, reservoirs, treatment facilities; broken transmission mains; failures at pipe joints; and failed equipment. Damages from water sloshing in tanks and clarifiers is unavoidable during earthquakes, but economical, preventive measures can be taken to reduce the amount of damage and recovery time after earthquakes. Many of the state's water systems' transmission mains and aqueducts cross active faults and dormant landslide zones, and are vulnerable to fault rupture or earthquake-caused slope failure. Because most of the transmission systems are underground, localized damage to such systems is unavoidable. Water and waste-water systems should stockpile replacement components needed after earthquakes.

Implementation

All water and waste-water systems should be inventoried to assess their earthquake performance. All water and waste-water systems would identify and report their emergency-response plans and procedures for the timely repair or replacement of earthquake-damaged water and waste-water systems. Establish appropriate and practical, uniform seismic-safety criteria and procedures and adopt a comprehensive policy on acceptable levels of earthquake risk in water systems. A report should be made to the state legislature that will make recommendations for any additional authority needed to develop and enforce an effective policy on acceptable earthquake risk, including uniform seismic-safety standards, and emergency-response and recovery plans if required.

Responsible Agencies

Utah Department of Environmental Quality
Water system owners (local governments, sanitation districts, etc.)
Waste-water system owners (local governments, sanitation districts, etc.)

Resources Needed

Cost to assess systems not available at this time.
Cost to the state to establish safety criteria and policies on acceptable risk unknown at this time.
Cost to upgrade systems depends upon results of assessments.

Reducing Earthquake Losses

In its last days of existence, the congressional Office of Technology Assessment (OTA) issued a report on the condition and efficacy of the National Earthquake Hazard Reduction Program (NEHRP). The report, entitled Reducing Earthquake Losses, states damaging earthquakes will strike the United States in the next decades, causing at a minimum dozens of deaths and tens of billions of dollars in losses. Wider use of known loss-reduction technologies and practices could save lives and money.

Although the NEHRP federal research-oriented earthquake program has existed since 1977, much of the United States remains at risk for significant earthquake losses. OTA reports that the federal earthquake program has improved our understanding of earthquakes and strategies to reduce their impact, but this understanding is often not applied. This "implementation gap" is in part the result of the federal program's strategy of supplying information, rather than using incentives or other methods to promote earthquake risk reduction.

OTA points out several steps that could improve the federal program. The first is to target efforts at areas likely to yield large benefits, for example, research on improving ways to strengthen existing buildings and reduce building damage (rather than focusing exclusively on preventing collapse), and evaluation of implementation efforts. The second is to set tangible and explicit goals for the overall program, and to regularly measure progress toward these goals. The third is to consider changes in federal disaster assistance and related programs, to ensure that these programs promote implementation of known technologies and practices.

OTA was a nonpartisan analytical agency that served the U.S. Congress until it was closed on September 30, 1995. Its purpose was to aid Congress with the complex and often highly technical issues that increasingly affect our society. For copies of the 176-page report, indicate stock number 052-003-01431-9 and send a check for $12.00 to Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7974, fax (202) 512-2250.

- Excerpted from EERI Newsletter, v. 29, no. 12, p. 2.

Utah Seismic Safety Commission High-Priority Actions Requiring State Funding

. . . identify the high-priority items . . to present the Governor and the 1996 Legislature.

Realizing the need for an incremental, long-term approach to implement the 33 strategies outlined in the *Strategic Plan*, the USSC met on May 10, 1995 and June 28, 1995 to set priorities for the near term. One goal in these meetings was to identify the high-priority items requiring state funding to present to the Governor and the 1996 Legislature. The following actions were highlighted:

1) **Improve earthquake resistance of state-owned buildings** (strategies 3.3, 3.4, and 3.5)

   Many older state-owned buildings are likely to be severely damaged and cause significant death and injury in a moderate-to-large earthquake. The state needs to evaluate its building inventory and implement a long-term plan to improve the seismic resistance of its hazardous buildings. Buildings are regularly being remodeled and renovated by DFCM and seismic improvements can be incorporated into these projects as they arise.

