

DEVELOPMENT AND IMPLEMENTATION
OF THE
UNIVERSITY OF CALIFORNIA
SEISMIC SAFETY POLICY

F. E. McClure (I)
Presenting Author: F. E. McClure

SUMMARY

In 1975, The Regents of the University of California adopted a University of California Seismic Safety Policy. The Policy established: the responsibility for its implementation, requirements that buildings be rated for their anticipated seismic performance, and seismic standards for reconstruction of hazardous buildings and construction of new buildings. The seismic performance ratings for over 44 million square feet of 1978 University buildings on the nine campuses are (by percentage of area): Good 34%, Fair 45%, Poor 13%, and Very Poor 8%. With the scarcity of State of California budget funds for education, the prospects for abating hazardous University buildings are not encouraging.

INTRODUCTION

The University of California was founded in 1868 as a public, State-supported land grant institution. It was written into the State Constitution as a public trust to be administered under the authority of an independent governing board, The Regents of the University of California. There are nine campuses: Berkeley, Davis, Irvine, Los Angeles, Riverside, San Diego, San Francisco, Santa Barbara, and Santa Cruz. The University has an average yearly enrollment of approximately 139,000 students and employs about 96,000 full and part-time faculty, staff and management. The physical plant has approximately 50 million square feet in over 3000 buildings. The 1983-1984 budget for current operations is \$2.6 billion dollars.

BACKGROUND

The oldest major University building is South Hall on the Berkeley Campus built in 1873. Fewer than one hundred major existing University buildings were constructed prior to 1933, the year the Field Act was passed in California. The Field Act applies to all new public, elementary and secondary schools and community colleges constructed after April 10, 1933, but does not apply to the State College and University System or to The Regents of the University of California. For a more detailed discussion of the Field Act, see Reference 1.

The University of California is exempt from local enforcement of earthquake design requirements but is subject to the provisions of the Riley Act seismic design standards set forth in Title 24 California Administrative Code or in the local building codes, whichever is more restrictive. These seismic design standards are not retroactively applicable to existing structures, including schools and hospitals. Therefore, the University is not required by statute to obtain a local building permit for its buildings or to have

(I) Senior Staff Scientist, Structural Engineer and Deputy Plant Engineer, Lawrence Berkeley Laboratory, Berkeley, California, USA

seismic designs reviewed by local building departments, any State agency, or independent "third-party."

The University is a Class A member of the International Conference of Building Officials (ICBO), a non-profit corporation that develops and promulgates the Uniform Building Code. This membership permits the campuses to take advantage of the independent, confidential third-party plan checking service available by ICBO to review building designs for compliance with the Uniform Building Code. This Code, used throughout the United States, contains the latest seismic building code provisions and is revised each year.

DEVELOPMENT OF THE UNIVERSITY SEISMIC SAFETY POLICY

The 1971 San Fernando, California earthquake caused minor damage to several pre-1933 buildings on the University of California, Los Angeles Campus which was located 22 miles from the epicenter. The Regents became concerned about the seismic safety of their buildings on all campuses and approved the use of approximately one-half million dollars for preliminary surveys and reports on the structural soundness of existing buildings.

Each campus engaged the services of a consulting structural engineer experienced in field investigation and analysis of earthquake damage to make detailed analyses of specific buildings based on their age and type of construction. The purpose of these studies was to make a qualitative determination of the adequacy of their earthquake resistance and to prescribe and estimate the cost of corrective measures where necessary.

The buildings were reviewed for compliance with the seismic provisions of the current Title 24, California Administrative Code and, by reference, the 1970 Uniform Building Code. There was no legal requirement for the University to have the buildings rated "safe" or "unsafe" using the above criteria. The investigations were generally well-performed and reported, although there obviously were some differences in approach at each campus.

By mid-1974, 170 buildings had been investigated and reconstruction costs for those buildings needing strengthening were approximately \$100.0 million. The University Budget for 1974 included \$10.0 million for seismic hazard studies and correction projects. During 1974, only \$1.5 million of the \$10.0 million for seismic hazard correction was released by the State Public Works Board. The State of California Department of Finance and the Legislative Analyst recognized that the seismic and life safety hazard correction problem was larger than first anticipated and recommended that the remainder of the \$10.0 million not be released until these problems had been more closely studied and the University had developed a University Seismic Safety Policy so that the seismic hazard could be evaluated on a more consistent basis.

