NSF/RA-790564

# Recent Awards: October-December 1979

**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 the awards made by PFR during the period October 1 through December 31, 1979 (first quarter, Fiscal Year 1980). The data have been reconciled with the NSF's Management Information System.

## PROTOCOL FOR SCIENTIFIC AND TECHNICAL COOPERATION IN EARTHQUAKE STUDIES:

## U.S. AND PEOPLE'S REPUBLIC OF CHINA

On January 24, 1980, the Directors of the National Science Foundation (NSF), the U.S. Geological Survey (USGS), and the State Seismological Bureau for the People's Republic of China (PRC) signed a Protocol for Scientific and Technical Cooperation in Earthquake Studies. The U.S. and the PRC have, for their mutual benefit, agreed to jointly organize and conduct scientific conferences, symposia, and lectures; to support cooperative research projects; and to exchange scientists and information.

Several NSF programs, including the Earthquake Hazards Mitigation program in NSF's Division of Problem-Focused Research (PFR), the Geophysics program in NSF's Division of Earth Sciences (EAR), and NSF's Division of International Programs (INT) will participate in these cooperative activities. Cooperation will be in the fields of earthquake prediction (primarily under USGS); earthquake engineering and hazard mitigation research (primarily under PFR/NSF), and basic and fundamental studies of earthquake phenomena (primarily under EAR/NSF).

For more information, write: U.S.-PRC Protocol, Attention: Ramona Lauda, Room 1134A, NSF, 1800 G Street N.W., Washington, D.C. 20550.

## UNSOLICITED RESEARCH PROPOSALS

Persons wishing to submit unsolicited research proposals to the Division of Problem-Focused Research should read the PFR section of the *Fiscal Year 1981 Budget to the Congress* to be certain that the proposed research meets current program objectives. The NSF Publication *Grants for Scientific Research* (NSF 78-41) should be used in preparing unsolicited proposals. These publications, plus a PFR Management Directory, can be obtained by writing to the Professional Assistant, PFR, Room 1134 A, NSF, Washington, D.C. 20550. General information on PFR, EAS or NSF can also be obtained from the Professional Assistant.

## 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 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 ammendment number, if applicable.
5. **Amount, Duration and Starting Date of the 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 program 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. Development of Tissue Culture Systems for Guayule; Toshio Murashige; University of California-Riverside, Department of Botany and Plant Sciences, Riverside, CA 92521; **Award #78-25829 A01** $80,634 for 12 months beginning January 1, 1980.

   This award provides continuing support to develop tissue culture systems for guayule which can be used to enhance the efficiency of the plant breeding program. During the first year of the project, methods were developed to establish callus and cell suspension cultures, and to regenerate whole plants from callus and explants. In the second year, the emphasis will be to achieve embryogenesis and plant regeneration from cell suspension and to regenerate haploid plants from anther and pollen cultures.
2. Regeneration, Selection and Evaluation of Plants From Protoplasts of Potato; James F. Shepard; Kansas State University, Department of Plant Pathology, Manhattan, KS 66506; **Award #77-12161 A02** $100,000 for 12 months beginning February 1, 1980.

   This research is developing the technology by which mutants of potato leaf protoplasts with certain desirable characteristics can be constructed, selected and regenerated into useful cultivars of potato.

   During the first two years of the project, a highly efficient procedure was developed to regenerate plants from potato leaf protoplasts. Some of the "clones" so regenerated displayed considerable resistance to early and late blight fungal diseases. Selected clones have given twice the yield of tubers than did the parent "Russet Burbank" cultivar in field trials in North Dakota. During the third and final year, emphasis will be on the selection of higher yielding clones with increased resistance to virus and other fungal diseases.

## 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. Simulation of Strong Earthquake Motion With Contained Explosive Line Source Arrays; G. R. Abrahamson; SRI International, 333 Ravenswood Avenue, Menlo Park, CA 94025, **Award #79-20722** $255,063 for 12 months beginning January 1, 1980.