   Cost: $10.5 million/year for 25 years

2) **Measure strong earthquake ground shaking** (strategies 4.8 and 4.9)

   There is a lack of Utah-specific data for local earthquake engineering and no means to rapidly assess and deliver strong-ground-shaking information to guide response and recovery efforts. We need appropriate instrumentation for measuring strong earthquake ground shaking in urban areas that will:

   - Characterize strong ground shaking for engineering evaluation and design.
   - Determine the influence of local soils, topography, and geology on ground shaking.
   - Rapidly determine the severity and extent of damaging ground shaking for emergency response and recovery.

   Cost: $200,000/year on-going

3) **Improve earthquake awareness and education** (strategies 1.1 and 1.2)

   Supplement existing programs and target groups having an impact on loss reduction with:

   - Materials to include in Utah science core curricula.
   - A public awareness campaign for the general public.
   - Earthquake-focused workshops for:
     -Schools (teachers, administrators, PTAs, boards),
     -Business, industry, and professional groups,
     -Local governments.
   - Utah-specific earthquake literature.
   - A Utah Earthquake Resources Guide.

   Cost: $155,000 first year; $95,000/year on-going

Utah Seismic Safety Commission Meets with Governor Leavitt and State Building Board

Chairman Les Youd and Commissioners Bill Juszcak, Suzanne Winters, and Walter Arabasz met with Governor Leavitt for 30 minutes in his office on August 18, 1995 to present the USSC's *Strategic Plan for Earthquake Safety in Utah*.

Dr. Youd gave an overview of Utah's earthquake threat and outlined the three high-priority USSC proposed actions requiring state funding (see preceding article). Bill Juszcak elaborated on the proposed DFCM program to gradually improve the seismic resistance of state-owned buildings - especially by taking advantage of cost-effective intervention during major remodeling projects. The Governor asked about comparative costs of retrofitting old buildings versus incorporating seismic resistance into new construction. Coincidentally, James Sorenson, a prominent Salt Lake City businessman, sat in on most of the meeting at the Governor's invitation. Mr. Sorenson commented on his involvement in the renovation of the Cathedral of the Madeleine, which included an extensive seismic retrofit, and the importance of community involvement.

Near the end of the meeting, Walter Arabasz emphasized that the three high-priority funding requests the USSC was making were intended to catalyze broad public and private-sector involvement in dealing with Utah's earthquake problems. He also emphasized the practical impor-

tance of any funding request being included in the Governor's budget and that the USSC was asking for help in having their proposals considered by his budget staff.

The Governor was receptive to the USSC's recommendations. In a summary of the meeting, the Salt Lake Tribune (Saturday, August 19, 1995, p. B1) reported the Governor's key remarks about the sobering reality of the problem, the obvious need to do advance planning, and the need to deal with an important problem, despite its perceived remoteness. The Governor said he had vivid impressions of the problem from his involvement in an earthquake exercise 1-2 years ago. Quoting from the Salt Lake Tribune report, "Leavitt made no promises, but urged the Commission members to submit their requests to his budget analysts so they can 'percolate through the priority process.'" He instructed the USSC to meet with Lynne Koga, the Director of his Office of Planning and Budget.

On September 5, the USSC met with Lynne Koga as requested by Governor Leavitt. Koga commented that it was still early in the budget process, but that the USSC's priority items would be considered as the Governor developed his budget for next year. They were placed on a list that is independent of agency requests, and thus will not directly compete with department or division priorities. [Editor's note: The final Governor's budget included only $200,000 one-time funding for the strong-motion program. The Legislature's budget did not include funding for any of the USSC's recommended actions.]

