Recent Awards: April-June 1980

NATIONAL SCIENCE FOUNDATION
Division of Problem-Focused Research
Directorate for Engineering and Applied Science
Washington, D.C. 20550

INTRODUCTION

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

This brochure describes awards made by PFR primarily during the period April 1 throught June 30, 1980 (third quarter, Fiscal Year 1980). Awards made before April 1, 1980 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.

CHARLES BABCOCK APPOINTED SECTION HEAD, EHM

The Division of Problem-Focused Research announces the appointment of Dr. Charles Babcock as Section Head of the Earthquake Hazards Mitigation (EHM) Program.

Dr. Babcock comes to NSF from the California Institute of Technology, where he had been Professor of Aeronautics, with emphasis on structural mechanics and structural dynamics. Dr. Babcock is located in Room 1136C and can be reached at (202) 357-9502.

HOW TO OBTAIN RESEARCH REPORTS

One of the most important objectives of PFR is the timely and widespread dissemination of the results 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.

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 exenditures 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).

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 progrm is directed toward alleviating national dependence on selected scarce resources by making alternative biological sources of materials available in the United States. Three topics have been selected for investigation in Fiscal Year 1980: Biological conversion of lignocellulosic materials to useful chemicals; production of speciality chemicals from arid land plants; and biosaline resources.

1. Lipids From Microalgae; Sheldon Aaronson; CUNY-Queens College, Department of Biology, Flushing, NY 11367; **Award #79-19669;** $115,033 for 24 months beginning March 15, 1980

   Microalgae produce useful products including vitamins, amino acids, flavoring agents, hydrocarbons and lipids widely used in the manufacture of surfactants, cosmetics, and foods. The lipid content of microalgae varies by strain, but in green algae ranges from 20 to 55 percent. Microalgae represent a largely unexplored source of industrial fats and oils.

   The objective of this project is to optimize the growth of the green microalgae *Botryococcus braunii* in pure and mixed cultures, and to maximize production of lipids. The lipid content of this algae is unusually high (53 percent). Specifically, this research involves optimizing culture conditions such a light intensity, temperature, salinity and nitrogen content. Simplified harvesting techniques, based on physical characteristics of the algae, are being investigated on a laboratory scale.

2. The Regulation of Rubber Formation in Guayule *Parthenium argentatum* Plants; Chauncey R. Benedict; Texas A&M University, Department of Plant Sciences, College Station, TX 77843; **Award #79-04650;** $14,805 for 12 months beginning September 1, 1980

   The objective of this project is to identify the metabolic block which inhibits the synthesis of rubber in non-stressed guayule plants. Electron microscopy studies have identified palisade cells as the site of rubber formation in the guayule leaf, and photosynthetic experiments have elucidated the early steps in the pathway of rubber synthesis. These studies are being continued to elucidate the pathway and the mechanism of regulation of rubber synthesis in stressed plants.

3. Bacterial Transformations of Lignin; Ronald L. Crawford; University of Minnesota, College of Biological Sciences, Minneapolis, MN 55455; **Award #79-06772 A01;** $50,202 for 12 months beginning August 1, 1980

   Lignin and cellulose are the two most abundant naturally occurring organic materials on earth and potentially represent important industrial raw materials. Due to increased utilization of these resources, lignocellulosic materials are also becoming a major waste disposal problem. The objective of this project is to assess the effectiveness of bacteria for converting lignin in agricultural- and forest-derived lignocellulosic materials to useful products. Specific objectives are to modify genetically lignin-degrading bacteria to produce catabolically blocked mutants, use the blocked mutants to map the catabolic pathways, and produce novel lignin-containing compounds.

4. *Crambe* Species as an Alternate Biological Source of Oil and Protein for Arid Lands; James L. Fowler, New Mexico State University, Department of Agronomy, Las Cruces, NM 88003; **Award #79-19931**, $99,472 for 24 months beginning May 15, 1980

   Crambe species are found in arid regions of the Near East, North Africa, West Asia and Central Asia. *C. abyssinica* has been grown in the wheat and corn belts of the United States. *Crambe* oil is a useful chemical intermediate for plasticizers, lubricants, and synthetic fibers.

   The objective of this award is to evaluate *Crambe* as a source of oil and protein for adaptation to arid land agriculture. Screening procedures for evaluating the potential of *Crambe* are being developed. The *Crambe* germplasm pool is being screened for adaptability to water deficits, heat, and salinity.

5. Chemical Stimulation and Breeding Improvement of Rubber Yield in Guayule; George Hanson; California Arboretum Foundation, 301 North Baldwin Avenue, Arcadia, CA 91006; **Award #80-09543**; $161,226 for 9 months beginning April 15, 1980

   This award provides suplemental funding for guayule research previously supported by NSF, until the Joint Guayule Commission (established under PL95-592) assumes responsibility for support of this area of research.

   In the interim, research on hybridization, selection and horticultural studies continues. The emphasis is to develop plants with improved rubber content, frost tolerance, disease resistance, ability to establish seedlings in the field, and responsiveness to yield stimulation by bioregulators. Bioregulator research is being extended to include pre-treatment of seeds and treatment of young seedlings and tissue cultures.

6. Enhancement of Biological Nitrogen Fixation by Genetic Manipulation of *Rhizobium*; Donald R. Helinski; University of California, San Diego, Department of Biology, La Jolla, CA 92093; **Award #77-25945 A02**; $107,609 for 12 months beginning June 1, 1980

   The objective of this project is to enhance the nitrogen-fixing ability of the bacterium *Rhizobium meliloti*, which forms a symbiotic relationship with alfalfa by genetic manipulation. During the first two years of this project, an effective cloning vector for *R. meliloti* was developed and a gene bank representing the total DNA of *R. meliloti* constructed in *E. coli.* In this third year, the research emphasizes the cloning of *R. meliloti nif* genes, the construction of *R. meliloti* strains with increased gene dosage, and the testing of the symbiotic efficiency of such cultures with alfalfa under greenhouse conditions.

7. Gordon Research Conferences: Chemicals and Materials from Renewable Resources; T.K. Kirk; Gordon Research Conferences, Pastore Chemical Laboratory, Lower College Road, Kingston, RI 02881; **Award #79-25003**; $2,380 for 6 months beginning May 15, 1980

   This award provided support for the Gordon Research Conference on Chemicals and Materials

from Renewable Resources held June 30 to July 4, 1980. The Conference provided a forum for scientists and engineers interested in or actively working to find improved ways to use biomass as a raw material or as a substitute for chemicals, fuels and materials presently derived from fossil resources. Major research areas discussed included improved and selective biomass production (biosynthetic pathways, genetics and bioengineering); degradation or extraction mechanisms for selective production of chemicals or materials from biomass (pulping, hydrolysis, pyrolysis); and relationships between the fundamental properties of biomass and its potential for utilization in various products.

8. Biological and Synthetic Systems for Protection of Hydrogen from Water; Alvin I. Krasna; Columbia University, Department of Biochemistry, New York, NY 10023; **Award #79-27221**; $115,086 for 12 months beginning June 1, 1980

   The objective of the research is the production of hydrogen from water or organic compounds using the energy of sunlight to drive the reaction. Two systems are being investigated. The first consists of hydrogenase-containing algae shown to catalyze biophotolysis of water to hydrogen and oxygen. The second consists of a completely synthetic system which has been shown to catalyze photoproduction of hydrogen from a variety of organic compounds.

   A major problem in biophotolysis of water is the inhibitory effect of oxygen on hydrogen production and the long-term stability of biological systems. Instead of using oxidizable substrates for removal of oxygen, methods will be investigated for reversible absorption and desorption of oxygen by oxygen-carrying proteins, synthetic heme analogues, transition metal complexes and perfluoro compounds. This permits continuous sustained production of hydrogen and oxygen. To permit long-term use of algae, immobilization of cells by a variety of methods is used. The modification of the synthetic system so that water serves as the electron donor for hydrogen formation is scheduled. This involves use of other photocatalysts or coupling the synthetic system to a second system which regenerates the organic donor so that it acts catalytically.

9. New Polymers Based on Vegetable Oils; John A. Manson; Lehigh University, Materials Research Center, Bethlehem, PA 18015, **Award #78-27336 A01**; $66,275 for 12 months beginning May 15, 1980

   The objectives of this project are to: (1) evaluate selected natural oils in terms of versatility for chemical reactions, present and potential availability, and cost (Oils being considered include drying oils such as tung, linseed and soybean, as well as oils from cultivars such as *Limnanthes* and *Lesquerella*. Emphasis is placed on oils that are primarily of industrial rather than nutritional interest); (2) synthesize new rubber-like products from the natural oils selected, and characterize their physical and chemical properties; (3) combine these natural oils with glassy and brittle polymers, such as polystyrene, to form interpenetrating polymer networks and characterize the final products; and (4) evaluate the cost-effectiveness of these new materials.

