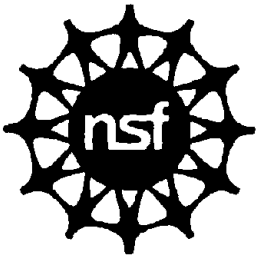
NSF/CEE-81102 PB82-249046



RECENT AWARDS

DIVISION OF PROBLEM - FOCUSED RESEARCH

January–March 1981

NATIONAL SCIENCE FOUNDATION
Directorate for Engineering
Washington, D.C. 20550

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. NSF/CEE-81102	2.	3. Recipient's Accession No. PB82 249046

4. Title and Subtitle
Recent Awards, Division of Problem-Focused Research, January - March 1981

5. Report Date
1981

6.

7. Author(s)
None listed

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
National Science Foundation
Directorate for Engineering
Division of Problem Focused Research
1800 G Street, N.W.
Washington, DC 20550

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
Directorate for Engineering (ENG)
National Science Foundation
1800 G Street, N.W.
Washington, DC 20550

13. Type of Report & Period Covered

14.

15. Supplementary Notes
Submitted by: Communications Program (OPRM)
National Science Foundation
Washington, DC 20550

16. Abstract (Limit: 200 words)
The reorganization of the National Science Foundation to broaden the agency's capability to support basic and applied research in the sciences and to give new emphasis to engineering research is announced. A major change was the establishment of a Directorate for Engineering, which includes the Divisions of Electrical, Computer and Systems Engineering; Chemical and Process Engineering; Civil and Environmental Engineering; and Mechanical Engineering and Applied Mechanics. The Science and Technology to Aid the Handicapped Program is introduced. Awards for this program and for the Hazards Mitigation Program are listed. For each award, the following information is provided: title, principal investigator, institution, award number, amount, duration, starting date, and an abstract.

17. Document Analysis a. Descriptors

Awards
Research
Earthquakes
Hazards
Femur
Transducers
Soils
Buildings
Structural analysis
Handicapped persons
Dams

b. Identifiers/Open-Ended Terms
National Science Foundations
Science and technology

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
NTIS	20. Security Class (This Page)	22. Price

ANNOUNCEMENT OF NATIONAL SCIENCE FOUNDATION REORGANIZATION

Effective March 8, 1981, the National Science Foundation reorganized to broaden the agency's capability to support basic and applied research in the sciences and to give new emphasis to engineering research.

A major change was the establishment of a Directorate for Engineering, which includes the Divisions of Electrical, Computer and Systems Engineering; Chemical and Process Engineering; Civil and Environmental Engineering; and Mechanical Engineering and Applied Mechanics.

The programs and personnel formerly in the Directorate for Engineering and Applied Science (which contained the Division of Problem-Focused Research) have been redistributed throughout the National Science Foundation.

In Fiscal Year 1981, the biological conversion of materials to useful chemicals topic of PFR's Alternative Biological Sources of Materials Program will be continued in the Renewable Materials Engineering Program in the Division of Chemical and Process Engineering. The biological nitrogen fixation and arid land plants topics will be continued in the Alternative Biological Resources Program in the Division of Physiology, Cellular and Molecular Biology, Directorate for Biological, Behavioral and Social Sciences.

In Fiscal Year 1981, PFR's Earthquake Hazards Mitigation Program will be continued intact in the Division of Civil and Environmental Engineering.

In Fiscal Year 1981, PFR's Human Nutrition Program will be located in the Division of Physiology, Cellular and Molecular Biology, Directorate for Biological, Behavioral and Social Sciences, but will be able to provide support for continuing grants only. No budget request for continuation of the Human Nutrition Program has been made for Fiscal Year 1982.

In Fiscal Year 1981, the Science and Technology to Aid the Handicapped Program will be continued intact in the Division of Electrical, Computer, and Systems Engineering.

SPECIAL NOTICE

As a result of the March 8, 1981 reorganization, PFR has been disestablished. Consequently, this is the last issue of *Recent Awards* that you will receive. The new Directorate for Engineering is planning to issue a similar publication for its research awards. You will automatically receive a copy of the first issue when it comes out, and will be given the opportunity to be placed on our mailing list for this new publication.

INTRODUCTION

Recent Awards keeps researchers, research users and policy makers informed about projects supported by NSF's Division of Problem-Focused Research (PFR).

This brochure describes awards made by PFR primarily during the period January 1, 1981 through March 31, 1981 (second quarter, Fiscal Year 1981). Awards made before January 1, 1981 are included here if they were not reported in a previous issue of *Recent Awards*. The data have been reconciled with the NSF's Management Information System.

DEFINITIONS AND EXPLANATION OF FORMAT

Study of Earthquake-Induced Bond Deterioration;[1] Neil M. Hawkins;[2] University of Washington, Department of Civil Engineering, Seattle, WA 89195;[3] **Award #76-15366 AO2[4]; $59,647** for 12 months beginning May 15, 1979.[5]

1. **Title of the Award**
2. **Principal Investigator:** the chief scientist or administrator who is responsible for the research plan and fiscal expenditures as an NSF awardee.
3. **Institution Conducting the Research:** any college, university, laboratory, industry, or other organization, whether operating on a profit or nonprofit basis, as well as State governments and Federal organizations.
4. **Award Number:** the award number and amendment number, if applicable.
5. **Amount, Duration and Starting Date of the Award** (a duration of 0 months means the amount awarded is a supplement to an existing award).

HOW TO OBTAIN RESEARCH REPORTS

One of the most important objectives of PFR is the timely and widespread dissemination of the result of PFR-supported research to potential users. The name and mailing address of the Principal Investigator and Grantee Institution is contained in each project description in this brochure. Persons wishing to obtain information on project findings, including project reports, monographs, journal articles, technical reports, and other materials should write to the Principal Investigator at the Grantee Institution to determine what information is available and at what, if any, cost it may be obtained. The Grantee Institution may charge a nominal amount for the duplication and mailing of such materials to cover costs. The Principal Investigator may furnish information on how interested persons may acquire reports and other materials from the National Technical Information Service (NTIS) of the Department of Commerce in lieu of furnishing the report or other material directly. NTIS is the central point in the United States for the public sale of Government-funded research and development reports and other analyses prepared by Federal agencies, their contractors, and grantees. The Principal Investigator may also cite journals or other publications where project information may be found instead of furnishing a copy of the article.