The University also recognized the need for a policy on seismic safety to: (1) identify potential seismic hazards wherever University operations and activities occur, (2) develop programs for abating these seismic hazards on a priority basis, and (3) provide uniform University-wide application of guidelines and standards for minimizing the risk of life loss or personal injury in the event of a major seismic disturbance.

The University of California Seismic Safety Policy (hereinafter referred to as the Policy) was developed by the author when he was a partner in the firm of McClure and Messinger, Consulting Structural Engineers, working closely with the University Systemwide Administration and the Office of the General Counsel for The Regents. The Policy developed from the conclusions

and recommendations of the Berkeley Campus Chancellor's Seismic Review Board (consisting of Professors Bruce A. Bolt, Ray W. Clough, Henry J. Lagorio, H. Bolton Seed, and Karl V. Steinbrugge, Chairman, and Elmo R. Morgan, Director of Facilities, Berkeley Campus, and former Vice President of Construction, Systemwide Administration). Henry J. Degenkolb and Michael V. Pregnoff provided wise counsel on the technical issues of the Policy.

On January 20, 1975, The Regents adopted the University Policy - Seismic Safety (Reference 2). The basic Policy states "It is University policy to the maximum extent feasible by present earthquake engineering practice to acquire, build, and maintain buildings and other facilities which provide an acceptable level of earthquake safety as defined in this policy for students, employees, and the public who occupy these buildings and other facilities, at all locations where University operations and activities occur. Feasibility is to be determined by weighing the practicability and cost of protective measures against the gravity and probability of injury resulting from a seismic occurrence." Additionally, the policy includes definitive wording concerning the following subjects: (1) President's and Chancellors' responsibilities, (2) programs for abating seismic hazards, (3) standards for seismic rehabilitation projects including the review of rehabilitation designs, and (4) policies for the design of new buildings.

The Policy is directed toward achieving an acceptable level of earthquake safety with respect to protection against loss of life or personal injury. It is not based on whether a building complies with a specific seismic code, but on the anticipated seismic performance of a building when subjected to one earthquake of the intensity of at least IX on the Modified Mercalli Intensity Scale (as modified by Charles F. Richter in 1958) and the resulting structural and nonstructural damage jeopardizing life and personal injury. Using these criteria, the buildings are rated Good, Fair, Poor, or Very Poor in their anticipated seismic performance.

It is important to note that under the Policy, buildings are not rated "safe" or "unsafe." The use of judgmental and qualitative evaluations of Good, Fair, Poor and Very Poor rather than "safe" or "unsafe" tells the decision-makers more and provides them with a broader basis to establish more definitive priorities for abating seismically hazardous buildings. The full definitions of the meaning of these seismic performance ratings follows.

A "Good" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is anticipated to result in some structural and/or nonstructural damage and/or falling hazards that would not significantly jeopardize life. Buildings and other structures with a "Good" rating would have a level of seismic resistance such that funds need not be spent to improve their seismic resistance to gain greater life safety and would represent an acceptable level of earthquake safety.

A "Fair" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is anticipated to result in structural and nonstructural damage and/or falling hazards that would represent low life hazards. Buildings and other structures with a "Fair" seismic performance rating would be given a low priority for expenditures to improve their seismic resistance and/or to reduce falling hazards so that the buildings could be reclassified "Good."

A "Poor" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is

anticipated to result in significant structural and nonstructural damage and/or falling hazards that would represent appreciable life hazards. Such buildings or structures either would be given a high priority for expenditures to improve their seismic resistance and/or to reduce falling hazards so that the buildings could be reclassified "Good" or would be considered for other abatement programs, such as reduction of occupancy.

A "Very Poor" seismic performance rating would apply to buildings and other structures whose performance during a major seismic disturbance is anticipated to result in extensive structural and nonstructural damage, potential structural collapse, and falling hazards that would represent high life hazards. Such buildings either would be given the highest priority for expenditures to improve their seismic resistance and reduce falling hazards so that the buildings could be reclassified "Good" or would be considered for other abatement programs, such as reduction of occupancy.

The same judgmental approach is used to establish the criteria for the seismic rehabilitation of buildings. The rehabilitation criteria is based on the sole consideration of protection of life and the prevention of personal injury and not on compliance with a specific building code. The intent of the rehabilitation is to reconstruct buildings so they will have a "Good" seismic performance rating. According to the Policy, the design of each seismic rehabilitation project is to be subject to a "third-party" review by a consulting structural engineer experienced in field investigations and analysis of damage caused by earthquakes.