10. Development of Red Squill as a Rodenticide; Anthony J. Verbiscar; Anver Bioscience Design, Inc., 160 E. Montecito Avenue, Sierra Madre, CA 91024 **Award #79-23514**; $102,000 for 12 months beginning May 1, 1980

    Red squill, *Urginea maritima*, is a bulbous plant that grows well in climates such as prevail in many areas of the Southwest. The bulb contains steroidal glycosides that are cardiotonic, emetic, and highly toxic. The inability of rats to vomit makes red squill a selective rodenticide.

    The objective of this award is to develop red squill as a crop for the southwestern United States. Analytical procedures such as high performance liquid chromatography are being devised, validated against rat assays, and employed to select productive plants with high toxicant content. Selections will be propagated by conventional or tissue culture methodology and tested in the field. The major steroidal glycosides are being isolated, identified, and their toxicity evaluated. Processes are being developed to prepare red squill powders, extracts or concentrates suitable for incorporation in practical rat poison formulations.

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 loadings; to develop an understanding of materials and structural components subjected to damaging dynamic loads; to develop procedures for analysis and design of non-structural and architectural systems for earthquake effects; and to study the influences of architecture and urban planning activities on the earthquake vulnerability of regions.

1. Research Initiation—Scale Modeling of the Seismic Resistance of Reinforced Concrete Components;

Daniel P. Abrams; University of Colorado at Boulder, Department of Civil Engineering and Architectural Engineering, Boulder, CO 80309; **Award #80-07094**; $39,998 for 15 months beginning May 15, 1980

This research investigates correlations in resistance mechanisms for large- and small-scale reinforced concrete structural components. By comparing the response of small scale beam-column assemblies with large scale assemblies, the merits of using small scale models can be assessed.

The work includes: (1) development of reliable test systems for subjecting both large- and small-scale specimens to loading reversals; (2) testing pilot specimens to provide sufficient data to initiate analytical and comparative studies; and, (3) analyses of the load-deflection relationships of the specimens to validate the use of physical models at small scales, or to recommend revisions in small-scale construction so that proper simulation is attained.

2. Research Initiation—Generation of Earthquake Design Spectrum Consistent Time History; Gilbert Aguirre-Ramirez; University of Louisville, Department of Applied Mathematics and Computer Science, Louisville, KY 40208; **Award #80-06349**; $39,999 for 15 months beginning May 15, 1980

   This research develops an algorithm for the construction of design spectrum-compatible motions that can be used to perform seismic analyses of structures by step-by-step integration. A computer program based on the algorithm developed is being written. The algorithm starts with an initial estimated notion for a target design spectrum. A correction to this initial motion is generated to obtain a new estimate. The process is repeated until a formulated criterion is satisfied. A typical structure will be analyzed using conventional techniques, and then analyzed using the spectrum compatible motion developed for this design spectrum.

3. A New Approach to the Prediction of Earthquake Strong Motion; Keiiti Aki; Massachusetts Institute of Technology, Department of Earth and Planetary Science, Cambridge, MA 02139; **Award #80-05720**; $238,360 for 24 months beginning July 1, 1980

   The objective of this project is to predict earthquake motion at a given site based on the laws of physics. Strong motion data and geologic data are synthesized to develop a "Barrier Model" for such prediction.

   The research focuses on: (1) study of the Coyote Lake earthquake of August 6, 1979 for deterministic verification of the Barrier Model; (2) study of long-period strong motion in epicentral regions; (3) statistical characterization of barriers; (4) theoretical study of scattering and attenuation of high-frequency seismic waves; and (5) measurements of attenuation of high-frequency waves in New England. Engineering applications of the research are emphasized.

4. Safety Evaluation of Structures to Earthquake Hazards; A.H-S Ang; University of Illinois-Urbana, Department of Civil Engineering, Urbana, IL 61801; **Award #80-02584**; $152,845 for 12 months beginning June 1, 1980

   This study develops a methodology for evaluating the lifetime safety of structures against the forces of earthquakes and other hazards. Specific tasks include: (1) developments and refinements of the random vibration method for testing non-linear-hysteretic structures; (2) modeling of structural systems and formulation of failure criteria; (3) determination of extreme seismic load and extreme combined loads; (4) safety evaluation of specific structures in terms of lifetime failure probabilities; and (5) formulation of probabilistic bases for hazard-resistant designs, with emphasis on criteria for earthquake resistance.

5. Reliability of Structures Retaining Soil Under Earthquake Loading; Dimitrios Athanasiou-Grivas; Rensselaer Polytechnic Institute, Department of Civil Engineering, Troy, NY 12181; **Award #80-02584**; $116,210 for 24 months beginning February 1, 1980

   This study assesses the reliability of earth retaining structures subjected to seismic loads. The seismic load on a retaining structure is expressed with two parameters: the peak ground acceleration and the duration of the event. The use of the root-mean-square of the acceleration peaks is explored as an alternative to peak acceleration.

   The total force on earth-retaining structures during an earthquake is determined by a quasi-static stability analysis. Experimental studies under dynamic loading have indicated that the shape of the pressure distribution along a wall is a parabolic rather than the customarily assumed linear vibration. In accord with the experimental findings, this study expresses the distribution of lateral pressures along a structure with the aid of the "method of redistribution of pressure" (Dubrova's method). This research is conducted as a joint effort with Professor Milton E. Harr at Purdue University.

6. Underground Lifelines in a Seismic Environment—Phase II; Melvin L. Baron; Weidlinger Associates, 110 East 59th Street, New York, NY 10022; **Award #78-15049 A02**; $428,428 for 12 months beginning May 1, 1980

   This is a continuing small-business research project on the analysis and design of water distribution and transmission systems to resist earthquake effects. The study develops rational and practical design procedures which can be used by utilities, government agencies, and manufacturers. Such procedures involve various aspects of current technology, such as earthquake data, pipe damage statistics, analysis and design procedures, joint types and pipe materials.

   The research concentrates on underground water distribution lifelines. Specific research tasks include studies of: (1) incoherent seismic motions; (2) pipeline failure/damage criteria; (3) pipe-soil interaction; (4) experimental test planning; (5) design decision

analysis; and, (6) design guidelines. Results are to be made available to the practicing design engineer in the form of a practical design methodology including design curves, tables, and formulas.

7. Research Initiation—Evaluation of Earthquake Hazard in Existing Buildings; Thomas E. Blejwas; Oklahoma State University, Department of Mechanical and Aerospace Engineering, Stillwater, OK 74074; **Award #80-07096**, $40,000 for 15 months beginning May 15, 1980

   The objective of this study is to develop a simple but reliable method of evaluating the potential hazard of existing buildings from ground motions. A simplified evaluation method is needed to establish priorities for rehabilitation, demolition, or detailed evaluation. Considerable attention is directed toward developing and verifying economical procedures for predicting the response of low- to medium-rise buildings and for incorporating response procedures into a hazard assessment.

   The utilization of quasi-static response analyses in conjunction with inelastic response spectra will be investigated. Verification by comparison with more elaborate analytical methods will be attempted. Damageability indices will be used as a measure of the level of potential hazard. Research will be conducted to determine the types of demand parameters required for implementation of simple but realistic damage models. The incorporation of response and damageability procedures should result in an economical method for quick evaluation of hazard potential.

8. Evaluation of Computer Modeling Formulation and Advanced Analytical Procedures for Earthquake Response of Multistory Buildings; Jack G. Bouwkamp; J.G. Bouwkamp, Incorporated, 1930 Shattuck Avenue, Berkeley, CA 94704; **Award #79-26734**; $278,206 for 24 months beginning June 15, 1980

   The data base of experimental findings from several forced-vibration studies and corresponding correlative analyses offers an opportunity to evaluate current analytical techniques and modeling procedures for a wide selection of different building systems. This will permit an evaluation of effects of both structural and non-structural components on the dynamic characteristics of such systems.

   This research develops a guide for computer modeling procedures of such components. The use of such procedures in both simplified and complex computer models is being evaluated and guidelines for the use of such procedures to predict the dynamic response under earthquake ground motions are prepared for use in design processes.