ALTERNATIVE BIOLOGICAL SOURCES OF MATERIALS

The Alternative Biological Sources of Materials program deals with selected aspects of the problem of meeting the Nation's future needs for raw materials. This program is directed toward alleviating national dependence on selected scarce resources by making alternative biological sources of materials available in the United States.

1. Guayule By-Products, Rubber Analysis and Seed Selection; Anthony J. Verbiscar; Anver Bioscience Design, 160 East Montecito Avenue, Sierra Madre, CA 00000; **Award #79-10187 AO1**; $104,500 for 12 months beginning 01/15/81.

   The objectives of this research are the investigation of the guayule plant as a source of useful by-products, and the development of a convenient method for assaying the quantity of rubber in individual plants. During the project's first year, seeds, leaves, and woody tissue from guayule plants were collected and analyzed, the oils from seeds and leaves characterized, and evaluation of the seed meal, leaf residue and woody tissue as animal feed initiated. A method for assaying rubber based on IR absorption was developed. These studies will be continued and completed during this, the second year of the grant.

EARTHQUAKE HAZARDS MITIGATION

The goals of the Earthquake Hazards Mitigation (EHM) program are to develop an understanding of earthquakes in relation to constructed facilities, and to reduce casualties, damage and social and economic disruption which are the result of earthquakes. The actions necessary to attain these goals are heavily dependent upon technical capabilities which require development through research.

Primary objectives of EHM-supported research are: to determine the nature of strong ground shaking during earthquakes; to develop analytical procedures to predict the spatial and temporal distribution of strong ground motion at different sites; to understand the dynamic behavior of soil and rock subjected to strong shaking; to determine the nature of the interaction of structures and their supporting soil during earthquakes; to determine the engineering aspects of reservoir-induced seismicity; to develop procedures for performing dynamic analyses of proposed or existing construction under earthquake

loading; to develop an understanding of materials and structural component subjected to damaging dynamic loads; to develop procedures for analysis and redesign of non-structural and architectural systems for earthquake effects; to study the influences of architecture and urban planning activities on the earthquake vulnerability of regions; and to determine the social and economic aspects of mitigation, preparedness, and disaster impacts.

1. Simulation of Strong Earthquake Motion With Contained Explosive Line Source Arrays; G. P. Abrahamson; SRI International, 333 Ravenswood Avenue, Poulter Laboratory, Menlo Park, CA 94025; **Award #79-28722 AO1; $226,542 for 12 months beginning 11/15/80.**

   This project will study an earthquake ground motion simulation technique utilizing contained explosions in line source arrays. Each line source consists of a steel canister in which an explosive is detonated and the explosive products vented at a controlled rate into an expandable rubber bladder which transmits the energy into the surrounding soil. With appropriate geometric placement of line sources, delay time between explosions, and number of explosions, control can be achieved over the frequency content, ground amplitude, and time duration of the simulated ground motion. Line sources once installed can be reused so that many tests can be performed in a short time and at low cost. This provides an economical and practical; method for studying earthquakes response of soils and structures under in-situ-like conditions.

2. Earthquake Response Analysis of Sediment Filled Valleys; Keiiti Aki; Massachusetts Institute of Technology, Department of Earth and Planetary Science, Cambridge, Massachusetts 02139; **Award #80-16243; $131,430 for 24 months beginning 01/01/81.**

   This project continues experimental and theoretical studies or the response of sediment-filled valleys to strong earthquakes. The research consists of two parts. The first is Operation of an existing array of seven digital strong-motion accelerographs in Garm, USSR. These instruments provide information on earthquake source mechanisms. The second involves accelerographs deployed across a small, sediment-filled valley. One is in a tunnel in hard rock bordering the valley, and three are on the valley surface itself over different thicknesses of sediments. The response of this valley to weak earthquake motion has been intensively studied and was found to contain features which, if also found in the response to strong-motion, might be important to seismic zoning. A method of computing the response of sediment-filled valley recently developed by two French seismologists will be used in this project.

3. Building Configuration as a Modifier of Damage Ratio Estimates for Single Family Housing; Christopher Arnold; Building Systems Development, 120 Broadway, San Francisco, CA 94111; **Award #80-22039; $75,501 for 12 months beginning 01/05/81.**

   Evidence from the San Fernando Earthquake of 1971 suggests that configuration was a major factor in damage susceptability in single family homes. The house-over-garage configuration apparently contributes to structural failures. More intensive land use is causing this configuration to be increasingly prevalent, and historical experience strongly suggests that this configuration will be very significant in future large earthquakes in urban areas.

   Engineering analyses of selected structural/architectural configuration models, in conjunction with historical data produce a damage amplification factor. This new damage parameter related to the buildings configuration is introduced into existing earthquake damage prediction methodologies. The modified vulnerability assessment methodology is applied to an inventory of representative structures in San Mateo county. Associated engineering studies are developed into a design guide for architects and home builders. This guide provides methods for avoidance of the failure of house-over-garage structures in future construction and for retrofitting such existing structures.

4. Symposium on Stability Problems of Tall Buildings, Chicago, Illinois, April 7-8, 1981; Lynn S. Beedle; Lehigh University, Fritz Engineering Laboratory, Bethlehem, PA 18015; **Award #80-22093; $14,500** for 12 months beginning 03/01/81.

   The Structural Stability Research Council has the aim of developing new and improved solutions for predicting and analyzing stability problems in metal structures and the translation of these solutions into specifications and design recommendations which will help transfer new information into professional practice. Among the activities of the Council is the organization of an annual technical session and colloquium. Each year the colloquium focuses on a stability topic of current importance.