The challenge facing the USSC now is to make a persuasive case that the three programs for which they seek funding will catalyze broader public and private-sector involvement and make a real difference in reducing future earthquake losses in Utah. With these funding requests, the USSC is clearly only at the start of a long process. To begin this process, the USSC met with the State Building Board on September 7 to present its priorities and emphasize the items related to seismic improvement of state buildings and strong-motion instrumentation. Nolan Karras, chairman of the Building Board, agreed that this was a very important matter and stressed that the State Building Board and the USSC share the same mission and need to work together. The Building Board highlighted the importance of identifying critical buildings that are needed to "keep the state in business" after a large earthquake and dealing with these buildings on a priority basis. The Building Board asked that they be keep informed of the USSC's activities and progress in promoting building safety.

. . . the three high-priority funding requests . . were intended to catalyze broad public and private-sector involvement in dealing with Utah's earthquake problems.

Large Earthquakes on the Wasatch Fault; Summary Fact Sheet

The following items summarize key points presented to the USSC by Stuart Nishenko from his upcoming publication: McCalpin, J.P., and Nishenko, S.P., 1996, Holocene paleoseismicity, temporal clustering, and probabilities of future large (M>7) earthquakes on the Wasatch fault zone, Utah: Journal of Geophysical Research, March, 1996.

- The combined average repeat time for large earthquakes (magnitude greater than 7) on any of the five central segments (Brigham City, Weber, Salt Lake City, Provo, and Nephi segments) of the Wasatch fault zone is 350 years.
- The average repeat time on any single segment ranges from about 1,200 to 2,600 years. The time since the last earthquakes on the five central segments ranges from 620 to 2,120 years.
- Based on the historical earthquake record and assuming earthquakes are random, the **probability of a large earthquake somewhere in the Wasatch Front area is** 16 percent in 50 years and **30 percent in 100 years.**
- Based on geologic studies and assuming earthquakes are random, the **probability of a large earthquake on the central segments of the Wasatch fault alone is** 13 percent in 50 years and **25 percent in 100 years.**
- Assuming that large earthquakes occur regularly and not randomly, the probability of a large earthquake on:
  - the Weber, Provo, or Nephi segment of the Wasatch fault is only 1-7 percent in 100 years, because of the short times since the last earthquakes on these segments.
  - the Brigham City or Salt Lake City segment is much greater because the time since the last earthquake is equal to or greater than the average repeat time. On the Salt Lake City segment, the probability may be as high as 57 percent in 100 years.

. . . the probability of a large earthquake on the central segments of the Wasatch fault alone is 13% in 50 years and 25% in 100 years.

Utah Seismic Safety Commission News

by Janine L. Jarva
Utah Geological Survey

Since early 1995, the Utah Seismic Safety Commission has been focusing on how best to implement *A Strategic Plan for Earthquake Safety in Utah.* Utah needs a consistent, long-term effort to reduce the structural hazards in state-owned buildings; without beginning incrementally now, it will become an even longer-term problem. Utah-specific strong-motion data and better earthquake education provide the necessary information to make better decisions. The USSC recognized that they needed the Governor's leadership and long-range vision to begin to achieve these objectives. In previous articles we report on the USSC's meeting with Governor Leavitt on August 18, 1995 and with the Utah State Building Board on September 7, 1995. At the urging of Commissioners Peterson and Knudson, the USSC made similar presentations to the Utah House Republican caucus on January 18, 1996, the joint Utah Senate caucus on January 23, 1996, and the Utah House Democratic caucus on January 30, 1996.

In its quarterly meetings on October 26, 1995 and January 16, 1996, the USSC planned these presentations and continued to look for ways to implement the *Strategic Plan.* Membership of the five standing committees is nearly finalized (see FLF, v. 12, no. 1-2, p. 4). At the urging of Jim Bailey, acting chair of the Engineering and Architecture Standing Committee, an additional standing committee was created to focus on Lifelines and Infrastructure. Commissioner Jim Golden (UDOT) will serve as acting chair to empanel the committee. The Engineering and Architecture and Earth Sciences Standing Committees have already met for the first time. Plans are proceeding to sponsor a Utah earthquake conference. The Earthquake Awareness Standing Committee will develop the program for the conference planned for fall 1996. The USSC will produce its first annual review of mitigation and preparedness accomplishments and progress in Utah, to be completed in 1996.