9. Research Initiation—Earthquake Forces on Buildings: A Workbook-Primer for Architects; John L. Briscoe; University of Oregon—Eugene, Department of Architecture, Eugene, OR 97403; **Award #80-07120**; $40,000 for 15 months beginning May 15, 1980

   This project uses existing research findings to develop a workbook primer on lateral loadings for practicing architects and architectural students. It will help to develop an understanding of how structural systems for various building configurations resist lateral loads and will relate these directly to architectural design. The workbook bridges the gap in existing material between a general discussion of earthquakes and detailed structural engineering analysis. The content and format of the workbook is appropriate for classroom use, self-study, and continuing education.

10. Liquefaction Induced by Cyclic Loads; Gonzalo Castro; Geotechnical Engineers, Incorporated, 1017 Main Street, Winchester, MA 01890; **Award #79-24731**; $89,891 for 15 months beginning April 15, 1980

    Liquefaction of saturated sands during earthquakes has caused numerous failures of building foundations, embankments, and natural slopes. Perhaps the best known examples are those of foundation failures in the Chilean earthquakes of 1960; in Niigata, Japan in 1964; slopes failures in Alaska in 1964; and, the lower Van Norman dam failure in San Fernando in 1971.

    This research consists of a laboratory investigation to determine the influence of stress and soil parameters (confining pressure, static shear stress, seismic history and density of the sand) on the susceptibility of saturated sands to liquefaction. Included are triaxial tests on two sands, a subrounded uniform sand and an angular uniform sand, that are typical of mine tailings. Steady state lines for the two sands are determined by monotonic undrained tests. Parametric studies include density of the sand, consolidation stress ratio, consolidation effective normal octahedral stress, and cyclic octahedral shear stress.

11. Seismic Behavior of Structural Systems: Analysis and Design of Structures; Anil K. Chopra; University of California—Berkeley, Earthquake Engineering Research Center, Berkeley, CA 94720; **Award #79-08261**; $259,927 for 12 months beginning June 1, 1980

    Considerable analytical research is needed to achieve a better understanding of seismic performance and modes of failure of structures, to increase the reliability of controlling seismic damage, and to develop methods of design based on correlative analytical and experimental studies. These analytical and design capabilities should be applied to ensure a proper balance between total cost and safety of structures constructed in a seismic environment.

    This project conducts comprehensive research to establish improved analytical and design capabilities for seismic engineering. Emphasis is on six complementary and interrelated sub-projects: (1) Analytical Study of Building Response, (2) Soil-Structure Interaction Effects in Building Response, (3) Dynamics of Rigid Blocks and Foundation Tipping, (4) Development of Nonlinear Structural Analysis Techniques, (5)

Probabilistic Studies of Seismic Response, and (6) Analytical Methods for Design.

12. Seismic Behavior of Complete Structural Systems; Ray W. Clough; University of California-Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #79-08257 A01**; $357,553 for 12 months beginning May 1, 1980

    The objectives of this project are to develop techniques to test selected types of structural systems to improve understanding of their seismic performance and to evaluate the analysis capabilities of computer programs using the test data. The earthquake simulator facility at the University of California, Berkeley, is used.

    Six subprograms will be integrated into a single research effort, which provides for maximum interaction among researchers and also improves overall productivity. These subprograms are: (a) Earthquake Simulator Studies—to perform dynamic tests of steel and concrete structures; (b) System Identification—to develop methods of evaluating mathematical properties; (c) Computer Program Development—to evaluate the dynamic response of the mathematical model; (d) Energy Absorption Devices—to develop and test special structural components for improving the seismic resistance of structural systems; (e) Field Measurements—to measure the dynamic properties of actual buildings and structures; and (f) Post-Earthquake Damage Studies—to conduct reconnaissance surveys and detailed engineering analysis of earthquake damaged structures.

13. Vibration Testing of An Epoxy-Repaired Four-Story Concrete Structure; Philip Coyle; Department of Energy; Nevada Operations Office, P.O. Box 14100, Las Vegas, NV 89114; **Award #78-12714 A01**; $173,041 for 12 months beginning April 1, 1980

    Epoxy-injection techniques have been used extensively to repair buildings, bridges and other types of reinforced concrete structures damaged by earthquakes in Alaska and California. Experiments have indicated that the epoxy-injection method is quite effective in the repair of laboratory test specimens for strength, but specimens exhibited a loss of stiffness when subjected to dynamic tests on the earthquake simulator.

    This project assesses the effectiveness of the epoxy-injection method to repair damaged reinforced concrete structures. The specific data are developed by vibrating an epoxy-repaired four story structure which was previously tested to ultimate strength.

14. Search and Rescue Missions in Natural Disasters and Remote Settings; Thomas E. Drabek; University of Denver, Department of Sociology, Denver, CO 80208; **Award #77-14162 A02**; $14,632 for 12 months beginning June 15, 1980

    The Mt. St. Helens eruption led to search and rescue activities to locate the dead and injured and remove citizens to safety. This research project attempts to determine the nature of the search and rescue activities, the problems encountered, and their implications for developing policy and plans for such missions in future disasters, including those caused by earthquakes, floods, and other agents.

15. Passive Control of the Dynamic Response of Structures; Dario A. Gasparini; Case Western Reserve University, Department of Civil Engineering, Cleveland, OH 44106; **Award #79-21772**; $61,776 for 18 months beginning June 1, 1980

    The primary objective of this research is to examine the feasibility of using vertically constrained viscoelastic layers or viscoelastic infill panels to increase the damping of structures and hence reduce their dynamic response to wind and seismic excitation.

    Damping is inferred from system responses to harmonic lateral loads. An existing finite element computer program is used to compute such responses for general viscoelastic materials. The technique of weighing components' damping contributions by their strain energy and summing contributions to obtain system damping is evaluated by comparing predictions with the steady-state response method. The variation in the effectiveness of the concepts with the type of lateral load distribution and building properties are quantified. If the concepts are promising, design criteria for the viscoelastic materials will be defined and actual appropriate materials will be identified.

    Two additional objectives are posed for the research. One is to examine the feasibility of using constrained viscoelastic layers between closely spaced buildings. The other is to study the use of vertical frictional interfaces, designed to slip only in seismic conditions, for reducing dynamic response.

16. Research Initiation—Data-Oriented Study of Strong Motion; Robert J. Geller; Stanford University, Department of Geophysics, Stanford, CA 94305; **Award #80-06471**; $39,990 for 15 months beginning July 1, 1980

    The goal of this research is to advance the state-of-the-art of understanding and predicting strong motion. Probablistic methods are used to quantify the ground motion which might be generated by an unknown earthquake in a broad general region. This research should provide the capability to generate an ensemble of data-based time histories for a given event. Statistical studies are performed to test various hypotheses on strong ground motion characterization.

    Strong motion records are used as the input to a probabilistic model. The feasibility of this concept is demonstrated by using strong motion records of aftershocks of the 1971 San Fernando earthquake recorded at Pacoima Dam to produce an ensemble of synthetic accelerograms which are qualitatively similar to the main shock records. Deterministic seismological technique are being pursued which allow the generation of realistic Green's functions, which include the effects of source complexity and geological structure.

This permits extension to regions for which no strong motion records are available.

17. Parameter Identification Methods for Structures Subjected to Earthquake Loadings; Will M. Gersch; University of Hawaii—Manoa, Department of Information and Computer Sciences, Honolulu, HI 96822; **Award #79-16262**; $96,526 for 24 months beginning February 1, 1980

    This research focuses on a theoretical and computational investigation of several research problems in seismically excited structures. Two particular problems and one general area of inquiry are investigated. One problem is the identification of the natural frequency and damping of linear building structure parameters from random excitation. The second problem is the identification of the mode shapes and lumped mass-spring-damping structure of tall buildings from the simultaneous recording of ambient vibrations from several different stories. In a third activity, a systematization of the fitting of parametric nonstationary and nonlinear discrete time models to regularly sampled vibration data is developed. In this third area of investigation, the inevitable model mis-specification and sampling variability errors in the fitting of models to data are distinguished and studied.

18. Second Specialty Conference on Seismic and Dynamic Response of Structures, January 14-16, 1981, Atlanta, Georgia; Barry J. Goodno; Georgia Institute of Technology, Department of Civil Engineering, Atlanta, GA 30332; **Award #79-24995**; $13,200 for 12 months beginning June 1, 1980

    The objective of this Conference is to foster continued dialogue between researchers, practitioners, analysts, and experimentalists concerned with behavior of structural systems acted upon by dynamic forces. The theme of the meeting is the use of experimentation, observation, prediction, and control approaches in the study and modification of dynamic response characteristics of structures. A complete set of proceedings for the Conference will be printed and distributed through the American Society of Civil Engineers.