   The 1981 meeting will have as its theme the stability of tall buildings subjected to dynamic loads. This topic is especially relevant because a number of new framing systems have been introduced in recent years.

5. Flexible Sub-Surface Building-Foundation Interfaces for a Seismic Design; John M. Biggs; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; **Award #79-02989 AO1; $125,542 for 12 months beginning 03/01/81.**

   This project is investigating the seismic behavior of a flexible, sub-surface, building-to-foundation interface with special emphasis on a sleeve-pile system.

   Ground motion studies are concerned with obtaining records of combined horizontal and vertical motions which can be used in dynamic analyses of the pile design.

   Soil-structure interaction studies are developing soil stiffness and damping parameters to be used in the dynamic analysis of various types of foundation systems. At this time, the study is limited to the seismic behavior of single piles. A computer program has been developed for use in parametric studies of the stiffness of sleeved piles during various earthquake excitations. These studies have resulted in the development of design procedures for sleeved piles based on indications that high strength steels are beneficial and that tapered piles are advantageous.

Current studies are investigating the effect of the latest ground motion records and their suitability for design, and the single pile concept is being expanded to include the ground effect of a system of piles. Wind effects, (high-stiffness, limited strength, and wind-shear resistance) are being investigated so that their effect can be included in the design process for earthquake resistance.

A refined method for the dynamic analysis of sleeved piles is also being developed. Typical systems are studied to determine the characteristics of the building with respect to the variations of the soil properties. Finally, on the basis of the previous studies, an evaluation of the proposed concept for the seismic behavior of the sleeved piles with respect to prediction of damage, economic feasibility, and range of application will be made.

6. The Earthquake Applications of Point Process Methodology; David R. Brillinger; University of California-Berkeley, Department of Statistics, Berkeley, CA 94720; **Award #79-01642 AO1; $47,983** for 12 months beginning 12/12/80.

One problem in seismic risk analysis is to quantify the characteristic locations of earthquakes in time and space. This research is to develop point process methodology (e.g., to treat earthquake sequence as a stochastic process) for such a quantification. The methodology involves the estimation of probabilities of event occurrence as a function of relevant exogenous variates. The specific objectives of this study are to develop sampling properties of estimates of product densities, to extend the weighting procedure for correcting data to deal with earthquake locations and magnitudes, and to develop improved estimates of product densities, further parameters of earthquake process, and a general approach to the preparations of risk maps.

7. Optimum Design of Three-Dimensional Building Systems Under Multicomponent Earthquake Motion; Franklin Y. Cheng; University of Missouri Rolla, Department of Civil Engineering, Rolla, MO 65401; **Award #80-19625; $169,178** for 24 months beginning 01/15/81.

This project continues study of the optimum design of structures under dynamic loadings. Three-dimensional building systems subjected to static loads, wind forces, three interactivated earthquake compounds, and building code provisions are considered. The structural systems are represented by three models for: 1) a two-dimensional model for symmetric buildings; 2) three-dimensional high-rise buildings with symmetric and unsymmetric plans as well as rigid diaphragms; and, 3) three-dimensional low-rise buildings with symmetric and unsymmetric plans as well as semirigid diaphragms.

The objectives of the project are: 1) to develop an efficient optimization method and computer programs for an automated design that has analysis options for structural models; 2) to evaluate the effectiveness of various bracing systems and shear walls in a seismic structural design for symmetric and unsymmetric stiffness requirements; 3) to investigate the influence of diaphragm rigidities on shear wall and column stiffness requirements, and on the overall stiffness distribution at critical regions as well as on the entire system; 4) to determine the influence of interacting earthquake motions on the design of constituent members and the entire system; 5) to study the adequacy of seismic force requirements in the Uniform Building Code and ATC-3 Provisions; and, 6) to examine the reliability and serviceability of the optimum design results.

8. Nonlinear Hydrodynamic Pressures on Dams During Earthquake; Allen T. Chwang; University of Iowa; Institute of Hydraulic Research, Iowa City, IA 52242; **Award #80-20564; $39,176** for 09 months beginning 03/11/81.

This project investigates the nonlinear effect of the fluid motion on the hydrodynamic pressures on dams. The analysis is based on the exact potential flow theory, with the hydrodynamic pressure being expanded in an ascending series in terms of the time variable t. No limitation is placed on the magnitude of the ground acceleration during an earthquake. The analysis includes flexible dams as well as inclined dams with constant slope. The effect of water surface waves caused by ground excitation is also studied.

A secondary objective of this project is to study the nonlinear response of a foundation with slowly varying properties. The Biot (1965) equations are to be solved for the case of constant properties, then perturbed and solved again. The material is allowed to consolidate after each time step, while increasing the pore-water pressure through empirical relations. The soil properties are also allowed to change in time.

9. Earthquake Behavior of Techi Dam; Ray W. Clough; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #78-19333 AO2; $52,481** for 12 months beginning 01/15/81.

The objective of this project is to extend for one additional year an on-going U.S.-Taiwan cooperative research project to obtain seismic response information from the Techi Dam in Taiwan. The Techi Dam is a thin shell concrete arch structure located in a region of significant seismicity, and thus offers researchers a unique opportunity to obtain data on the actual seismic behavior of arch dams.

Of the six tasks included in the original project, the following are completed: 1) calculation of the dam vibration properties; 2) measurement of the dam vibration properties; 3) evaluation of response to actual and predicted earthquakes; and, 4) shaking table experiments of nonlinear effects. The following tasks are carried out in this project: 5) installation of additional seismographs in Techi Dam by the Taiwanese and, 6) refinement of the mathematical model. Task is divided into three subtasks: development of a linear computer program that will account for the monolith joint mechanism; evaluation of Reservoir Compressibility Effects; and evaluation of Foundation Interaction Effects.

10. Analysis of High Frequency Strong Earthquake Accelerations; Marijan Dravinski; University of Southern California, Department of Civil Engineering, Los

Angeles, CA 90007; **Award [redacted]; $82,092** for 24 months beginning 03/01/81.