IMPLEMENTATION OF THE UNIVERSITY SEISMIC SAFETY POLICY

The Regents have had a policy on seismic safety in place since January 10, 1975. Immediately following The Regents' adoption of the Policy, the University Systemwide Administration developed a plan to assist each campus Chancellor in implementing the Policy. Each campus retained a consulting structural engineer to assist in the evaluation of campus facilities as outlined in the Policy. This time all the campuses were following the same guidelines. Each campus reviewed and identified its seismic hazards using their previous and new consulting engineer's seismic studies. Project Planning Guides with cost estimates and requests for funding of the high priority projects were submitted to Systemwide for inclusion in the annual University Capital Improvement request to the State of California. These requests were reviewed by the Department of Finance and the Legislative Analyst who made recommendations to the Governor and the State Legislature for inclusion in the annual State Budget.

In 1974 the California Seismic Safety Commission was created and began to consider the seismic hazards of all State buildings. In late 1975 University President David Saxon wrote Governor Jerry Brown in an appeal for action at the State level by the Commission to assist the Department of Finance and Legislative Analyst in review of the University's seismic safety program. He further pointed out that the University had identified seismic hazards, had developed a seismic safety policy and a plan for implementation, and was then waiting to undertake prudent corrective measures in an orderly manner subject to the release of State funds. President Saxon concluded by stating that the University was in a very undesirable holding position at that time, that of being unable to proceed with the abatement of serious known seismic hazards pending resolution of the State's position.

In 1976, the Legislative Analyst recommended that the California Seismic Safety Commission undertake a study to determine the need for a Statewide

seismic safety rehabilitation program and to report its findings to the Legislature by January 1977. The State administration continued to delay release of construction funds for University seismic safety projects pending development of a State policy on funding such projects. State construction funds for these University projects have not been appropriated since the 1974 budget year. Each year since 1972, the University has listed specific projects for correction of seismic safety deficiencies in Capital Improvement Program budget requests to the State. The State Budget, for the past several years, has not included seismic rehabilitation projects pending completion of the Commission's evaluation, recommendations and reports for all State-owned building seismic hazards. As a result, the University now does not include any seismic rehabilitation projects in its State budget requests. Instead, a separate non-budget table of seismic safety projects is included in the annual University Capital Improvement Program should the State indicate a willingness to provide funds for seismic safety.

Also in 1976, the Legislative Analyst recommended that the University conduct a preliminary seismic evaluation of all significant buildings (over 4,000 sq. ft. with human occupancy) following the procedures in the Policy. The University engaged H. J. Degenkolb and Associates to conduct this survey. The investigation was conducted in the Fall of 1977 and Spring of 1978 by Loring Wyllie Jr. of the Degenkolb firm and the author, at that time University Engineer, Systemwide Administration, with advice and counsel from Henry J. Degenkolb.

The investigation was carried on in the following manner. First, campus buildings with human occupancy and greater than 4,000 sq. ft. in area were identified and an evaluation sheet prepared for each building. The previous reports which evaluated specific buildings on each campus were read and critical points were noted on the evaluation sheet for each building. Two to four full days were spent on each campus reviewing the available drawings of each major building, taking walking tours of the campus, and taking photographs to assist in the recollection of specific buildings. Obviously, the review of each building was extremely brief and was generally limited to quickly reviewing design drawings and observations of the building exteriors.

A seismic performance rating of Good, Fair, Poor, or Very Poor was assigned to each building. These judgmental and qualitative ratings were based on field observations of earthquake damage to similarly constructed buildings, an understanding of, seismic codes and construction practices at the time the buildings were constructed, and how buildings of various types of configurations and materials of construction perform in earthquakes. No attempt was made to perform any detailed structural analysis. Structural calculations, when available, were given a cursory review for completeness and concept. Falling hazards from seismic ground shaking were also noted. Upon completion of the visits to all nine campuses, a review was made of the relative ratings between buildings located on different campuses in an attempt to provide consistency in the ratings throughout the University.

As a result of the qualitative and judgmental nature of the ratings, different ratings can sometimes be assigned to the same building by different engineers. However, if the evaluations are performed by earthquake engineers who have benefited from the experience of earthquake damage investigation, the ratings will be very close. With this in mind, one must caution that the rating assigned to a specific building should only be considered as tentative and subject to further evaluation before planning decisions are made for the future of the building. It is believed, however, that

the overall findings of this survey were sufficiently accurate to define the magnitude of the University's seismic exposure.