19. Research Initiation—Probabilistic Evaluation of Damage Potential in Earthquake-Induced Liquefaction in a 3-D Soil Deposit; Achintya Haldar; Georgia Institute of Technology, Department of Civil Engineering, Atlanta, GA 30332; **Award #80-06348**; $39,967 for 15 months beginning May 15, 1980

    The research objective is to develop a simple but efficient and practical probabilistic model to determine the damage associated with earthquake-induced liquefaction. To have noticeable damage at a referenced location, a minimum volume of sand needs to undergo a considerable amount of strain due to liquefaction. Attempts are made to identify this minimum volume. The nonhomogeneity in soil properties affecting liquefaction in that soil volume are modeled probabilistically in three dimensions. This study also helps to identify the minimum amount of soil exploration required to model soil properties probabilistically in three dimensions for the liquefaction. Effects of some important factors on liquefaction, such as preparation of test specimens, size of specimens, sample disturbances, effect of system compliance, soil fabric, age of deposit, overconsolidation, and multidirectional shaking are considered.

20. Earthquake Engineering Design Investigations; William J. Hall; University of Illinois-Urbana, Department of Civil Engineering, Urbana, IL 61801; **Award #80-02582**; $168,020 for 12 months beginning May 1, 1980

    The objective of this research is to develop simplified methods of analysis and design for the excitation forces arising from an earthquake. This includes consideration of ground motions and resulting soil-structure interaction. The nonlinear behavior of materials and structural systems, and the damping characteristics of the total structure are studied.

    In-depth research is performed on such topics as: soil-structure interaction; wall and floor interaction with the structural system; ductility of the building; considerations of the multi-degrees of freedom of a building; and, the seismic behavior of buildings one to five stories in height. The improved design concepts are developed in the form of design criteria and techniques suitable for use by designers, practitioners, building officials, and government agencies.

21. Estimating the Cost of Community Ash Cleanup; William Hallagan; Washington State University, Department of Economics, Pullman, WA 99163; **Award #80-20875**; $8,156 for 3 months beginning June 15, 1980

    This study is gathering data on the costs of ash cleanup folowing the eruption of Mt. St. Helens in a sample of affected communities. With these data, cost functions are being estimated to determine the effects of ash precipitation levels, capital and labor inputs, speed of cleanup, and a vector of community attributes on the costs of cleanup per street-mile. The research addresses such questions as: How does the level of ash precipitation affect cleanup costs? Do small communities incur higher costs per street-mile than large communities? How much does the speed of cleanup affect the costs?

22. A Cooperative Research Program in Earthquake Engineering on the Repair and Retrofit of Structures; Robert D. Hanson; University of Michigan, Department of Civil Engineering, Ann Arbor, MI 48109; **Award #78-16730 A01**; $48,562 for 12 months beginning May 1, 1980

    This project initiates a new international cooperative effort to exchange the results of earthquake engineering research on the repair and retrofit of existing buildings. This Cooperative Program serves as the focal point for the U.S.-Japan Panel on Wind and Seismic Effects.

Activities include coordination of research efforts, establishment of priorities for specific projects, and the promotion of the exchange of information between the two countries through periodic meetings, workshops, conferences and publications.

23. Strong Motion Seismology; Donald V. Helmberger; California Institute of Technology, Department of Geophysics, Pasadena, CA 91104; **Award #79-21769**; $209,393 for 24 months beginning April 1, 1980

This project addresses basic strong motion seismology problems associated with wave propagation and emphasizes the study of faulting and its relationship to induced surface motions. Four specific research items are carried out: (1) study of faulting parameters by waveform inversion methods using near field and/or teleseismic earthquake data; (2) study of the rupturing process and estimation of local ground motion at high frequency; (3) simulation of main event motions using aftershock and small earthquake data; and (4) study of peak acceleration amplitude and the effects of faulting geometry and geological focusing.

Both distant (teleseismic) seismograms and synthetic ground displacement records at near fields are used. The study contributes to the understanding of earthquake source mechanism and effects of faulting and local geology on surface motion, and improves the accuracy of estimating design earthquake loads for engineering structures.

24. Develop Improved Techniques for the Simulation of Earthquake-like Ground Motions with High Explosives; Cornelius J. Higgins; Higgins, Auld & Associates, 2601 Wyoming Boulevard, N.E., Suite H-1, Albuquerque, NM 87112; **Award #79-23500**; $78,919 for 18 months beginning March 15, 1980

Previous studies have shown the potential of using explosives to simulate earthquake ground motions. Because of a lack of data on the response of structures to earthquakes, the ability to simulate earthquake behavior for prototype structures becomes important. This research involves analytical studies (1) to synthesize the recent experimental data acquired by several organizations in simulation tests; (2) to extrapolate the results to a wider range of geologies; (3) to examine techniques to reduce accelerations while maintaining high levels of velocity and displacement; and (4) to determine the most important characteristics of ground motion that must be simulated for specific types of structures.

25. Seismic Response of Structures and Strong-Motion Instrumentation; George W. Housner; California Institute of Technology, Department of Engineering and Applied Science, Pasadena, CA 91104; **Award #77-23687 A02**; $560,324 for 14 months beginning April 1, 1980

This multiyear program of research includes the analysis of recorded earthquake motions of structures; dynamic testing of structures; the analysis of vibrations in the digital accelerograph network; operation and upgrading of existing strong-motion instrument networks of the program; and analysis of earthquake data to improve seismic design criteria. The results of the research have practical application to the safe and economical design of structures to resist earthquakes.

26. Research Initiation—Response of Eccentrically Braced Tall Buildings to Earthquakes; P. Jayachandran; Worcester Polytechnic Institute, Department of Civil Engineering, Worcester, MA 01609; **Award #80-06425**; $39,848 for 15 months beginning May 15, 1980

Recent designs of earthquake-resistant tall steel buildings utilize ductile moment-resisting frames in combination with eccentrically connected bracing elements with floor brace-girders. Such eccentrically braced frames are efficient because they utilize the ductility and the energy-absorbing capacity of the moment-resisting frames to resist ground shaking and the relatively high stiffness of the braced frames to help minimize drift and sway resulting from wind storms or earthquakes. The dynamic response of such eccentrically braced tall steel buildings in the elastic and inelastic range is being studied in this research project.

Dynamic response analyses of 10-story, and 40-story tall buildings is being performed to examine the seismic behavior of eccentric, split K, and diagonal bracing elements. Based on a study of the load-deformation characteristics of the structural elements, column-girder connections, and brace-girder connections, recommendations are made for the design of connections and a methodology of design for tall buildings as a whole. Results of this research will improve the understand the earthquake behavior of tall steel buildings with braced frames.

27. Adaptive Response to Transportation Service Interruption by Volcanic Fallout; Jack D. Kartez; Washington State University, Environmental Research Center, Pullman, WA 99163; **Award #80-20876**; $5,756 for 3 months beginning June 15, 1980

Cities and counties in Eastern Washington and Northern Idaho have taken extraordinary actions to maintain essential public services during and after the eruption of Mt. St. Helens. This project is gathering data on the types of adaptive strategies local governments have used to maintain transportation. Contacts with planners, managers, and key officials in ten cities and ten counties are being used to document the spatial and technical details of adaptive circulation plans; the problems encountered in the coordination of local units and the acquisition of manpower and equipment; and opinions on how future planning measures can be incorporated into conventional ongoing planning.

28. Statistical Investigation of Engineering Seismology; Leon Knopoff; University of California—Los Angeles, Institute of Geophysics, Los Angeles, CA 90024;

Award #80-08588; $100,077 for 12 months beginning July 1, 1980

This project continues research into the statistical and stochastic character of earthquake sequences and seismic risk. The research (1) Investigates higher-order moments of reliable earthquake catalogs to resolve lack of uniqueness in equivalent statistical distributions discovered in the two-point correlation analysis; (2) Studies the properties of a recently proposed test for stationarity of an earthquake catalog. The tests are to be carried out on synthetic earthquake catalogs as well as on real earthquake catalogs, including the Worldwide Catalog; (3) Studies the properties of source-time functions for complex (multiple) sources by assuming that self-similarity for aftershocks is a process that extrapolates into time intervals sufficiently close to the origin of an earthquake so that overlap occurs among the seismic signals from individual components of the complex fracture; and (4) Analyzes the stochastic properties of catalogs of earthquakes that are synthesized from a small set of deterministic parameters.