   This award provides additional support for studying the use of a contained-explosion array technique for generating earthquake-type ground motion in soils. The technique uses line sources consisting of a steel canister in which explosives can be detonated and the explosive products vented into a rubber bladder, which transmits the energy into the surrounding soil. In this way, amplitude and frequency content can be controlled. With a suitable arrangement of line sources and explosive delay times, earthquake-like ground motions can be simulated for use in studying dynamic soil behavior and response of soil-supported facilities.

   Previous work utilized one-third-scale tests. This work utilizes full-scale line sources to demonstrate

the reusable nature of the sources and to study multiple delayed explosions within a single source to provide additional ground motion generation capability.

2. The Earthquake Applications of Point Process Methodology; David R. Brillinger; University of California-Berkeley, Department of Statistics, Berkeley, CA 94720; **Award #79-01642** $37,166 for 12 months beginning December 1, 1979.

   One important problem in seismic risk analysis is to quantify to the finest degree possible the characteristic locations of earthquakes in time and space. This research develops a point process methodology which treats the earthquake sequence as a stochastic process for such a quantification.

   The specific objectives of this study are to develop sampling properties of estimates of product densities; to extend the weighting procedure for correcting data on probability functions concerning earthquake locations and magnitudes; and to develop improved estimates of product densities and a general approach to the preparation of risk maps.

3. Tsunami Propagation and Run-up Research; George F. Carrier; Harvard University, Department of Applied Science, Cambridge, MA 02138; **Award #79-21774** $50,000 for 12 months beginning December 1, 1979.

   Three studies of the dynamics of tsunamis will be conducted. The first is analysis, via shallow water theory, of the wave which would be generated and propagated when ground motion occurs in the piecewise linear topography typical of shelf and slope geometries in tsunami-producing areas. This study is intended to clarify the role of dispersion, particularly its importance as a function of the characterizing parameters.

   The second study deals with the effect of geometric asymmetry on the wave leakage from a "harbor" oscillating in its fundamental "sloshing mode". This work is expected to give insight into the ringing of harbors which is typical after a strong tsunami.

   The third study analyzes the importance of friction in the run-up process. It is clear that the large-scale features of the first encroachment are not significantly affected by friction, but the subsequent run-down process may be deterred by friction to an extent that it is important in the run-up of any subsequent waves.

4. Cyclic Stress-Strain Parameters of Soil-Structure Interfaces for Earthquake Design of Structures; C. S. Desai; Virginia Polytechnic Institute, Department of Civil Engineering, Blacksburg, VA 24061; **Award #79-14045** $133,771 for 24 months beginning December 15, 1979.

   This research develops stress-strain or constitutive laws for interfaces between structural and foundation media subjected to cyclic earthquake loadings. The stress-strain and strength parameters to define the laws are determined by using a new laboratory dynamic multi-degree-of-freedom shear device capable of simulating loading under various degrees-of-freedom.

   The guidelines and the procedure to be developed can have significant impact on current procedures for design involving analysis of sliding behavior at junctions between structures and foundations, and on determining histories of motions under earthquake loads. Current design procedures often ignore the effects of soil-structure interaction due to dynamic behavior of interfaces. These procedure will permit improvements in design leading to reduced risks of earthquake hazards.

5. Energy Absorption Boundary Mechanisms for Seismically Loaded Structures; Joseph Genin; Purdue University, Department of Mechanical Engineering, Lafayette, IN 47907; **Award #79-02884** $74,877 for 24 months beginning November 1, 1979.

   The objective of this research is to establish criteria for, and gain knowledge of, the energy absorption and dissipation mechanisms contained in general boundary forms for structures such as buildings and bridges. The results should be of significance in establishing design criteria for structures in high risk seismic areas as well as for the design of hardened sites.

   A well-posed boundary value problem is used to study the stability, and hence energy absorption and dissipation mechanisms, for a structure with a most general boundary (foundation) form representing the case when the dynamic forcing function approaches zero. After examining this case for system stability, the question of the contribution of each term in the boundary form to the system's overall stability will be studied.