The project is related to the mathematical modeling and experimental verification of the basic data gathering and recording devices and automatic computer processing of ground motion data. The overall problems of instrument testing, calibration, and mathematical modeling are examined. The force balanced acceleration transducer (FBA), which is used in the current kinemetrics CRA-1 system and will be extensively used in the future generations of digital recording systems for strong-motion seismology, is specifically analyzed and evaluated. The research tasks include the mathematical modeling of FBA system and FBA coupled to galvonometer, laboratory testing of components and the entire feed back loop system, and development of detailed computer programs for instrument correction of CR-1 records up to very high frequency range (about 100 Hz). The high frequency motion recorded in the County Service Building in El Centro (1979) is also studied.

11. Random Vibration Analysis of Earth Dams Under Earthquakes; George Gazetas; Case Western Reserve University, Department of Civil Engineering, Cleveland, OH 44106; **Award [redacted]; $68,222** for 18 months beginning 02/15/81.

In the evaluation of the seismic safety of earth dams, a large variability in responses can result from differences in the earthquake motion and structural parameters used in the analysis. Random-vibration based analyses, as formulated in this project, directly provide probabilistic information on the response, thus helping the designer to make rational decisions regarding safety. Research under this project is focused on: 1) obtaining probability distributions of response in earth dams, using random vibration techniques; 2) examining effects on the dam failure due to ground motion parameters, the soil properties and the dynamic modelling of the dam; 3) developing simplified, cost-effective, random-vibration-based methods to assess the seismic safety of various types of embankment dams; 4) evaluating the developed methods in the light of observed field performance of existing dams which have experienced earthquake excitations.

12. U.S.-Japan Cooperative Earthquake Research Program: Test of Full-Size Reinforced Concrete Building; Robert D. Hanson; University of Michigan, Department of Civil Engineering, Ann Arbor, MI 48109; **Award [redacted] AO1; $272,450** for 12 months beginning 03/01/81.

The U.S.-Japan Cooperative Earthquake Program plans to coordinate efforts utilizing full-size tests, small scale component tests, subassemblage tests, and analytical studies to improve seismic practices in the United States and Japan.

One of the primary efforts of the cooperative program is the large-scale test of a multistory reinforced concrete building. This project constructs, at the Building Research Institute/Ministry of Construction test facility in Tsukuba, Japan, a full-scale seven-story reinforced concrete test specimen to be used for major research studies in this cooperative program.

13. National Information Service for Earthquake Engineering; George W. Housner; California Institute of Technology, Department of Civil Engineering, Pasadena, CA 91104; **Award [redacted] AO1; $92,609** for 12 months beginning 01/01/81.

The National Information Service for Earthquake Engineering, located at the California Institute of Technology, functions as a research library for researchers and users at universities and industry, and provides digitized data of earthquake records upon request.

The service which CalTech provides is an essential element in the total process of mitigating the many losses as a result of a seismic event. This service is one of the principal methods of disseminating research results on earthquake studies to the many decision-makers who have a need for the information developed. Results include reports, articles, card decks, and magnetic tapes of accelerograms.

14. Seismic Analysis of Port and Harbor Facilities; S. J. Hung; Agbabian Associates, 250 North Nash Street, El Segundo, CA 90245; **Award [redacted]; $109,585** for 09 months beginning 04/01/81.

This research project provides architects and engineers with information about the safety, economics, and risk associated with seismic effects on port and harbor facilities. Response calculations and sensitivity analyses of typical port and harbor facilities are conducted to establish conditions under which structures fail or approach failure and to ascertain a relationship between failure and the physical parameters of foundations and characteristics of earthquakes. Critical and sensitive parameters of the soils and subsurface conditions are identified and their relationship to the foundation behavior and the structural response are established using field, laboratory, and analytical data. These collected data are used to assess potential earthquake damage and corrective measures for existing waterfront structures. Guidelines for site selection and facility design are developed. The research provides information that allows port and harbor managers and officials to make intelligent decisions about possible courses of actions that might be undertaken to mitigate or avoid major earthquake damage. Recommendations relating structural design practices to the range of geological and seismic conditions prevailing at various sites are also developed.

15. U.S.-Japan Cooperative Earthquake Research Program: Full-Scale Tests of Beam-Column Joints; James O. Jirsa; University of Texas-Austin, Department of Civil Engineering, Austin, TX 78712; **Award [redacted] AO1; $44,368** for 12 months beginning 03/01/81.

As an integral part of the U.S. Japan Cooperative Earthquake Research Program on Large-Scale Testing, this project focuses on the quasi-static tests of reinforced concrete joint assemblies. Three joint assemblies are tested: exterior column-to-beam as-

semblies. Loading is applied in a controlled deformation pattern and in three reversed cycles corresponding to deformation levels in the elastic, inelastic, and near failure ranges. These tests permit correlation of experimental data from laboratory studies of full-scale joints with the response of a full-scale structure subjected to simulated earthquake loads. The results provide a basis for a critical examination of current design practice and recommendations for joints in reinforced concrete structures. These tests are fully coordinated with the full-scale seven-story structure to be tested at Tuskuba, Japan.

16. Dynamic Behavior of Embedded Foundations; Eduadro Kausel; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, MA 02139; **Award [illegible]; $147,481** for 24 months beginning 01/01/81.

Classical solutions for dynamically loaded foundations are restricted to simple geometries and soil conditions. It is known that three-dimensional effects, as well as embedment, play a significant role in the behavior of structures with rigid foundations. These effects are not tractable by analytical procedures. Current research is focused on the study of one or more foundations, but with no embedment. Some of the reasons for avoiding embedment are the cost involved and the computer resources required. It is thus important to develop procedures for three-dimensional embedded foundations which are both cost-efficient and accurate.

The objectives of this research are to survey available numerical procedures and to develop efficient computer programs for the study of embedded foundations. These programs will then be used in parametric studies to assess the effects of embedment, foundation shape, seismic environment, etc.