Elliott Mittler, a public policy and natural hazards consultant, and Craig Taylor, EQE International, made a presentation to the USSC at the January 16, 1996 meeting. They were recently awarded a three-year grant by the National Science Foundation to study "Overcoming barriers in lifeline seismic risk reduction." They will be conducting case studies of organizations that have successfully adopted seismic risk reduction programs and trying to elucidate what makes programs succeed instead of what leads to program failure. Organizations they will evaluate include Utah's own Mountain Fuel Supply Company. Because lifeline utilities are commonly regulated by agencies, their project will also focus on understanding how utilities and their regulators manage to adopt and implement seismic safety procedures.

Also at the January 16 meeting, Stuart Nishenko, Natural Disaster Research, Inc. (formerly at U.S. Geological Survey), presented the results of work he has undertaken with Jim McCalpin, GEOHAZ Consultants (formerly at Utah State University Department of Geology). They used data from recent trenches on the Wasatch fault to calculate new earthquake probabilities for various Wasatch fault segments. A summary fact sheet from the presentation preceeds this article.

The USSC's next quarterly meeting will be on March 13, 1996 at 9 a.m. in Room 414 of the State Capitol. The primary purpose of this meeting will be to plan 1996 activities and discuss details of the 1996 earthquake conference. Anyone interested in attending is welcome. Please contact staff for more details: Janine Jarva, Utah Geological Survey, (801) 467-7970, fax: (801) 467-4070, or Brenda Edwards, Utah Division of Comprehensive Emergency Management, (801) 538-3752, fax (801) 538-3770.

CEM-UGS County Earthquake Hazards Maps

by Robert D. Carey
Utah Division of Comprehensive Energy Management

A new series of countywide 1:100,000-scale maps are near completion. They depict Quaternary faults, liquefaction potential, and landslides, as well as selected critical facilities such as hospitals, fire stations, and schools. These maps give a broad view of earthquake hazards as they relate to these critical facilities. They are GIS maps compiled from data coverages in the State Geographic Information Database by Pam Hemon, CEM intern.

The Salt Lake, Weber, and Davis County maps are currently in production and should be available in March (this date is dependent on passage of the Federal budget in which printing funds are appropriated). The map for Utah County should be completed in the spring of 1996. It is anticipated that maps for Cache, Box Elder, Morgan, Summit, Wasatch, and Tooele Counties will be done in the future.

The CEM EPICenter is the lead agency developing and funding this map series. Cooperating agencies include the Utah Geological Survey, the U.S.D.A. Forest Service Region 4 GIS Lab, and the Utah Automated Geographic Reference Center. Both CEM and UGS will have these maps available. The first printing will be free to the public.

UUSS Uses Added State Funds to Enhance Statewide Seismic Studies

by Walter J. Arabasz and Susan J. Nava
University of Utah Seismograph Stations

The Seismograph Stations has been productively using a recent base-budget increase of $75,000 from the state legislature to expand seismographic capabilities and research in southern and central Utah. One initiative has involved the installation this past summer of three new seismographic stations in southern Utah. The new stations are located (1) on Blowhard Mountain, south of Brian Head, (2) near Indian Springs, west of the Beaver Dam Mountains, and (3) on Barney Top, in the Escalante Mountains. A fourth new station will be installed east of Kanab this fall. These stations are aimed at improving seismographic coverage of rapidly growing nonmetropolitan areas of Utah, particularly the St. George and Cedar City areas. A damaging earthquake of magnitude 5.8 struck the St. George area in September 1992.