In the model, an earthquake occurs under a definable set of rheological conditions, and stresses are redistributed. The redistribution of stress, plus the build up due to plate motions, triggers the next earthquake (including aftershocks). Long term changes in patterns of seismicity should be recognizable. Correlations between seismicity patterns and physical parameters are sought.

29. Numerical Modeling of Tsunamis; Philip L. Liu; Cornell University, Department of Environmental Engineering, Ithaca, NY 14850; **Award #78-15358 A01**; $59,964 for 12 months beginning May 1, 1980

Tsunamis are generated primarily by undersea earthquakes of shallow focus depth during which vertical dislocations of the sea floor occur. Large tsunamis present major hazards to life and property. To minimize loss, it is essential to develop an accurate and efficient computation method describing the generation, propagation, and amplification of tsunamis. This project is primarily devoted to the problem of tsunami wave generation, including non-linear and dispersion effects.

In this study, the Boundary Integral Equation Method (BIEM), which can solve free surface flow problems more efficiently and economically than either finite difference or finite element methods, is formulated, investigated, and applied to tsunami problems. Special attention is paid to the examination of (1) two-dimensional problems (such as landslide-induced waves and topographic effects), (2) axially symmetric problems, (3) three-dimensional problems (numerical procedures and solutions), (4) numerical approximation, (5) higher order representation, (6) open boundaries situations, and (7) to the development of a general numerical analysis computer program.

30. United States-Republic of China Research in Earthquake Engineering—Part II; Le-Wu Lu; Lehigh University, Department of Civil Engineering, Bethlehem, PA 18015; **Award #77-07470 A03**; $6,200 for 4 months beginning April 1, 1980

This amendment provides supplemental funds to cover increased costs for test specimens and fixtures for the United States-Taiwan Cooperative Science Program. The objective of this cooperative program between Lehigh University (LU) and the National Taiwan University (NTU) is to study fundamental subjects in siting and design and to obtain technical information which will benefit both countries.

This project deals with earthquake resistance and strengthening of concrete buildings with foundation settlement and partial structural damage. This problem is of major concern to engineers because of the increased height of new buildings. Both analytical and experimental studies are conducted to investigate the earthquake response and the strength, stiffness, and damage characteristics of such structures in an effort to improve engineering design and practices.

31. Research Initiation—Indirect Damage Assessment of Trusses Subjected to Earthquake Loads; Vernon C. Matzen; North Carolina State University at Raleigh, Department of Civil Engineering, Raleigh, NC 27607; **Award #80-07389**; $40,000 for 15 months beginning May 15, 1980

This research develops a procedure for the indirect assessment of damage to planar, linear elastic trusses. Information is used about excitation and response at selected degrees-of-freedom. Both static and dynamic loading are considered. The heart of the procedure is a system identification computer program which finds the set of parameters in a mathematical model for which the squared weighted error between the measured response and computed response is a minimum. Information from the identification algorithm is used to determine where sensors must be located on the structure and what loading cases must be used in order to find all parameters. The assessment of damage is made by noting any change in values of the parameters (member stiffness) that occurs during an earthquake. By comparing the values before and after the disturbance, it should be possible to determine which members have been damaged and the extent of damage. The procedure can be verified with static and dynamic (shaking table) laboratory experiments. The models considered are one- and two-story trusses in both determinate and indeterminate configurations.

32. International Workshop on Earthen Building Materials and Methods in Seismic Areas; Gerald W. May; University of New Mexico, Department of Civil Engineering, Albuquerque, NM 87106; **Award #79-19671**; $34,935 for 18 months beginning April 15, 1980

This project is for the planning, management, and documentation of an international research workshop on improvement of the seismic resistance of earthen low-rise buildings. The workshop brings together domestic and foreign researchers (1) to develop a clear statement of the problems associated with earthen low-rise buildings in seismic areas; (2) to define the existing state-of-the-art with regard to earthen building materials, design and construction methods; (3) to identify and categorize national and international research findings in related areas and seek to establish their applicability to the seismic design and construction of earthen buildings; (4) to identify appropriate channels for technology transfer across international boundaries and to explore social and economic barriers to such transfer; (5) to identify opportunities for cooperative international research; and (6) to identify and describe gaps in present knowledge and to define research needs. The workshop is to be held at the University of New Mexico, Albuquerque in the fall of 1980.

33. Seismic Behavior of Masonry Structures; Hugh D. McNiven; University of California, Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #79-08251 A01**; $123,737 for 12 months beginning May 1, 1980

    Masonry structures are particularly susceptible to earthquake damage because of their relatively low shear strength and moment resistance. This project continues an integrated research program of experimental and analytical studies on masonry structures. The experimental work conducts shaking table tests of single-pier specimens and double-spandrel girders and detailed parametric analysis to provide an adequate base of experimental data from which analytical models can be developed. The research correlates experimental results with predictions of various mathematical models.

    Work during the project period includes: (1) exploratory studies of mathematical models relating loading and deformation; (2) investigation of hysteretic behavior of masonry piers; (3) prediction of ultimate strength of the shear, flexural, and sliding models of failures; and, (4) evaluation of the adequacy of existing building codes.

34. Evaluation of Techniques for Predicting Soil Liquefaction and *In Situ* Shear Wave Velocity; Cyril M. McRae; J.H. Kleinfelder & Associates, 1501 N. Broadway, Suite 308, Walnut Creek, CA 94596; **Award #79-18559**; $78,220 for 12 months beginning May 15, 1980

    Although methods are available for estimating and predicting liquefaction potential for specific sites, these methods lack an effective procedure for correlating field data with liquefaction potential. There is a need to verify and compare newer prediction methods, which use soil-structure measurements as a part of the analysis, with methods established under actual field conditions.

    Data are obtained from sites in areas of high seismicity underlain by deposits considered to be subject to liquefaction. Evaluations are performed on sites near the San Andreas fault, where evidence indicates liquefaction during the 1906 San Francisco Earthquake. The established method correlates liquefaction potential with adjusted field Standard Penetration Test (SPT) data. The new method correlates liquefaction potential with a Structure Index derived from field measurements by an electrical probe.

    A second part of this research studies the relationship between seismic shear wave velocity and Structure Index (one of the parameters derived from the electronic probe measurements). Data will be compared to relationships reported to have been established between SPT values and shear wave velocity.

35. Seismic Reliability of Damaged Reinforced Concrete Buildings; Christian Meyer; Columbia University, Department of Civil Engineering and Engineering Mechanics, New York, NY 10027; **Award #79-24695**; $84,467 for 18 months beginning May 1, 1980

    The purpose of this research is to develop a reliable and practical procedure by which existing building damage can be identified and residual strength estimated. Specific tasks are: (1) development of a damage model; (2) development of a response prediction model; (3) development of a reliability model; and (4) development of a practical method of damage and reliability assessment. Based upon the results of these studies, improved design guidelines are developed and recommendation for retrofitting of damaged buildings are made.

36. U.S. Earthquake Intensity Data File; Herbert Meyers; Solid Earth Geophysics Division, National Geophysical and Solar-Terrestrial Data Center, National Oceanic and Atmospheric Administration, Boulder, CO 80302; **Award #80-05552**; $44,000 for 12 months beginning June 15, 1980

    Since 1928, NOAA has published the annual "U.S. Earthquakes" and "Earthquake History of the U.S.". This project is designed to complete a digital file representing the earthquake intensity data in these publications. These publications are the official record of earthquake intensity and damage in the U.S. They are the basis for many decisions relating to siting and structural design. The availability of a computerized file will make it much simpler for planners, engineers and seismologists to determine the earthquake intensity history for any community or region. It will provide a convenient file for computer analysis of the effect of various types of earthquakes.

    The information in the Earthquake Intensity File includes the name, coordinates and intensity for each community feeling the effects of an earthquake. In addition, earthquake parameters (magnitude, coordinates, depth, etc.) are included.