17. Hydrodynamic Effects of Strong Earthquake Excitation in Confined Aquifers; Y. K. Lee; Tetra Tech Inc., 630 North Rosemead Blvd., Pasadena, CA 91107; **Award [illegible]; $74,883** for 12 months beginning 02/15/81.

This project studies the earthquake response of confined aquifers (underground geological formations which are porous and contain water). Many underground facilities within and/or penetrating aquifers have been damaged by earthquakes, and the nature of the loadings, and particularly the role of hydrodynamic forces, is not fully understood. The objective of the research is to characterize and mathematically represent the loadings on underground facilities, such as wells and storage facilities, resulting from earthquake excitation of confined underground aquifers.

An analytical model representing the generation and propagation of seismic motions in realistic aquifer formations is developed. The aquifer systems are treated as water-saturated, elasto-porous solids, confined between impermeable elastic formations. Both near-field and far-field effects of earthquake excitations are considered. Both earthquake field data and underground explosion data are used to verify the model developed and to test its application.

18. U.S.-Japan Cooperative Earthquake Research Program: Design and Preliminary Experimental Studies for the Recommended Structural Steel Test Building; Le-Wu Lu; Lehigh University, Department of Engineering, Bethlehem, PA 18015; **Award [illegible] AO1; $96,970** for 16 months beginning 04/01/81.

As part of the "U.S.-Japan Cooperative Research Program Utilizing Large-Scale Testing Facilities," a full-scale, seven-story, structural steel building has been recommended for testing to study its response and resistance to earthquakes. The test structure is designed according to the current building design practices in both countries and is loaded pseudo-dynamically to simulate the effect of earthquake ground excitations.

This project is to complete the detailed structural design of the steel test building, to perform preliminary elastic and inelastic dynamic analyses for selected ground motions, and to conduct cyclic load tests on certain girder-to-column connections in the structure. In addition, preliminary planning of other types of component and associated tests are carried out.

19. Nonlinear Analysis and Design of Steel Frames; William McGuire; Cornell University, Department of Structural Engineering, Ithaca, NY 14850; **Award [illegible]-15357 AO2; $141,511** for 12 months beginning 02/15/81.

This project will develop an interactive computer graphics capability for the static and dynamic nonlinear analysis and design of a three dimensional steel frame structure. This will enable the designer to visualize the behavior of a building subjected to earthquake loads and enable him to make changes in the design to affect an economical and safe building.

Progress to date has resulted in the development of methods to program the linear behavior of a three-dimensional steel frame subjected to dynamic loads. The dynamic program has provisions for modal analysis. The computer program permits the designer to evaluate the analysis results by interacting with the graphical representation of the solution on a computer screen.

The project's current objective is to develop a capability for nonlinear static analysis of three-dimensional frameworks and to emphasize the development of a capability for design techniques based on the analysis programs. This study is concentrating on the program capability to handle all types of earthquake records; design capability for static type conditions, such as wind and gravity loads; and the methods of performing dynamic analyses by computer graphics.

20. Computational Techniques for Active Control of Large Structures Under Seismic Loading; Leonard Meirovitch; Virginia Polytechnic Institute, Department of Engineering Science and Mechanics, Blacksburg, VA 24061; **Award [illegible]; $144,367** for 24 months beginning 02/01/81.

This research is concerned with the active control of large structures subjected to external forces, such as the inertial forces caused by earthquakes. The research can be divided into three interdepen-

dent phases: i) system modeling, ii) control design, and iii) sensitivity studies.

Large structures generally contain distributed members and must be discretized in space. Discretized models ordinarily possess a large number of degrees of freedom. Discretized models are only approximations of the actual systems, so modeling errors should be expected. The most indicated method for the control of large structures is control in modal space, which consists of independent control of the various modes of vibration. Because the natural frequencies and models of vibration derived from a discretized model are only approximations of the actual ones, one must investigate how sensitive a control design based on the approximate modal information is to errors in this information. In particular, the interest lies in a control design that is relatively insensitive to errors in the natural frequencies and modes of vibration. Excitation caused by earthquakes is stochastic in nature, so that special attention is being given to stochastic control.

The object of the research is to develop computational techniques for the active control of complex structures to reduce excessive vibration and damage caused by external factors, such as foundation motion, resulting from earthquakes.

21. The Dynamics of Structures With Localized Nonlinearity; Richard K. Miller; University of Southern California, Department of Civil Engineering, Los Angeles, CA 90007; **Award #80-18272; $93,609** for 24 months beginnining 01/15/81.

This project is concerned with the study of the dynamic response of structures whose nonlinear behavior is confined to a simple location. In previous research the steady harmonic and stationary stochastic response of discrete locally nonlinear systems, whose level of nonlinearity was small or moderate has been studied. This project is to continue this line of research and to 1) investigate weighting function techniques for the development of approximate analysis techniques for discrete locally nonlinear systems with large nonlinearity, and 2) perform laboratory experiments on small models of locally nonlinear systems to test the validity of the theoretical results. Attention is focused on the earthquake behavior of such structures as adjacent structures connected by a flexible element, buildings with a soft first story, and structures which experience foundation up lift.

22. Minority Citizen Warning Response and Involvement in Community Hazard Planning; Ronald W. Perry; Battelle Memorial Institute, 4000 N.E. 41 Street, Seattle, WA 98105; **Award #80-19297; $307,542** for 24 months beginning 02/15/81.

The objective of this project is to examine group differences in disaster warning response and involvement in community emergency preparedness planning, and to suggest strategies for enhancing minority group warning response and involvement in the planning process. The analysis of warning response is structured around understanding factors in minority definitions of personal risk, warning belief, interpretations of message content, and the social networks through which warning information is received. The study is examining the evacuation warning response of whites, blacks, and Mexican-Americans, as well as their patterns of involvement in hazard planning, in three communities. In each community a probability sample of warning recipients is being interviewed along with a sample of community officials.

23. A Study of Education and Utilization of Engineers 1980-2000: Status, Needs, and Opportunities, Phase I; Kerstin B. Pollack; National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, DC 20418; **Award #81-07881; $71,000** for 06 months beginning 02/01/81.