A second initiative involved a joint venture with the USGS in installing a high-quality broadband station in central Utah about 4 miles east of Marysvale. The digital station will be part of the U.S. National Seismographic Network (USNSN) and will be linked by satellite telemetry to Golden, Colorado. From there, data will be channeled back to UUSS via Internet. This new USNSN station is being strategically sited to capture high-quality data for the Sevier Valley area, where some of Utah's largest historical earthquakes have originated—including a damaging shock of about magnitude 6.5 near Richfield in 1901 and two damaging shocks of about magnitude 6.0 near Elsinore in 1921.

A third initiative involves seismological studies of coal-mining-related seismicity in the Wasatch Plateau and Book Cliffs mining districts of east-central Utah. Key objectives include (a) the space-time correlation of seismic energy release with detailed histories of coal extraction, (b) the discrimination of seismic events originating in the direct vicinity of mining openings from those associated with movements on geological structures hundreds of meters or more away from the mining, and (c) high-quality measurements of the dynamic characteristics of mine tremors based on near-source digital recordings. One experiment is currently under way in a coal mine in the Wasatch Plateau west of Price. There, three state-of-the-art digital accelerographs are being operated underground within hundreds of meters of an advancing longwall miner while data from a seismograph located at the surface are being continuously telemetered back to Salt Lake City.

- reprinted from GEO, Down to Earth, University of Utah, Department of Geology and Geophysics, Autumn, 1995, v. 12, no. 1, p. 11.

Utah Geological Survey Does WEB and BBS!

by William R. Case
Utah Geological Survey

The Utah Geological Survey (UGS) has a web site on the Internet and a BBS (bulletin board system) conference on UTAHNET, the Utah State Bulletin Board. The web site address for the Utah Geological Survey home page is **http://utstdp www.state.ut.us/~ugs/**. The phone number for the UTAHNET BBS from the Salt Lake City area is **538-3383**, and **800-882-4638** from Utah sites outside of the Salt Lake City area.

The UGS home page contains data files concerning Utah's hazards, including earthquake hazards. In January, resources available under this subheading include:

- Wasatch Fault Model, from UGMS Public Information Series 6
- Wasatch Fault Map of Salt Lake County, UGS Public Information Series 3
- Wasatch Fault Map of Utah County, UGS Public Information Series 11
- Wasatch Fault Map of Davis County, UGS Public Information Series 2
- Wasatch Fault Map of Weber County, UGS Public Information Series 1
- Epicenters in the Utah Region, from UGMS Public Information Series 6
- Wasatch Front Counties Liquefaction Potential Maps
- Utah Geologic Hazards Information Sources
- University of Utah Seismograph Stations Assessment of Utah's Earthquake Threat
- Earthquake Information Available at the University of Utah Seismograph Stations
- New Study! Major Wasatch Front Earthquake More Likely Than Originally Thought
- Large Earthquakes on the Wasatch Fault - Probabilities Revisited
- Earthquake-Related Publications Available from the Utah Geological Survey Bookstore
- Earthquake References from the Utah Geological Survey Geologic Hazards Database
- Liquefaction Publications Available at the Utah Geological Survey Bookstore

Many of the files can be downloaded. There are links to other geology web sites, graduate student home pages, contract research summaries, and the UGS Bookstore. The *Fault Line Forum* will be available for downloading from the UGS home page beginning with volume 11, no. 3-4.

The UTAHNET BBS conferences contain text files that can be read directly and compressed files of large documents with graphics which cannot be viewed on a BBS. UTAHNET communication parameters are: 8 data bits, 1 stop bit, duplex mode, no parity. The UGS Bookstore is conference number 32; the Utah Geological Survey is a sub-conference of the Department of Natural Resources (DNR) conference number 20. Most of the files available on the Internet home pages may be downloaded from the UGS Bookstore conference.