6. Behavior of Lightweight Concrete Columns for Seismic Effects; Norman W. Hanson; Portland Cement Association, 5420 Old Orchard Road, Skokie, IL 60076; **Award #79-02611** $350,902 for 24 months beginning December 1, 1979.

   This project develops design information for use by structural engineers and code bodies to ensure against catastrophic failures due to unknown design factors for columns of lightweight aggregate concrete. Tests of 19 full-size column specimens will be conducted to establish reinforcement details and design recommendations for the seismic-resistant design of columns in ductile moment-resisting frames.

   Each test specimen represents a portion of a building frame at the joint between column and beams. The column portion extends from midheights of the stories above and below the joint. Repeated and reversed bending requires inelastic hinging in the column adjacent to the joint. Important design

parameters will be evaluated to gain design information to ensure that a reserve of strength exists even after large inelastic deformations have taken place.

7. Earthquake Ground Motion Scaling for the Central United States; Robert B. Herrmann; St. Louis University, Department of Earth and Atmospheric Science, St. Louis, MO 63103; **Award #79-09795** $197,113 for 24 months beginning December 1, 1979.

   Earthquake-resistant design criteria for buildings and fixed civil works in the central United States require improvements to overcome deficiencies due to the lack of strong motion data and an understanding of the earthquake processes for the region. Problems such as excitation of long-period structures at distances of several hundred kilometers from the earthquake source are peculiar to the central United States due to the low inelastic attenuation of seismic energy.

   This research will establish new empirical relations for estimating peak earthquake ground motions in the central United States and generate realistic earthquake ground motion time histories. Observational as well as applied theoretical studies which take into account the specific character of elastic wave propagation in the central United States will be undertaken.

8. Standard Experimental Methods for Determining Seismic Behavior of Structural Components; Helmut Krawinkler; Stanford University, Department of Civil Engineering, Stanford, CA 94305; **Award #79-02616** $97,415 for 18 months beginning December 1, 1979.

   Various user communities have expressed a need for a more systematic approach to experimentation and presentation of data in earthquake-related laboratory investigations of the performance of structures. This project investigates experimental procedures for determining seismic response characteristics of components of structures. A set of recommendations will be developed for experimental work needed to produce reliable information which can serve as a basis for the development of rational design criteria. Specifically, the types of test specimens and experiments needed to evaluate the performance of components will be identified. The low-cycle fatigue characteristics of components will be studied in order to develop recommendations for cyclic loading histories and testing procedures. Parameters needed to describe the behavior of component parts of a structural system subjected to one or several seismic events will be identified. The specific needs to which this research is directed are: (1) to identify the objectives of experimental studies; (2) to develop guidelines for the selection of test specimens, testing procedures, and presentation of experimental data; (3) to establish guidelines for a consistent user-oriented evaluations of experimental data; and, (4) to aid in an evaluation, (and, if necessary, revision) of present national standards concerned with relevant testing procedures.

9. Effects of Vertical Ground Acceleration on Structural Response Under Earthquake Excitations; Y. K. Lin; University of Illinois-Urbana, Department of Aeronautical Engineering; Urbana, IL 61801; **Award #79-19619** $111,960 for 24 months beginning January 1, 1980.

   This research program will use advanced concepts of probability and stochastic processes to develop an analytic procedure for the computation of structural response which fully account for the effects of vertical ground acceleration. It has been common to neglect vertical ground motion when computing structural response under earthquake excitations. This is based on the reasoning that most structures are vertically stiff, and that vertical ground accelerations rarely exceed the magnitude of one gravitational acceleration. Initial calculations have shown that vertical ground motion plays the role of parametric excitation; thus, without being large in magnitude, vertical motion can enhance the destructive effects of horizontal motion. A basic theory will be developed using a simple one-degree-of-freedom linear structural model. The analysis will then be extended to include multi-degree-of-freedom systems, soil and sub-structure compliancy, and nonlinear behavior.

10. Travel and Administrative Services in Support of International Science Activities Sponsored by NSF; Louise Lynch; Courtesy Travel Service, 1629 K Street, N.W., Washington, DC 20006; **Award #77-26877 A07** $10,000 beginning November 8, 1979.