The National Academy of Sciences, Assembly of Engineering proposes to undertake a major study of the status, needs and opportunities for the education and utilization of the engineer in 1980-2000. In the project's first phase, the Assembly will: (1) identify issues likely to affect the vitality of U.S. engineering education and the utilization of the nation's engineers during the remainder of this century; (2) develop the scope of a manageable study and a methodology for analyzing the issues selected from those identified, evaluating them, and providing policy and program options and priorities; and (3) define the range of expert knowledge needed to undertake an in-depth analysis and evaluation of the issues.

24. International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics; Shamsher Prakash; University of Missouri Rolla, Department of Civil Engineering, Rolla, MO 65401; **Award #80-26585; $15,709** for 16 months beginning 01/10/81.

Considerable research is devoted to geochemical earthquake engineering and soil dynamics throughout the world. An International Conference on Recent Advances in Earthquake Engineering and Soil Dynamics is being held in St. Louis, Missouri, April 26-May 2, 1981. The areas covered include recent advances in areas of dynamic stress-strain properties, liquefaction, earth pressure problems, dynamic soil-structure interaction, dynamic problems of off-shore geotechnology centrifuge testing, earth dams, stability of slopes during earthquakes, case histories and numerical methods in earthquake geotechnology.

25. Effects of Stress Waves in Dynamic Soil Tests Employing the Centrifuge Technique; Jean H. Prevost; Princeton University, Department of Civil Engineering, Princeton, NJ 08540; **Award #80-15987; $40,000** for 12 months beginning 01/15/81.

A centrifuge can simulate gravity-induced stresses in soils. This leads to a set of scaling relationships which test soil and soil-structure interacting systems. The objective of this research is to assess the feasibility of performing such experiments in a dynamic mode. In particular, the interference of inevitable wave reflections upon desired measurements, and the degree to which transmitted waves can be phys-

ically influenced by wall treatments are examined. Controlled dynamic shock loads are created and their consequences interpreted.

26. U.S.-Japan Cooperative Earthquake Research Program: Participation in Full-Scale Reinforced Concrete Building Tests; Dixon Rea; University of California-Los Angeles, Department of Mechanics and Structures, Los Angeles, CA 90024; **Award [illegible]; $17,415** for 12 months beginning 01/01/81.

This project provides salary and travel support to enable the Principal Investigator to participate as an on-site expert, in the testing of a seven-story full-scale reinforced concrete building. This testing is the central part of the joint U.S.-Japan Earthquake Research Program established between the NSF and the Ministry of Construction and Science and Technology Agency of Japan.

During the actual testing period commencing the Spring of 1981, the Principal Investigator stays at the test site to: (1) review the operation of the data aquisition system for the tests (2) evaluate the computer on-line test procedure, and (3) participate in the planning of the experimental procedures and the selection, calibration, and installation of the transducers for the tests.

27. Seismic Resistance of Buildings With Suspended Floors; Damoder P. Reddy; Agbabian Associates, 250 North Nash Street, El Segundo, CA 90245; **Award [illegible]; $124,350** for 24 month beginning 03/01/81.

The objective of the research is to attain a better understanding of the earthquake behavior of high-rise buildings with suspended floors, and to achieve an improved design method for this new building concept. This research project is divided into two major phases. The first phase is devoted to the selection and analysis of two types of buildings with suspended floors. A typical building type is selected based on preliminary analytical results, and is used to develop a structural model for testing in the second phase. In the second phase, a structural model is designed and fabricated. Testing is conducted in a laboratory to investigate the structural behavior due to seismic loadings. Correlation of analytical and experimental results is performed in the second phase. Based on the results of the experimental investigation and correlation study, the analytical models are modified to achieve a better representation of the actual structures. Various design parameters are evaluated and verified by using the upgraded analytical models to achieve an improved design method for this building concept.

28. Quantitative Studies of High Frequency Strong Ground Motion; Paul G. Richards; Columbia University, Lamont Doherty and Geological Observatory, Palisades, NY 10964; **Award [illegible]; $50,234** for 12 months beginning 03/15/81.

At present, there exist at least two different interpretations of peak and root-mean-square accelerations of earthquakes in terms of the relation of observed data to source properties of the causative earthquakes (by Hanks and McGuire 1980, and McGarr et al. 1980). This project studies high frequency strong ground motion (HFSGM) by comparing these methods of analysis and differences. The high frequency (2-10 Hz) strong ground motion (HFGSM) is studied by developing and constructing synthetic seismograms which take into account the complexity of the rupture process. Complex source functions in conjunction with a wave propagation technique are involved. The main goal of this work is to predict quantitatively the HFSGM at a given site due to an earthquake in its vicinity. Extensive use is made of observations regarding HFSGM to constrain the theoretical models.

29. A Model for Measuring Regional Economic Responses to Earthquakes and to Earthquake Predictions; R. B. Roberts; University of South Carolina at Columbia, College of Business Administration, Columbia, SC 29208; **Award [illegible]; $159,374** for 12 months beginning 01/15/81.

The major objectives of this study are to develop a general methodology for modeling the economic effects of catastrophic events and the consequences of warnings in a regional context, and to demonstrate that such a model can be used by policy makers to evaluate the costs and benefits of earthquake prediction and hazard mitigation alternatives.

The methodology concentrates on supply side factors—such as transportation, housing, and utility systems—that are likely to be affected by catastrophic change, and the alteration of these factors over time, both with and without warning. The analysis demonstrates how data for the likely forces to be expected in the case of an earthquake, the structures on the various sites in the region, and the expected damages can be incorporated into a regional model to assess economic effects. While the project simulates the consequences of the earthquake hazards in a specific region, the model that is developed can also serve as a prototype for models to analyze earthquakes and other disasters in other regions.

30. Feasibility of Force Pulse Generators for Earthquake Simulators; Frederick B. Safford; Agbabian Associates; 250 North Nash Street, El Segundo, CA 90245; **Award #77-15010 AO2; $49,501** for 06 months beginning 11/01/80.