Funding Received for Earthquake Education

by Deedee O'Brien
University of Utah
Seismograph Stations

The University of Utah Seismograph Stations (UUSS), in cooperation with the Utah Division of Comprehensive Emergency Management (CEM), has received $50,000 from the Federal Emergency Management Agency (FEMA) for *Earthquakes in the Utah Science Core Curriculum; part II*. This funding is targeted for the following:

1. Adaptation of the FEMA/AGU (American Geophysical Union) curriculum *Seismic Sleuths* for use in secondary classrooms.
2. Development of Utah-specific earthquake teaching materials in support of the new 9th grade Earth Systems course.
3. Presentation of a minimum of eight teacher training workshops throughout the state for both elementary and secondary teachers. The project goal is to reach at least 200 teachers.

The earthquake teaching materials that support the elementary science core curriculum were developed in 1995 by a team of Utah elementary teachers and geologists. The 1995 development team now becomes the instruction team for teacher workshops. Essentially the same format will be followed to develop and implement the secondary science core curriculum materials.

The Earthquake Education Resources Partnership has made an essential contribution to this entire project by providing the geologists involved (Sandra Eldredge of the Utah Geological Survey and Paula Wilson of the University of Utah College of Mines and Earth Sciences). CEM has been essential in securing the funds. Deedee O'Brien, coordinator of Earthquake Education Services at UUSS, is the principal investigator.

WSSPC Annual Meeting

by Gary E. Christenson
Utah Geological Survey

The 1995 annual meeting of the Western States Seismic Policy Council (WSSPC) was held September 18-21, 1995 in Flagstaff, Arizona. Delegates from all member states, including Guam and British Columbia, attended.

WSSPC was reorganized this year and has undergone major changes. It is now led by a Board of Directors consisting of 3 state emergency-management-agency directors, 3 state geological-survey directors, and 1 at-large director (either emergency management or geological survey). In addition, a full- time executive director to provide staff support was hired in November.

Highlights of the 1995 meeting included panel discussions on (1) insurance-related legislation being considered by the United State Congress, the Clinton Administration, and insurers; and (2) the future of multi-state earthquake consortia, including the New England States Emergency Consortium (NESEC)and the Central U.S. Earthquake Consortium (CUSEC), as well as WSSPC.

Recent earthquake and hurricane disasters have caused insurers to re-evaluate their involvement in natural hazards insurance and have increased pressure for passage of federal insurance legislation like the Natural Disaster Protection Act. Other proposals include a national "all hazards" mandatory insurance program, modeled after the National Flood Insurance Program; a federally assisted reinsurance program backing private insurers against excessive losses; and creation of an independent non-federal insurance corporation.

Because earthquakes are often multi-state hazards that require response from many disciplines, earthquake consortia are providing critical assistance to states. The executive directors of NESEC and CUSEC participated in a panel discussion that highlighted their roles as clearinghouses of information, translators of technical data, and coordinators of responders, including state and federal agencies, universities, and local governments. In general, a greater role for consortia such as WSSPC is envisioned.

Representatives from FEMA reported on their activities in implementing the new national mitigation strategy and stressed FEMA's shift in emphasis from response to mitigation. The USGS gave a status report on their national earthquake hazards mapping program for the 1997 NEHRP provisions and their efforts to incorporate comments received in their regional workshops.

A highlight for Utah at the meeting was formation of a Basin and Range Province Committee, organized by Craig dePolo of the Nevada Bureau of Mines and Geology. The first activity planned by the committee is a scientific state-of-the-art summit to discuss technical aspects of the earthquake hazard in the Basin and Range Province and the issues related to long-recurrence Basin and Range faults and temporal clustering of earthquakes. The summit is tentatively planned for spring 1997, pending acquisition of funding.

The coming year will be important in defining WSSPC'S new role and how it will function after the reorganization. The next annual meeting will be in Montana in September 1996.