37. A Study of Power Spectral Density of Recorded Earthquake Accelerograms; Bijan Mohraz; Southern

Methodist University, Department of Civil and Mechanical Engineering, Dallas TX 75275; **Award #80-04824**; $66,753 for 24 months beginning June 15, 1980

This research will perform statistical analyses to study the mean power spectral densities of accelerograms, and to correlate statistical summaries of these power spectral densities with earthquake ground motion and response spectra. Influences of site geology, magnitude, epicentral distance, peak ground acceleration and the duration of strong motion on the power spectral density will be examined. For each influence, the mean power spectral density will be obtained by groupings accelerograms, generating their power spectral density normalizing individual power spectral densities to the same variance, and computing the mean spectra at various frequences. Relationships between peak ground acceleration and variances of the power spectral density will be established which will make it possible to obtain the mean power spectral density for any specified site acceleration.

38. Research Initiation—Seismic Considerations for Compliant Offshore Structures; James R. Morgan; University of Houston, Central Campus, Department of Engineering, Houston, TX 77004; **Award #80-06467**; $36,956 for 15 months beginning May 15, 1980

Compliant offshore platforms have been suggested as an alternative to traditional gravity structures for deep water applications. The use of compliant structures would make exploration for and production of oil and gas possible when traditional platform designs would prove financially prohibitive.

Compliant structures are designed to reduce the effects of water waves, but may be more vulnerable to the effects of earthquake ground motion. This research investigates the behavior of an inverted pendulum during ground motion. The resistance function for the pendulum includes a bouyant restoring force and the possibility of mooring lines and represents typical compliant offshore structures. Efforts focus on the identification of design parameters which are particularly sensitive to seismic excitation.

39. Seismic Safety and Public Policy Processes: A Study of Three Jurisdictions in San Bernardino County, California; Richard S. Olson; University of Redlands, Department of Political Science, Redlands, CA 92373; **Award #79-23495**; $194,104 for 24 months beginning June 1, 1980

This study focuses on factors which facilitate or impede the initiation, adoption and implementation of measures to improve local seismic safety. Measures considered include those which would decrease pre-impact vulnerability and those related to increasing post-impact response capability. The research is conducted in three jurisdictions in California: the cities of San Bernardino and Redlands, and the County of San Bernardino. Sources of data include interviews with community decision-makers and observers, and public documents and newspapers. Information is gathered on how seismic safety issues and question have been dealt with during the last ten-year period and the current status of hazard mitigation measures. Several hypotheses on public policy development are tested in order to improve the basis for effective decision-making.

40. Fire Loss in Earthquakes; Irving J. Oppenheim; Carnegie-Mellon University, Department of Civil Engineering, Pittsburgh, PA 15213; **Award #79-23350**; $124,111 for 12 months beginning June 1, 1980

Fire-induced loss of life, property, and services is a severe potential earthquake effect, but no procedure exists whereby it might be estimated. This is partly because the body of data from past earthquakes is inadequate to permit extrapolation. While attempts have been made to model loss as a function of fire-causing and fire-limiting variables, such procedures have not been applied to the problem of earthquake-caused damage. The inability to model fire loss prevents planners from assessing the efficacy (or urgency) of mitigation procedures.

This research models fire loss as a function of three vectors: conflagration potential (CP), ignition frequency (IF), and fire loss suppression (FLS). At the disaggregate level, it is possible to adapt analytical models, to use extensive non-earthquake data, and to employ subjective opinion in generating estimates of a loss function. In a sample application, parameters are generated for one CP, over a representative range of IF and FLS; data requirements for other ranges of the variables are identified. Existing procedures can then be used to calculate the direct effects of an earthquake, which are an increase in IF and a decrease in FLS. With fire losses expressed in terms of those variables, expected fire loss due to seismic hazard can be estimated.

41. Factors Affecting the Design and Implementation of Community Disaster Evacuation Plans; Ronald W. Perry; Battelle Memoral Institute, Battelle Human Affairs Research Center, 4000 N.E. 41st Street, Seattle, WA 98105; **Award #77-23697 A02**; $6,400 for 6 months beginning June 15, 1980

Mt. St. Helens erupted on May 18, 1980, significantly affecting the social and physical environments in its immediate vicinity and throughout a large region of the West. Protective actions undertaken by responsible officials near Mt. St. Helens included evacuating residents who seemed at risk. A record of this and other responses to the volcano hazard is being developed by researchers and should be useful in planning for future responses to various kinds of environmental hazards, including earthquakes and floods.

This research is conducted under a supplement to an earlier current award, entitled "The Design and Implementation of Community Disaster Evacuation Plans." This supplemental research focuses upon prob-

lems related to evacuating threatened populations in four communities. The research team initiate a quick response data collection effort while events are still fresh in the minds of those involved in emergency actions associated with the Mt. St. Helens disaster. Because of previous research conducted on the Mt. St. Helens volcano hazard by the PI, this new effort provides a rare before-and-after perspective on social response to the disaster.

42. Seismic Behavior of Structural Components; Egor P. Popov; University of California, Berkeley, Department of Civil Engineering, Berkeley, CA 94720; **Award #79-08984 A01**; $501,624 for 12 months beginning April 1, 1980

    An important goal of earthquake engineering research is to establish reliable predictive capabilities for inelastic structural response under intense ground shaking. This project undertakes an integrated research program of experimental and analytical studies to achieve this goal.

    The project conducts experimental research on the seismic behavior of various types of (1) braced steel frames, (2) reinforced concrete, (R/C) walls and infilled frames, (3) R/C ductile frames (4) R/C beam column components, and (5) develops computer programs incorporating both experimental and analytical data. In the experiments, large-scale components of structural systems are designed, fabricated, and laboratory tested by subjecting them to loading in a quasi-static manner simulating earthquake motions. The results of the experimental work are used as the basis for the construction and verification of mathematical models of structural components. The analytical work and experimental efforts are complementary, so that the capabilities for analyzing the inelastic behavior of structural components can be broadened. The research findings of this project will lead to a better understanding of structural behavior and improved methods of analysis and design of earthquake-resistant steel and reinforced concrete structures.

43. Development of Collaborative United States—Japan Socio-Behavioral Disaster Research; Enrico Quarantelli; Ohio State University, Department of Sociology, Columbus OH, 43210; **Award #80-09036**; $20,650 for 12 months beginning June 1, 1980

    Extensive research has been conducted in the United States and Japan on preparations for responses to, and, recovery from earthquakes and other types of disasters. This project will determine what comparable work has been done in the two countries and the possibility for collaborative socio-behavioral disaster studies. Specifically, the study will: (1) examine relevant socio-behavioral disaster studies and producing an inventory of the empirical work in both countries; (2) organize a conference in Japan between leading Japanese disaster researchers and American researchers to discuss possible joint and common studies that might be undertaken; and (3) recommend a program of research priorities as well as alternative structural strategies and institutional arrangements for collaborative work.

44. Cyclic Moment Characteristics of Semi-Rigid Steel Beam-Column Connections; James B. Radziminski; University of South Carolina at Columbia, Department of Civil Engineering; Columbia, SC 29208; **Award #79-23520**; $62,916 for 18 months beginning May 15, 1980

    An analytical and experimental study is conducted to determine the static and cyclic moment-rotation behavior of steel beam-to-column connections (commonly designated "semi-rigid" or "wind moment" connections). The connections include beam web angles and clip angles fastened to the top and bottom flanges of wide flange beam sections and to the flanges of supporting column sections.

    From the investigation of the cyclic behavior of semi-rigid connections, the earthquake resistance of existing buildings utilizing wind moment connections can be evaluated more completely. In addition, this study determines the effectiveness of adding flange clip angle as a means of retrofitting structures with simple framing, for improvement of their earthquake resistance. This is particulary significant for older structures constructed in low seismic-risk areas or designed to less stringent seismic code provisions than those currently in effect.

45. The Impact of Volcanic Ash Fallout on Eastern Washington: Perceptions and Behaviors Related to Health and Housing; Marsha L. Roberts; Washington State University, Department of Child and Family Studies, Pullman, WA 99163; **Award #80-20874**; $11,564 for 3 months beginning June 15, 1980

    Twelve hundred persons living in Eastern Washington at the time of the major eruption of Mt. St. Helens were mailed a questionnaire designed to ascertain the following: (1) What health and safety-related behaviors were employed during the fallout? (2) What sources of information were used when making health and safety decisions? (3) What current and projected levels of safety both to property and self are perceived? (4) To what extent is the perception of safety, or the lack thereof, related to plans to maintain or change current housing or place of residence? and (5) To what degree do differences in persons' orientation to issues of control relate to the above variables? The relationships between selected personnel and family variables, as well as the amount of ash fall they experienced, will be examined against the information gathered through the questionnaire.