    This award supports scientific exchange visits with the People's Republic of China (PRC) in connection with the Earthquake Hazards Mitigation Program.

11. Methods of Non-Destructive Evaluation of Masonry Structures; James L. Noland; Atkinson-Noland and Associates Inc., P.O. Box 3611, Boulder, CO 80303; **Award #79-16572** $82,737 for 15 months beginning December 15, 1979.

    At present, the structural assessment of existing masonry buildings is based upon visual observations and data obtained from destructive tests of small specimens taken from the buildings. Visual observations can only reveal gross defects, and testing of a sufficient number of speciments from a building to permit a comprehensive assessment may be prohibitive due to cost, time, and aesthetic considerations. Most buildings of unreinforced masonry were constructed when seismic requirements were not in force, and therefore may not be resistant to seismic forces. Regulations are being developed to require

a strengthening of these existing buildings. The objective of this project is to evaluate the building resistance and existing strength properties of building materials by nondestructive methods. This project investigates non-destructive tests used for other materials to determine their applicability to masonry construction. Test methods to be evaluated are: Schmidt hammer, mechanical pulse velocity, ultrasonic pulse velocity, and various vibration techniques.

12. Evaluation of Three-Dimensional Effects on the Response of Earth Dams During Earthquakes; H. B. Seed; University of California-Berkeley, College of Engineering, Berkeley, CA 94720; **Award #79-18267** $111,885 for 24 months beginning November 15, 1979.

    Considerable progress has been made in understanding the behavior of earth dams subjected to earthquake effects. Methods of evaluating both seismic stability and potential deformations have been developed. A serious limitation of many currently proposed design procedures is that the dynamic response analyses used in their development are based on the assumption that the response of an earth dam can be predicted with reasonable accuracy by a two-dimensional or plane-strain type of analysis.

    This is not necessarily true for high dams, which are usually built in relatively narrow valleys. Accordingly, an investigation will be made of the three-dimensional response of typical earth dams to determine the extent to which plane-strain analyses provide an adequate basis for evaluating potential seismic response. Guidelines will be developed to estimate the three-dimensional response characteristics of dams.

13. Dynamic Earth Pressures Using Shaking Table; Mehmet A. Sherif; University of Washington, Department of Civil Engineering, Seattle, WA 98195; **Award #79-09794** $178,002 for 24 months beginning December 1, 1979.

    Using an 8' x 6' x 4' shaking table, pressure transducers and load cells, the static and dynamic earth pressures exerted by sands against rigid scale-model retaining walls will be determined as a function of soil density and moisture content, wall movement, acceleration levels, and water table elevations. The model will be subjected to earthquake-like random dynamic loading. Wall movements to be considered include rotation about the base; rotation about the top; and translational movement of the retaining structure. The results of the model tests will be utilized to estimate the forces on prototype structures subjected to earthquake loading.

14. Methodology for Damage Assessment of Existing Structures; James T. Yao; Purdue University, Department of Civil Engineering, Lafayette, IN 47907; **Award #79-06296** $218,679 for 24 months beginning November 1, 1979.

    At present, the damage assessment of existing structures is performed by a relatively few experienced engineers. This research studies ways to mathematically formulate a methodology for making damage assessments of existing structures subjected to natural hazards. Methods of pattern recognition and the theory of fuzzy sets are used to deal with this problem.

    Tasks include: 1. the definition of structural, as well as nonstructural, damage; 2. the identification of significant parameters; 3. illustration and demonstration of the methodology; 4. limited collection, processing and interpretation of existing and available test data and records; and 5. dissemination of research results.

## 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 to be achieved by supporting basic and applied investigations of the physical, chemical and biological changes that occur as a result of processing. Problems 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. No awards were made under this program in the first quarter of Fiscal Year 1980.

## SCIENCE AND TECHNOLOGY TO AID THE HANDICAPPED

In Fiscal Year 1980, the Science and Technology to Aid the Handicapped program will support 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. No awards were made under this program in the first quarter of Fiscal Year 1980.