Earthquake Activity in the Utah Region

by Susan J. Nava
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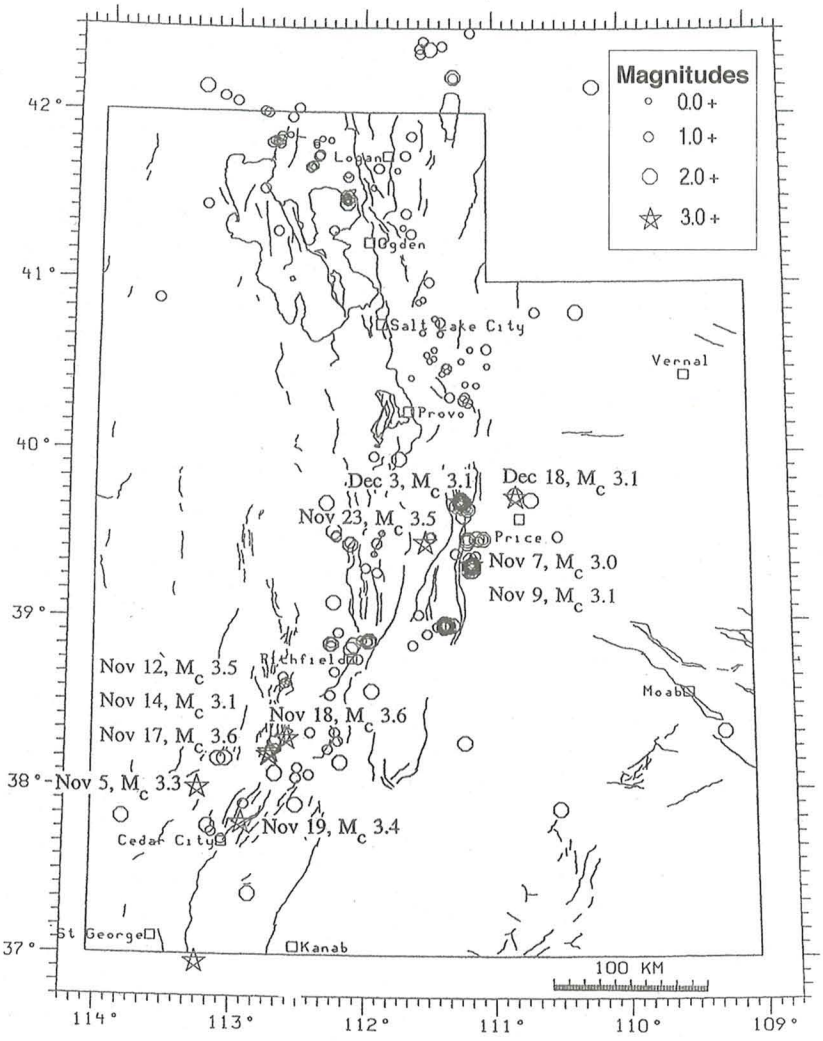
October 1 - December 31, 1994

During the period October 1 through December 31, 1994, the University of Utah Seismograph Stations located 312 earthquakes within the Utah region. The total includes 13 earthquakes in the magnitude 3 range and 151 in the magnitude 2 range. Earthquakes which have magnitudes of 3.0 or larger are plotted as stars and specifically labeled on the epicenter map. There were five earthquakes reported felt during the report period. Magnitude is either local magnitude, M_L, or coda magnitude, M_C. All times indicated are Mountain Standard Time.



Significant Main Shocks and Clusters of Earthquakes

• **Eastern Wasatch Plateau-Book Cliffs area near Price** (coal-mining related): five clusters of seismic events (magnitude 1.0 to 3.3) make up 44% of the shocks that occurred in the Utah region during the report period. These clusters are located: (a) 25 miles WNW of Price, (b) 20 miles WSW of Price, (c) 25 miles WSW of Price, (d) 30 miles SW of Price, and (e) 55 miles SW of Price. Significant earthquakes include:

M_C 3.0	November 7	6:57 p.m.	10 miles NW of Orangeville
M_C 3.1	November 9	10:40 p.m.	10 miles NW of Orangeville
M_C 3.1	December 3	1:39 p.m.	11 miles NE of Fairview
M_C 3.1	December 18	8:32 p.m.	3 miles NNE of Helper