This project is developing and fabricating servo-controlled gas pulsers that will produce a thrust to excite structures to motions similar to those they would experience in an earthquake. Pulsers are to be placed on existing structures in a prescribed array, and their pulse trains tailored in amplitude, number of pulse, and durations in order to reproduce a desired structural motion. Ultimately, the pulser devices are used to test various inplace or prototype structures to determine their earthquake response characteristics.

Preliminary studies have indicated that the gas pulsers can be servo-controlled to mitigate or eliminate structural motions that are induced by earthquakes. The primary difference between inducing an earthquake motion to a structure or restraining such motion lies in the manner in which the pulse trains are programmed. Essentially, the same equip-

ment is used to do either function. Inasmuch as the pulser equipment is located at Berkeley to demonstrate the capability to produce earthquake motions, an addition to this test procedure is to allow a demonstration of its anti-earthquake capabilities.

31. Earthquake Risk Analysis for Land Use Planning; Charles R. Savino; Rice Center, Rice University, Houston, TX 77019; **Award [illegible]; $160,462** for 18 months beginning 12/15/80.

Numerous techniques have been developed for estimating the magnitude of seismic hazards and for performing seismic risk assessments. Generally, these techniques allow seismic loadings to be calculated and allow relationships to be estimated between loadings and expected damages to structures of various types. Although considerable uncertainty still surrounds the technical exactitude of these techniques, a central problem for planners concerns applications. In the planning and policy-making arena, there is a need for more comprehensive and standardized approaches to seismic risk assessment.

This research investigates the problems of risk definition, problems of transferring risk information into the policy-making arena, and develops more comprehensive and standardized approaches to local risk assessment. The research includes a systematic review and evaluation of available seismic hazard and risk analysis techniques. A procedure is being developed which allows for the combination of the results of risk analyses into a more comprehensive framework. A basic component of this procedure is a microzonation scheme which allows display of the magnitude and spatial distribution of expected risk. Policy-making and regulatory applications for the procedure are also being investigated.

32. A Preliminary Evaluation of the Liquefaction and Cyclic Mobility Behavior of Fine Coal Refuse Tailings; Roger K. Seals; Louisiana State University-Baton Rouge, Department of Civil Engineering, Baton Rouge, LA 70803; **Award [illegible]; $40,000** for 15 months beginning 03/01/81.

The liquefaction and cyclic mobility behavior of fine tailings from coal preparation processes are being studied using laboratory cyclic and monotonically-loaded undrained triaxial compression tests. Principal variables being investigated include the composition and density of the tailings and the confining pressure. The results of this research will be utilized to develop a methodology for predicting the potential liquefaction and cyclic mobility behavior of fine coal refuse tailings under earthquake loads.

33. A Generalized and Global Study of Earthquake Damage and Insurance Risk; Haresh C. Shah; Stanford University, Department of Civil Engineering, Stanford, CA 94305; **Award [illegible]; $154,367** for 24 months beginning 01/15/81.

This project is to further research in seismic risk and to focus the study on loss estimates and applications in earthquake insurance. The principle objective of the study is to bridge the gap between the current knowledge in seismic risk analysis, insurance risk and damage estimation on one side, and the procedures for practical use by planners, decision and policy makers, insurance analysts and engineers on the other side.

The project consists of three research tasks: 1) development of loss assessment procedures; 2) development of algorithms for assessing risk for insurance and investment purposes; and 3) study of current status of earthquake insurance and development of improved procedures. Equal emphasis is placed on the engineering and societal/policy aspects of the research in this project.

34. Seismic Design Response Evaluation of Structural Systems With Nonproportional Damping Characteristics; M. P. Singh; Virginia Polytechnic Institute Department of Engineering Science and Mechanics, Blackburg, VA 24061; **Award [illegible]; $43,651** for 12 months beginning 03/01/81.

Structural systems consisting of elements with different energy dissipation characteristics generally have nonproportional damping matrices which cannot be diagonalized by undamped normal modes. As a result, the normal mode (and thus the response spectrum approach) cannot be used to obtain design responses of such structural systems for earthquake design inputs prescribed in the form of response spectra curves. Some simplifying assumptions can be made to permit use of a response spectrum approach; this may, however, introduce large errors in the calculated response for some structural systems.

The purpose of this investigation is the development of rational analytical methods in which nonproportional damping matrix can be used without any simplifying assumption. The developed methods will be accurate, analytically efficient, and similar to the conventional square-root-of-the-sum-of-the-squares (SSRS) procedures (which are used with proportionally damped systems) in which given seismic response spectra curves can be used directly. These methods are of direct use to the designers of many structural systems subjected to earthquake induced ground motions.

35. Strength Characteristics of Buried Jointed Pipelines; Avi C. Singhal; Arizona State University, Department of Civil Engineering, Tempe, AZ 85281; **Award [illegible]; $36,320** for 12 months beginning 04/01/81.

This research has two basic objectives. The first is the determination of the relative importance of various parameters (i.e., pipe diameter, size, shape and properties of the rubber gasket, and depth of burial) on the failure behavior of pipe joints. This is accomplished by analyzing the results of experiments performed at Arizona State University (A.S.U.). The outcome of this first task is the identification of the parameters which control the behavior of a pipeline joint.

The second objective is the formulation of analytical models to predict the force-deformation relations and failure criteria for pipeline joints under various types of external loads. Thus, the overall thrust of the research is to analyze the experimental

data obtained at A.S.U. and determine the failure, leakage and strength characteristics of pipeline joints. The present study provides the link between the analytical stiffness characteristics of the joint and those found through experiments.

36. Analysis of Optimal Base Isolation of Earthquake Effects in Structures; Iradj G. Tadjbakhsh; Rensselaer Polytechnic Institute, Department of Civil Engineering, Troy, NY 12181; **Award #80-07785; $121,600** for 24 months beginning 01/02/81.