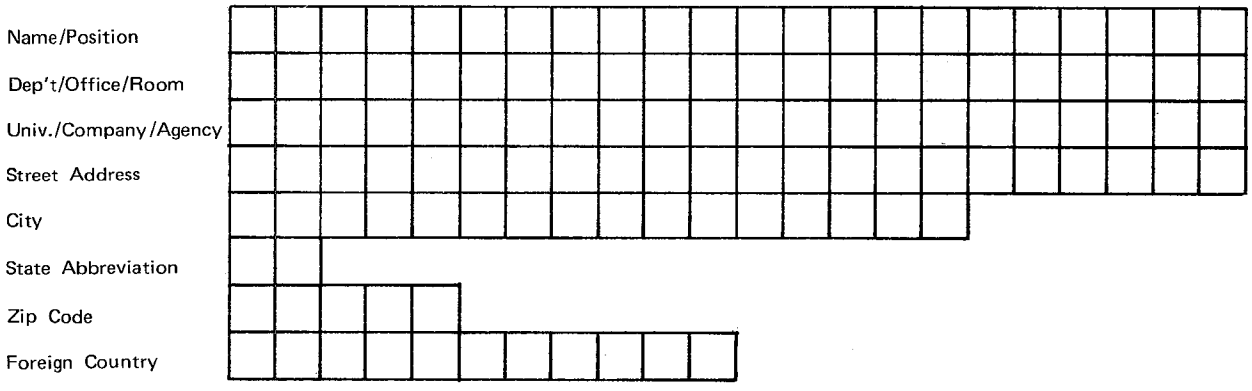
# ENGINEERING AND APPLIED SCIENCE
## Recent Research Reports

*Recent Research Reports* is published approximately four times a year by EAS. *Recent Research Reports* contains abstracts of new technical reports and other documents which result from research supported by the Directorate for Engineering and Applied Science. A typical abstract looks like this:

Cornell University, Department of Structural Engineering
Jimenez-Perez R, Gergely P, White RN
August 1978 375p 7623896
NSF/RA-780328 PB288885/NKS

An experimental and analytical investigation was conducted to assess the transfer of cyclic shear forces in cracked reinforced concrete by means of the interface shear transfer and dowel action mechanisms. Two test series evaluated the transfer of shear forces by the combination of the interface shear transfer and dowel action mechanisms, and the dowel action mechanism alone. The initial crack width and the reinforcement ratios provided at the shear stress intensity were the main variables studied using a test specimen modeled after an idealized section of the cracked structure. The average shear displacement, crack width, and reinforcement strains were measured in each specimen for all load increments. Simplified equations were developed to describe the first loading cycle stiffness exhibited by both the interface shear transfer and dowel action mechanism. A bilinear idealization was proposed for the experimental hysteresis curve of each mechanism together with the corresponding stiffness coefficients. Equations were derived from a nonlinear regression analysis for the splitting failure force for axial or dowel forces, and for their interaction. An equation was also proposed for the ultimate shear stress that can be transferred across a precracked shear plane. The research concluded that shear forces can be efficiently transferred across cracked surfaces by the combined action of the interface shear transfer and dowel action mechanisms.

Document cited in *Recent Research Reports* may be ordered from the National Technical Information Service (NTIS) of the Department of Commerce. If you would like to be placed on our mailing list to receive *Recent Research Reports*, return the form below to Mr. George James, Room 1108, NSF/EAS, 1800 G Street N.W., Washington, D.C. 20550.



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☐ *I WOULD LIKE TO RECEIVE ADDITIONAL INFORMATION, INCLUDING NOTIFICATION OF WORKSHOPS/SEMINARS, FOR THE FOLLOWING PFR PROGRAMS:*

☐ *Alternative Biological Sources of Materials*
☐ *Earthquake Hazards Mitigation*
☐ *Human Nutrition*
☐ *Science and Technology to Aid the Handicapped*

☐ *Check here if your firm is a Small Business*

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