• **Central Utah:** a swarm of 11 earthquakes ($M \leq 2.5$) occurred 4 miles SSW of Aurora (10 miles NW of Richfield). Most of the shocks in this sequence occured on November 21 and 22. Significant shocks include:

M_C 3.5	November 23	9:30 a.m.	2 miles SSW of Spring City: felt in Spring City, Ephraim

• **Northern Utah:** a cluster of nine earthquakes ($M \leq 1.6$) occurred 27 miles W of Garland (45 miles W of Logan). A separate cluster of 11 shocks ($M \leq 2.7$) occurred 5 miles W of Perry (25 miles SW of Logan), primarily during the month of November.

• **Southern Utah:** seven earthquakes, ranging in magnitude from 3.1 to 3.6, occurred in southwestern Utah during the month of November. Five of these shocks occurred within a 15 mile radius of Beaver (40 miles NNE of Cedar City). Significant earthquakes include:

M_C 3.3	November 5	10:05 a.m.	22 miles WNW of Summit
M_C 3.0	November 11	7:55 a.m.	14 miles S of Beaver
M_C 3.5	November 12	9:18 p.m.	8 miles SSW of Beaver: felt in Beaver
M_C 3.1	November 14	10:49 a.m.	6 miles SSW of Beaver
M_C 3.6	November 17	4:11 a.m.	7 miles SSW of Beaver; felt in Beaver
M_C 3.6	November 18	7:11 p.m.	3 miles ENE of Beaver; felt in Beaver, Greenville
M_C 3.4	November 19	11:01 a.m.	1 mile ESE of Summit; felt in Cedar City
M_C 3.4	November 26	11:30 p.m.	15 miles WSW of Colorado City

Additional information on earthquakes within the Utah region is available from the University of Utah Seismograph Stations.

Meetings and Conferences

- April 1-2, 1996, **Seismic Design and Performance of Building Structures**, Salt Lake City, Utah. Sponsored by the American Society of Civil Engineers Continuing Education, this seminar is aimed at structural engineers with limited experience concerning the behavior of structures subjected to strong ground motion. Most building code seismic design provisions are prescriptive in nature and provide little or no insight into actual structural performance. This seminar provides a thorough introduction to the current principles of seismic design and performance. The instructors make extensive use of experience and practical applications of earthquake engineering to give participants a solid foundation in seismic design philosophy and the basic tools necessary for evaluating seismic performance of new and existing structures. For more information, contact ASCE Continuing Education Services, 345 East 47th Street, New York, NY 10017-2398, (800) 548-2723, (212) 705-7668, fax (212) 421-1826, e-mail: conted@ny.asce.org.
- April 18-19, 1996, **Geological Society of America Rocky Mountain Section Meeting**, Rapid City Civic Center, Rapid City, South Dakota. Preregistration deadline is March 8, 1996. For information, contact Colin Paterson, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East St. Joseph Street, Rapid City, SD 57701-3995, (605) 394-5414, e-mail: paterson@silver.sdsmt.edu.
- April 22-24, 1996, **Geological Society of America Cordilleran Section Meeting**, Red Lion Hotel at Lloyd Center, Portland, Oregon. Preregistration deadline is March 15, 1996. For information, contact Michael Cummings, Department of Geology, Portland State University, P.O. Box 751, Portland, OR 97207-0751, (503) 725-3022, e-mail: michael@ch1.pdx.edu.
- July 21-26, 1996, **Sixth International Symposium on Natural and Man-Made Hazards**, Toronto, Canada. The theme of this symposium is "Major Natural Disasters In the 90's - What Can We Learn From Them?" For more information, contact Dr. S. Venkatesh, Chair, Scientific Committee HAZARDS-96, Environment Canada, 4905 Dufferin St., Downsview, Ontario M3H 5T4, Canada, (416) 739-4911, fax (416) 739-4221, e-mail: svenkatesh@cid.aes.doe.ca.

Recent Publications

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