46. Dynamic Stiffness of Pile Foundations; Jose M. Roesset; University of Texas-Austin, Department of Civil Engineering, Austin, Texas 78712; **Award #79-20956**; $299,773 for 24 months beginning May 15, 1980

A combined analytical and experimental study is conducted of the dynamic stiffness of isolated piles and pile groups under low and high levels of excitation. For low levels of strain, a comparison of existing design methods is made using test results from small scale piles. Of particular interest are the variation of stiffness with frequency, and the magnitude of the radiation damping.

For high levels of excitation, the research evaluates various nonlinear soil models, determining appropriate parameters from laboratory tests. Using these models in continuum solutions, researchers are matching the results that would be obtained from curves for lateral and axial cyclic static loading. A number of static field tests are also conducted.

47. Natural Disaster Mitigation and Recovery: Enhancing the Dissemination of Research Results to State and Local Officials; Claire B. Rubin; Academy for Contemporary Problems, 400 North Capital Street, N.W., Washington, D.C. 20036; **Award #79-24999**; $144,463 for 12 months beginning March 1, 1980

The purpose of this project is to enhance the dissemination and utilization of research results related to natural hazards mitigation, response and recovery.

Specific objectives are to: (1) maximize the use of existing research results and resources by local and State officials; (2) create a stronger tie between the hazards and disaster research community and government officials responsible for emergency management; (3) document and disseminate the positive experiences of states and communities in achieving long-range recovery and mitigation; and (4) foster hazard mitigation efforts and long-term recovery planning among State and local officials.

Project tasks include: (1) a literature review; (2) development of research summaries; (3) review of relevant organizational experience in the hazards field; (4) development of a record of organizational experience in hazards reduction and response; (5) distribution of information; and (6) creation of a Resource Referral Service. This project is also being supported by the Federal Emergency Management Agency.

48. Research Initiation—A Preliminary Evaluation of the Liquefaction and Cyclic Mobility Behavior of Fine Coal Refuse Tailings; Roger K. Seals; West Virginia University, Department of Civil Engineering, Morgantown, WV 26506; **Award #80-07093**; $40,000 for 15 months beginning May 15, 1980

The liquefaction and cyclic mobility behaviors 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 their 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.

49. *Induced Seismicity at Nurek Reservoir, Tadjikistan,* USSR; D. W. Simpson; Columbia University, Lamont Doherty Geological Observatory, Palisades, New York 10964; **Award #79-09794**; $80,197 for 12 months beginning May 1, 1980

Reservoir-induced seismicity is occurring at the Nurek Dam in Tadjikistan Soviet Central Asia. As the reservoir has filled a marked increase in local seismicity has been observed. The average level of seismicity within 10 km of the reservoir has increased by a factor of 4 since the reservoir first began to fill in 1969. Changes in the level of seismicity appear to be related to changes in the rate of filling. Increasing the rate of filling leads to temporary decreases in seismicity, whereas an abrupt decrease in the filling rate causes increased seismicity.

Nurek is especially suited for the study of reservoir-induced seismicity because it is the highet (315 m) dam in the world and the most seismically active reservoir at the present time. This project continues monitoring of seismicity by the telemetered network of seismograph stations around the reservoir, and analyzes the extensive collections of data gathered during the early states of this project. The ultimate goal of the research is to establish the physical relationships between induced seismicity and reservoir filling and to investigate the impacts on dam safety.

50. Effects of Earthquake Motions on Reinforced Concrete Buildings; Mete A. Sozen; University of Illinois-Urbana, Department of Civil Engineering, Urbana, Illinois 61801; **Award #78-16318 A01**; $269,070 for 12 months beginning April 1, 1980

The objective of this study is to develop behavioral information to improve design methods, and to investigate the effect of abrupt changes in stiffness on the response of structural frames and frame-wall combinations in the nonlinear range of response.

The principal experimental program involves small-scale structures subjected to simulated earthquake motions. The scope of the work includes: (1) Tests of a nine-story frame with a tall first story; (2) Tests of three nine-story structures, each comprising two frames and a wall; (3) Development of analytical models to interpret and expand the scope of the experimental results; (4) Comparative studies of the observed behavior of all types of structures tested in the course of the project (coupled walls, frames, and frame-wall combinations); and (5) Synthesis of the resulting information develop practical methods for proportioning structures and for selecting structural systems for earthquake resistance.

The amount and distribution of reinforcement in each test structure are based on a simple "design model" which reflects the influence of design decisions made concerning the tolerable damage in different structural elements. Thus, each test run of each

structure serves as a physical test of a design approach as well as producing data to be used as a benchmark for the inelastic-response model.

51. Response Statistics Due to Earthquakes With Evolutionary Spectra; Pol Spanos; University of Texas-Austin, Department of Aerospace Engineering, Austin, Texas 78712; **Award #80-06569**; $68,375 for 24 months beginning June 1, 1980

    This research uses probabilistic approaches to study linear, nonlinear, and inelastic response of structures to seismic excitation. Ground motion is modeled by an evolutionary random process to account for the nonstationarity of the motion. The distributed element model for hysteresis is used to investigate inelastic characteristics of the structural response. The technique of stochastic averaging is used to obtain a first-order differential equation governing the evaluation of the response amplitude. The solution of this equation provides the time-dependent statistics of the structural response. This research is expected to lead to the development of refined methods for analysis and design of structures under random-type earthquake loading.

52. Research Initiation—Teleseismic Analysis of Hazardous Earthquakes; Seth Stein; Northwestern University, Department of Geological Sciences, Evanston, IL 60201; **Award #80-07166**; $39,951 for 15 months beginning May 15, 1980

    The objective of this research is to study teleseismic data from global networks to determine the classes of earthquakes which pose major seismic hazards. Large destructive earthquakes occured in 1638 and 1755 off Cape Ann, Massachusetts, prior to instrumental seismology. Similar large earthquakes along the geologically identical continental margin in Canada in this century are studied to determine seismic risk along the eastern U.S. coast. Investigation of historic earthquake data will help to determine the nature of the long-period motions of sources and the relation of long-period motion to engineering hazards assessment. Large reservoir-induced earthquakes are examined to improve the quality of focal mechanism determinations, and to relate the depth moment and rupture processes to the physical processes and hazards.

53. Earthquake Hazard Mitigation Through Land Use Management: A Guide for Planners and Public Officials; Charles Thurow; American Planning Association, Research Division, 1314 East 60th Street, Chicago, IL 60637; **Award #79-15290**; $87,273 for 9 months beginning May 15, 1980

    This project reviews research and prepares a guidebook on the topic of Earthquake Hazard Mitigation and Land Use Planning. The guidebook is written primarily for use by professional planning staff in local government agencies as a primer on earthquakes and earthquake hazards and as a guide-to-practice manual on land use related techniques to avoid or lessen the impact of seismic hazards.

    The objective of the guidebook is to gather information on earthquakes and land use-related techniques. The project includes a search of existing literature, interviews with planning agency staffs and individuals with expertise in the field of earthquakes and earthquake hazard mitigation. The guidebook will be a much needed synthesis of information on earthquakes and land use related mitigation techniques for use by public officials and professionals in day-to-day land use decisions.

54. Tsunami Risk Analysis; Chi C. Tung; North Carolina State University at Raleigh, Department of Civil Engineering, Raleigh, NC 27607; **Award #80-05553**; $71,089 for 24 months beginning June 1, 1980

    Tsunamis, long ocean waves generated principally by sea bed dislocations during earthquakes, constitute one of the most destructive natural hazards in terms of loss of life and property. This project addresses the problem of risk analysis in tsunami situations. Historic data on tsunami events and seismotectonic information are used to obtain probabilistic properties of tsunamis and associated ground motion characteristics. Existing methods of computation of tsunami generation, propagation, and coastal effects based on hydrodynamic considerations are incorporated in the risk analysis. Emphasis of this research is placed on the examination of the effects or uncertainties of the statistical and non-statistical information on risk and the use of the Bayesian statistical method for the incorporation of these uncertainties.

55. Research Initiation: Development of a Model Recertification of Buildings Process; Ralph Warburton; University of Miami, Department of Architecture and Planning, Coral Gables, Florida 33124; **Award #80-07119**; $40,000 for 15 months beginning May 15, 1980

    This research program concentrates on the study of recertification procedures for existing buildings located in seismically active region. Existing buildings are a serious problem for all natural hazard areas because a large number of such structures may not provide adequate safety for occupants. Simply replacing all suspect structures is not economically feasible. Procedures are needed to identify the degree of hazard in existing structures and to determine what type of model ordinances for building evaluation might be appropriate for recertification of existing structures.