The problem of isolating a structure from earthquake effects by base isolation depends upon the type of the structure, the properties of the supporting soil, and the characteristics of the earthquake. Each of these elements can influence the problem in a widely varying manner. Recent investigations have been directed toward the development of suitable bearing elements which have the desired properties of stiffness in the vertical and horizontal directions, as well as a measure of damping to dissipate the mechanical vibrational energy.

This project undertakes a quantitative analysis of the influence of the parameters of the base isolation system for optimal passive control of the response of structures. Isolation means significant reduction in the amount of force transmitted to the structure, control of residue displacements that the structure may suffer during the passage of ground shock, and provision of sufficient rigidity against minor tremors. In the initial phase, effort is being directed toward analysis of double-raft foundation systems which isolate industrial sites or complexes by means of distributed structural springs, dampers, and dynamic vibration absorbers.

37. Los Angeles Basin Strong Motion Accelerograph Network; Ta-Liang Teng; University of Southern California, Department of Geological Sciences, Los Angeles, CA 90007; **Award #80-11543; $58,157** for 12 months beginning 02/15/81.

To increase the strong motion data return from anticipated major earthquakes and existing high seismic activities, a project to install, in collaboration with the California State Strong Motion Instrumentation Program, about 100 accelerographs in a well-planned grid-shaped array in the Los Angeles basin has been completed. This array fills a serious gap in the existing strong-motion network in the Los Angeles metropolitan area. The data gathered by the array would enable numerous advanced studies of the distribution of strong shaking, the attenuation patterns, the shear velocity structure, and the surface soil characteristics around Los Angeles. The results would have applications for other large metropolitan areas which are located on sedimentary basins in earthquake-prone regions.

38. Response of nonlinear soils to seismic disturbances; E. Benjamin Wylie; University of Michigan, Department of Civil Engineering, Ann Arbor, MI 48109; **Award #80-17429; $130,391** for 24 months beginning 01/01/81.

The prediction of the nonlinear hysteretic behavior of soil during major seismic events is an essential feature in the design of earthquake-resistant structures. One of the objectives in this research focuses on the development of a numerical model that exposes the unique response characteristics of nonlinear hysteretic behavior of one-dimensional layered soils. The method of characteristics is the basis for the numerical method. Additionally, the method of characteristics is used to study the dynamic behavior of soils in two spatial dimensions. This procedure is being developed and validated utilizing linear materials, followed by applications to nonlinear layered soils. Both procedures, when complete and made available to the public should enhance the analysis and design capabilities of practicing engineers.

HUMAN NUTRITION

An increasing percentage of the American Diet comes from refined and processed foods. Concern is growing about the nutritional value of such foods and about the effects of long-term consumption of processed foods on human health and performance. The major objective of the Human Nutrition program is to evaluate nutritional changes brought about by processing, including refining, cooking, packaging, storage and the use of additives, supplements and substitutes.

No awards were made by the Human Nutrition program in the second quarter, Fiscal Year 1981.

SCIENCE AND TECHNOLOGY TO AID THE HANDICAPPED

The Science and Technology to Aid the Handicapped program supports fundamental scientific research which may lead to products, treatment methods, or societal and environmental changes of significant benefit to the handicapped. (As defined for purposes of this program, handicapped persons are those who have a physical or mental impairment which substantially limits their vocational, educational or social activity.) Awards are made on the basis of scientific and technical merit and the probability that the research will be successful in helping to meet high-priority needs of the handicapped.

1. Application of Personal Computing to Assist the Handicapped; Paul L. Hazan; Johns Hopkins University, Department of Applied Physics, Baltimore, Md. 21218; **Award 80-17898 A01; $14,200** for 00 months beginning 03/01/81.

The availability and relatively low cost of personal computers make them attractive as potential aids to handicapped persons. This project will harness the creative imagination of hundreds of personal computer users to identify applications of personal computers to assist the handicapped. It will also indicate the feasibility and cost-effectiveness of using national competitions to develop innovative and imaginative solutions to real problems.

2. Integrated Electro-Mechanical Transducer Systems; John G. Linville; Stanford University, Department of Electrical Engineering, Stanford, CA 94305; **Award #78-22167 A02; $56,000** for 12 months beginning 02/01/81.

The electrical properties of polyvinylidene fluoride sheets are being examined and used to develop models that characterize devices fabricated with this polymer. Primary device interest is centered on tactile sensors that consist of arrays of vibrating plates. Novel methods for using the polymer to stimulate the plates or to serve as the plates themselves are being studied. One objective of the program is to develop a planar technology approach to the design of the electro-mechanical transducers. The program is also concerned with the design of integrated driver circuits for the transducers.

3. Analysis and Design of Implants for a Fractured Femur; Victor I. Weingarten; University of Southern California, Department of Civil Engineering, Los Angeles, CA 90007; **Award [illegible]; $79,079** for 12 months beginning 04/01/81.

Clinical management of femoral fractures has been generally based on an empirical approach. There exists a need to develop a rational basis for fracture healing improvements which will eliminate abnormal stress distributions in the healing fracture area that cause either disuse atrophy with osteoporosis and bone resorption or overload hypertrophy.

Research investigators in the Department of Civil Engineering and the School of Medicine at the University of Southern California are collaborating on a project to develop and experimentally verify a mathematical model of stress distributions in the upper part of the human femur. This model will be employed to study the design and effect of internal fixation devices used to fix the fracture elements and promote healing.

A mathematical model using a nonlinear finite element computer program is being developed to consider the effects of substructuring, contact elements, healing phenomena, as well as new nonlinear material law models. The initial study models both the intact human femur and intertrochanteric fractures stabilized by condylocephalic nails. For validation and refinement of the analytical model, the Universal Scientific Computerized Test System simulator is being employed to load cadaveric femurs with and without implants. Multiple-channel strain gage data from sensors located in the specimen are used to describe the behavior of both the femur and the fixation devices. The stress-strain behavior of the composite system can then be used to refine and develop a practical computer model for analysis of fracture healing.