A report, "Investigation of Seismic Hazards, University of California Campuses" by H. J. Degenkolb and L. A. Wyllie, Jr. (Reference 3) was submitted to the University in June 1978. Approximately 800 buildings, representing over 44 million gross square feet of 1978 University buildings, were evaluated. A summary of the Seismic Performance Ratings is presented in the following table as taken from this report. Nearly 35 million square feet of building, or nearly 80% of the total building gross area, were evaluated as Good or Fair, representing a low life hazard to the occupants. Over 9 million square feet of building, or 21% of the total building area, were evaluated as Poor or Very Poor, representing an appreciable or high life hazard. The majority of these later buildings were pre-1933 buildings with unreinforced masonry construction. However, a sizable number of the Poor and Very Poor buildings which were constructed after 1960 contain non-ductile concrete frames or discontinuous shear walls which were permitted by building codes at the time of their design and construction.

SUMMARY OF SEISMIC PERFORMANCE RATINGS					
UNIVERSITY OF CALIFORNIA					
CAMPUS	BUILDING AREAS (in thousands of square feet)				
	TOTAL	GOOD	FAIR	POOR	VERY POOR
Berkeley	9,744	3,714	4,229	1,382	419
Davis	5,146	2,805	1,323	717	301
Irvine	2,603	651	1,419	401	132
Los Angeles	12,316	1,990	6,897	1,379	2,050
Riverside	2,131	704	803	583	41
San Diego	4,377	1,657	1,746	474	500
San Francisco	2,783	1,382	1,246	155	0
Santa Barbara	3,179	954	1,686	468	71
Santa Cruz	1,861	1,118	463	280	0
<u>TOTALS</u>	44,140	14,975	19,812	5,839	3,514
<u>PERCENTAGES</u>		34%	45%	13%	8%

It is difficult to estimate the cost to mitigate the hazards represented by the buildings rated Poor and Very Poor. In 1978, the University estimated an approximate cost of \$300 million at 1978 construction costs. The 1983-86 University Capital Improvement Program (not included for Budget Approval) includes \$294.0 million for 56 State-funded buildings and \$67.0 million for 38 non-State-funded buildings for abating seismic safety hazards in these

highest priority buildings.

The priority ranking of the buildings in the above Capital Improvement Programs was based on the results of the report, "Seismic Hazard Survey - University of California Buildings," August 10, 1981 by H. J. Degenkolb and Associates. This report was prepared in response to the requirements of the current State Seismic Safety Commission Building Evaluation Program. This Program is based on the Seismic Safety Commission Report, SSC 79-01 "Evaluating the Seismic Hazard of State Owned Buildings," February 8, 1979 and SSC 604 "Seismic Hazard Survey, State of California Buildings," April 9, 1981. These two reports were prepared for use by the Department of Finance and the Legislative Analyst in response to the University's annual request for construction funds to implement the Policy.

In 1982, the State Public Works Board released \$175,000 to the University to study the seven highest priority University buildings based on the SSC 604 Report. The SSC 79-01 Report is currently being used to establish priority ranking for the abatement of Poor and Very Poor non-State-supported University buildings. A final program for correction of seismic safety deficiencies in non-State buildings is currently being developed.

It is important to note that the State of California has become more aware of seismic deficiencies in other State buildings, as well as University buildings, as the University attempts to implement its Policy in the face of diminishing State support for the University. Since 1971, it is estimated that the University has spent a little over four million dollars for the development and implementation of the University Policy - Seismic Safety.

CONCLUSIONS

The California Seismic Safety Commission Report SSC 82-01, "Earthquake Hazards Management, An Action Plan For California," September 1, 1982, proposes a level of recommended spending by the State of California of a total of \$80.0 million through 1987 for the seismic rehabilitation of all State-owned buildings, including University of California buildings. Conservatively, allowing for the increase in seismic rehabilitation costs caused by inflation resulting from the time necessary to plan and implement a University seismic safety program, the University of California would need approximately \$500.0 million to mitigate all of its seismic hazards (Reference 3). With the scarcity of State Budget funds for education, not to mention seismic safety programs, the immediate prospects for abating hazardous University of California buildings are not encouraging.

REFERENCES

1. Jephcott, Donald, K., "Fifty Years Experience with Seismic Building Standards for California Public Schools, The Field Act," Proceedings of the Eighth World Conference on Earthquake Engineering, 1984.
2. University of California, Facilities Manual, Section B. Administration, 3. University Policies, 2. Seismic Safety, Pages B.3.2 (1) through B.3.2 (4), January 28, 1977.
3. Degenkolb, H. J. and Wyllie, Jr., L. A., "Investigation Seismic Hazards, University of California Campuses," June 9, 1978.