    Dade County, Florida provides an excellent opportunity for the study of building recertification procedures based on a county recertification ordinance adopted in 1975. This ordinance applies to structures over 40 years old and provides a valuable data base for comparison with similar data from seismic areas contemplating similar ordinances.

56. Assessing Vulnerability to Volcanic Ashfall in East Central Washington: Decision-Making and Adjustments in the Agricultural Section; Richard A. Warrick; Clark University, Center for Technology, Environment, and

Development, Worcester, Massachusetts 01610; **Award #80-20877**; $9,375 for 3 months beginning July 1, 1980

This research is concerned with the vulnerability of agricultural systems in Eastern Washington to the ashfall eruption of Mt. St. Helens. The study focuses on the processes by which vulnerability is increased or decreased as farmers experience, perceive, and adjust to the continuing adverse impacts of the ash. Principal research objectives are: (1) to determine the factors which guide decisions by farmers regarding adjustments to actual and anticipated ashfall effects; and (2) to discover and document which actions or adjustments are effective in coping with the impacts, and which may exacerbate the problems under different conditions. The study employs a combination of interviews and field observations in the area of heaviest ashfall.

57. Seismic Design for Gravity Retaining Walls; Robert V. Whitman; Massachusetts Institute of Technology, Department of Civil Engineering, Cambridge, Massachusetts 02139; **Award #79-19666**; $191,123 for 24 months beginning May 15, 1980

    This research utilizes an approach to the design of gravity retaining walls which is based on deformation limits rather than the normally used strength criteria. The approach was first suggested by R. Richards and David Elms in New Zealand. Specific studies undertaken are: (1) Theoretical studies using improved versions of the Richards-Elm model; (2) Theoretical studies using a specific finite element program wherein the soil is linear (with properties adjusted for strains) except along a preselected failure surface where thin frictional elements are used; and (3) Planning for shaking table tests and for tests aboard a large centrifuge. This research is being carried out in cooperation with Richards and Elms.

58. Research Initiation—Foundation Flexibility Effects in Seismic Super-Structure-Subgrade Interactions; W. L. Whittaker; Carnegie-Mellon University, Department of Civil Engineering, Pittsburgh, Pennsylvania 15213; **Award #80-07090**; $39,940 for 15 months beginning May 15, 1980

    The objective of this research to investigate the role of foundation flexibility as an issue in superstructure interaction analysis for the combined system of superstructure, foundation, and a continuum subgrade. The analysis is performed in the framework of a global harmonic impedance solver. The work is a departure from existing analysis in that here both the flexibility and the three-dimensionality of foundation plates are considered. Cases for analysis are selected to illustrate the relative importance of geometric and material parameters, with special attention to foundation plate flexibility.

59. Experimental Investigation of Reinforced Concrete Beam-Column Connections Subjected to Earthquake-Type Loading; James K. Wight; University of Michigan, Department of Civil Engineering, Ann Arbor, Michigan 48109; **Award #78-24556A01**; 62,668 for 12 months beginning May 1, 1980

    Twenty-four internal and external beam-to-column connections are constructed and subjected to laboratory loading that simulates earthquake-type loading. In order to simulate real beam-to-column subassemblages, half of the specimens have a floor-slab and transverse beams in addition to the main beam and columns. The other half of the specimens are "bare" connections intended to serve as benchmarks for comparison with existing experimental data. The results of the experimental investigation to date compare closely with design recommendations recently presented by Joint Committee 352 of the American Concrete Institute and the American Society of Civil Engineers.

    An analytical investigation parallels the experimental studies. The first phase of this project developed a mathematical model capable of reproducing the experimental results. This second phase incorporates the model into an inelastic structural analysis program and studies its effect on the seismic response of various buildings.

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. The objective is achieved by supporting basic and applied investigations of the physical, chemical and biological changes that occur as a result of processing. Research at the interface of food science and nutrition are encouraged, as are proposals that stress interdisciplinary research and research in disciplines not traditionally involved in nutrition research.

1. Dietary Fibers and Bioavailability of Nutrients; George V. Vahouny; George Washington University, Department of Biochemistry, Washington, DC 20052; **Award #79-18561**; $59,587 for 24 months beginning February 15, 1980

    The overall objective of these studies is to elucidate, by direct approaches, the mechanism(s) by which *"natural" dietary fiber and purified fiber constituents* affect bioavailability of macro- and micronutrients in the gastro-intestinal tract. The experimental model uses rats which have been trained to ingest an entire daily allowance within a two hour period. Their purified diets contain wheat bran, alfalfa meal, cellulose, hemicellulose, pectin, lignin, or cholestyramine.

These animals are used in three separate approaches. The first studies bioavailability of nutrients—glucose, methionine, oleic acid, cholesterol, starch, albumin, triolein, Cu^{2+}, Zn^{2+} and Na^{+}. These studies are designed to provide definitive data on gastric emptying, intestinal transit, colonic retention, absorbability of the nutrient, digestion of carbohydrate, protein and lipid, composition of colonic and fecal acidic steroids, and excretion of specific trace elements. The second approach includes *in vitro* studies designed to differentiate between bulk phase effects of the diets and direct effects on transepithelial transport of specific nutrients. The third is a study of the specific effects on intestinal cell cytokinetics including epithelial cell turnover, functional maturation of epithelial cells and goblet cell secretory activity.

SCIENCE AND TECHNOLOGY TO AID THE HANDICAPPED

In Fiscal year 1980, 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. A General-Purpose System for the Synthesis by Rule of Natural-Sounding Speech; Ignatius G. Mattingly; Haskins Laboratories, Inc., 270 Crown Street, New Haven, CT 06510; **Award #80-06144**; $227,443 for 24 months beginning June 15, 1980

   This project develops a set of rules for the synthesis of General American English and a computer system for synthesis of natural-sounding speech from these rules. The project is of practical interest (because of the need for improved synthetic speech in devices to aid the handicapped and other applications) and of scientific interest (because of the light it may shed on the production and perception of phonetic units). The quality, intelligibility, and comprehensibility of speech that can now be synthesized by rule still falls well short of natural speech.

   Even moderate degradation of speech, as judged by its intelligibility, has a very significant adverse effect on its comprehensibility. This project concentrates on phonetic as distinct from phonological aspects of the problem, takes the syllable as the unit of processing, and emphasizes timing rules. While the primary objective is to produce synthetic speech of high quality, an important secondary objective is to make a system that phoneticians can easily use.

2. Speech Perception in Noise by the Hearing Impaired; Bertram Scharf; Northeastern University, Department of Psychology, Boston, MA 02115; **Award #80-06146**; $210,386 for 24 months beginning June 15, 1980.

   A series of experiments examines the psychoacoustical bases for poor speech perception in noise by persons with sensorineural impairment. Two major hypotheses are being tested. First, because persons with cochlear impairment are less able than normal-hearing persons to separate incoming signals on the basis of spectral differences (a deficit referred to as reduced frequency selectivity), they are less able to localize one sound in the presence of other sounds. Second, this reduced localization ability makes it difficult for the hearing-impaired person to take advantage of the spatial separation of a target speech source and other interferring sources. Such separation is common in real environments and facilitates speech perception by normal-hearing persons.

   Tests on these hypotheses, and of the general notion that reduced frequency selectivity is a prime cause of impoverished speech perception in sensorineural impairment, are conducted by means of detailed psychoacoustical measures of frequency selectivity (and the critical band) and of localization and speech perception under masking. Tone bursts, bands of noise, computer-synthesized speech, and natural speech will be presented via earphones or via loudspeakers in a free field. These data should provide a basis for developing binaural hearing aids with appropriate signal processing.

3. Capuchin Monkeys as Aides for the Severely Disabled; Mary J. Willard; New England Medical Center Hospital, Rehabilitation Institute, Boston, Massachusetts 02101; **Award #80-01936**; $48,572 for 12 months beginning July 1, 1980

   A small pilot project to train capuchin monkeys as aides for the severely disabled has shown that monkey helpers are able to perform many tasks for the handicapped, supplementing the assistance provided by personal care attendants and mechanical devices. The goal of this project is to train two capuchin monkeys to perform as aides for two disabled individuals in their respective home environments. This requires that the animals master a variety of helping skills and behaviors. Operant conditioning procedures will be used to achieve these objectives. Determining which procedures best achieve these objectives is the focus of this research. A training manual is being written detailing the training program found to be more effective.

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